

**INDUSTRIAL REVENUE BONDS:
TESTS OF
CAPITAL STRUCTURE THEORY
AND
SEGMENTATION OF THE TAX-EXEMPT BOND MARKET**

by

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(ABSTRACT)

Industrial revenue bonds (IRBs) possess special tax characteristics which provide an opportunity to test the interest tax shield hypothesis of Modigliani and Miller [1963]. The announcement day excess returns for IRB issues reflect a positive significant market reaction. However, this excess return is unrelated to the tax shield on the debt. Nor is it a function of non-debt tax shields, a proxy for an interior optimal capital structure, or the risk of the issue. It is consistent, however, with the argument that IRBs provide a subsidy to issuing firms.

Miller's [1977] equilibrium model predicts that the tax rate of the marginal buyer of debt will be equal to the corporate tax rate. The Miller hypothesis is tested by comparing the yield spread between IRBs and taxable corporate debt. The empirical estimation indicates a segmentation of the market for tax-exempt debt. For short-term issues, the implied tax rate is not significantly different from the corporate tax rate, consistent with Miller's prediction. For long-term issues, the implied tax rate is significantly less than the corporate tax rate and decreases with maturity. This is consistent with the the excess supply of tax-exempts being purchased by individuals in increasingly lower tax brackets.

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1.0 Introduction

One of the most studied issues in corporate finance is the effect that capital structure has on firm value. Various theoretical models have been developed, with firm value implications being closely related to assumptions about the tax code, bankruptcy costs, and information asymmetries. The empirical tests of capital structure theories have likewise resulted in conflicting implications. The purpose of this dissertation is to provide another test of the effect of capital structure changes on firm value. It will be argued that the instruments used in some previous tests violate the critical assumptions of the tax based theoretical models, with the result that a market reaction to the issuance of straight debt has not been observed [Eckbo, 1986]. A unique financing instrument, the industrial revenue bond (IRB hereafter), is used for the empirical tests in this dissertation. It will be argued that this is the only corporate debt instrument that satisfies the critical tax assumptions of theories predicting an increase in firm value as a result of an increase in leverage. In addition, this dissertation tests Miller's [1977] hypothesis that, in equilibrium, the tax rate of the marginal investor in taxable debt is equal to the corporate tax rate.

1.1 The Internal Revenue Code and IRBs

The tax exempt status of interest income on municipal debt is provided by Section 103 (a) (1) of the Internal Revenue Code which states that "[g]ross income does not include interest on the obligations of a State, a Territory, or a possession of the United States, or any political subdivision of any of the foregoing, or of the District of Columbia." Section 103 (b) of the Code defines IRBs as issues by or on behalf of municipalities, but for which the proceeds are to be used by private entities. Section 103 (b) also sets forth the criteria that must be met in order for the interest investors receive from IRBs to fall under the tax exemption provisions of Section 103 (a).¹

Two categories of tax-exempt IRBs are described by the code. The first is the "small issue" exemption bond, the proceeds from which may be used for any purpose. The interest on bonds with face values of \$1,000,000 or less is tax-exempt if the proceeds are used to acquire or construct land or depreciable property. There is no limit to the number of \$1,000,000 issues a firm can make, as long as the proceeds for each are used in different municipalities. IRBs may also be issued by firms in amounts up to \$10,000,000 provided the firm's aggregate capital expenditure in the municipality does not exceed \$10,000,000 in the period from three years before to three years after the issue. The second category is the "exempt facility" bond, which can be issued in any amount, but only for specified purposes such as industrial parks, docks and warehouses, and pollution control.

¹ The discussion here describes the Code as it existed during the time period covered by the data in this dissertation (1980-1985). Significant changes to the Code occurred in 1986, with tighter restrictions being placed on the amount and use of proceeds from IRB issues.

1.2 The Issuance Process

After a firm has made the decision to construct or expand facilities, it prepares an "inducement resolution" for consideration by the municipality in which the facilities will be located. The resolution establishes that the municipality's offer to issue the bonds has induced the corporation to construct its facilities there. In general, the municipality will approve resolutions only for those firms that can provide economic benefits to the locality without without inflicting environmental damage. Once the resolution has been passed, the firm may begin to incur capital costs to be paid with the proceeds from the issue, even though the actual issue may come later.²

The next step for the firm is to contact its bank or an investment banker and to decide on the specific terms of the issue. The ultimate issue may be in the form of a private placement or a public offering. Private placements are negotiated directly with a commercial bank or life insurance company which purchases the bonds. Large firms with access to national securities markets may choose to use public offerings.

There are two basic documents associated with an IRB issue: a loan agreement or lease agreement between the firm and the municipality, and a trust indenture between the municipality and the trustee for the bondholders. The loan agreement or lease agreement states the municipality will make the proceeds from the issue available to the firm. In return, the firm agrees to pay to the bondholders' trustee, on behalf of the municipality, amounts exactly equal to the debt service on the bonds. Loan agreements are usually used unless state law requires a lease agreement. With a loan agreement, the

² Failure to receive approval of the inducement resolution does not prohibit the firm from locating in the municipality. Rather, it means that subsidized financing will not be available.

firm retains title to the assets financed, and makes an unconditional promise to make the payments needed to service the debt. With a lease agreement, the title transfers to the municipality, which then leases the assets back to the firm for amounts exactly equal to the debt service requirements. At the end of the lease, title to the assets is usually transferred back to the firm for a price of \$1.

The trust indenture describes the duties of the trustee, the interest rate, maturity date, redemption dates, and other features of the bond. For public offerings, a prospectus and underwriting agreement are also prepared. The next step is to obtain a commitment from the purchaser for an interest rate, and to obtain final approval from the municipality for the issue. The final step is the closing, at which the bonds are delivered to the purchaser, and the proceeds are transferred to the trustee. The proceeds are placed into a Construction Fund, from which the firm may make withdrawals to meet its capital expenditures.

In summary, the municipality serves two functions with respect to IRBs. First, it provides investors with tax-exempt interest income, thereby lowering the interest rate firms must pay on the bonds. At the same time, the interest or lease payments the firm makes to the municipality in connection with an IRB are deductible from operating income in computing the firm's tax liability. Second, it acts as a transfer agent for the bond proceeds and the interest and principal payments on the bonds. The economic reality of this arrangement is the issuance of tax-exempt debt by private corporations. The municipality's incentives for issuing IRBs are an increase in employment and in the tax base of the community.

This dissertation examines several issues related to IRBs. The first issue is common stock price reaction for firms issuing IRBs. An interest tax shield hypothesis is devel-

oped and tested. In addition, a subsidization hypothesis is developed and tested to measure the possible impoundment of an allocation of a scarce resource, the limited availability to firms of the privilege of issuing tax-exempt securities. There is also a test of the Myers and Majluf [1984] hypothesis that the riskier the security issue, the more adverse the stock price reaction. Finally, the study examines the primary market pricing of IRBs and its relation to the pricing of taxable corporate bonds. An examination of the yield spread between IRBs and taxable corporate bonds is included to test the Miller [1977] hypothesis that, in equilibrium, the personal tax rate of the marginal buyer of taxable debt is equal to the corporate tax rate.

2.0 Literature Review

2.1 Introduction

This chapter reviews the literature on capital structure theory and related empirical tests, the interaction of financing and investment decisions and related empirical tests, empirical tests of the Miller [1977] yield spread hypothesis, empirical tests for segmentation of the municipal bond market, and empirical bond pricing models.

2.2 Capital Structure Theory

The question of whether changes in capital structure have an effect, *ceteris paribus*, on firm value is one of the most important issues in corporate finance. Indeed, if firms can increase their value by merely repackaging the cash flows being generated, they would be expected to do so until the marginal benefit received equals the marginal cost of ad-

justment. However, if markets are in equilibrium, then, by definition, firms cannot change their value via capital structure. This is so because equilibrium implies that marginal benefits and marginal costs are already equal.

The theories of capital structure may be classified according to several schemes. The one used here classifies theories as either tax based, agency based, or signalling based. Examples of tax based capital structure theories include Modigliani and Miller [1958,1963], Miller [1977], and DeAngelo and Masulis [1980]. Agency based theories include Jensen and Meckling [1976] and Myers [1977]. Signalling based theories include Ross [1977] and Myers and Majluf [1984].

It is not the purpose of this dissertation to examine all theories of capital structure. Rather, because the unique characteristics of IRBs are tax based in nature, they provide a special opportunity to test the tax based capital structure theories. To this end, the focus will be primarily on the tax based theories.

The evolution of tax based capital structure theories has progressed from Modigliani and Miller [1958] where taxes are ignored altogether, to more sophisticated models (DeAngelo and Masulis [1980]) that account for personal and corporate taxation, as well as non-debt tax shields. The implications of these theories have changed from no valuation effects of debt, to value maximization with an all-debt capital structure, to an interior optimal capital structure. The evolution and implications of the tax based theories is examined next.

The seminal papers on capital structure theory were written by Modigliani and Miller (hereafter referred to as MM) [1958,1963]. In their 1958 paper, they consider a firm in a world where: (1) capital markets are frictionless, (2) individuals can borrow and lend

at the risk free rate, (3) there are no costs to bankruptcy, (4) firms issue only risk-free debt and risky equity, (5) all firms are in the same risk class, and (6) all cash flow streams are perpetuities.

In the absence of income taxes, either corporate or personal, an arbitrage proof shows that the value of the levered firm must equal the value of the unlevered firm. This is because the investor can replicate the earnings of the levered firm by buying shares of the unlevered firm and borrowing on his own account. The conclusion MM reach is that capital structure has no effect on firm value, and it is known as "MM Proposition 1."

In their "Correction" [1963], MM take proper account of corporate income taxes and the deductibility of the interest expense on debt. They now find that the value of the levered firm *is* a function of capital structure, and is given by: $V^L = V^U + \tau_c B$ where V^L is the value of the levered firm, V^U is the value of the unlevered firm, τ_c is the (assumed constant) corporate income tax rate, and B is the market value of the firm's debt. Copeland and Weston [1983] call this "perhaps the single most important result in the theory of corporation finance obtained in the last 25 years." In a world with corporate income taxes, but no personal income taxes, firms can maximize their value simply by issuing debt and using the proceeds to retire all of the equity in their capital structure.

Miller [1977] examines the effect of capital structure on firm value when personal income taxes on bond interest income (but not equity income) and corporate income taxes exist. By examining the supply of funds and demand for funds in the bond market, he shows that, in equilibrium, the tax rate of the marginal investor is equal to the corporate tax rate. This result, when combined with a cash flow analysis of levered versus unlevered firms, leads to the conclusion that firm value is independent of capital structure. This result is appealing for two reasons: (1) personal taxes, which are ignored in the MM

papers, do exist, and (2) firms with all debt in their capital structure, as predicted by the MM "Correction", are not observed.

DeAngelo and Masulis [1980] extend the Miller model by including more realistic assumptions about tax laws, such as non-debt tax shields (for example, depreciation) and personal taxes on equity income. They examine the supply of and demand for debt, and are able to show that, even in the absence of leverage related costs of bankruptcy and agency, an interior optimal capital structure exists for each firm. This optimum results because, while there is a constant marginal personal tax disadvantage to corporate debt, the marginal debt may not produce any tax shield benefits to the firm in those future states in which earnings are insufficient to permit full capture of already existing tax shields.

The papers discussed above look at capital structure decisions in isolation. Next, the literature on the theory of simultaneous financing and investment decisions is examined.

2.3 Interactions of Financing and Investment Decisions

Myers [1974] develops an adjusted present value (APV) method for evaluating the interactions of financing and investment decisions. The APV of an investment project is its net present value (NPV) if all equity financed plus the NPV of financing decisions caused by acceptance of the project. The APV method is useful for examining the effect of the tax shield on interest from debt financing. In this case, the project's APV is its NPV if all equity financed plus the present value of the interest tax shield. This method

is well suited to valuing investments with subsidized financing, as is the case with IRBs. In this case, the project's APV is its NPV if all equity financed plus the NPV of the subsidized loan, where the loan's cash flows are discounted at the firm's cost of capital for an unsubsidized loan. A general rule emerges: a project's APV is its NPV if all equity financed plus the sum of the present values of all side effects of accepting the project.

Fama [1978] argues that firm value is independent of both financing and investment decisions. The former holds because if investors have equal access to the capital markets, then any decisions made by the firm can be offset by investors on their own accounts. Additionally, if there are perfect substitutes for the securities of any firm, then changes in the financing decisions of that firm are just offset by other firms in order to maintain market equilibrium. Fama holds investment decisions to be irrelevant because if the firm fails to follow any investment strategy other than the optimal one, then it will pay for outsiders to buy the firm and implement the optimal strategy. The conclusion is that all firms are already following the optimal investment strategy.

Myers and Majluf [1984] examine the effects of corporate financing and investment decisions when there is an information asymmetry between the firm's managers and investors, including current stockholders. They show that the type of financing chosen sends a signal to the market regarding the value of future investment opportunities. The result is that the firm may pass up valuable investment opportunities if it must issue equity, since to do so would signal to investors that managers feel the firm's stock is overpriced relative to the available investment opportunities. Their model also shows that the less risky the source of financing used, the less adverse the stock price reaction. Thus, internal financing is preferred to debt, which is in turn preferred to equity.

2.4 Empirical Tests of Capital Structure Theory

Modigliani and Miller [1958] provide a simple test for the effect of capital structure on firm value. They perform a cross sectional regression of the weighted average cost of capital (WACC) on the debt ratio for a sample of electric utilities and oil companies. They are unable to reject the null hypothesis that WACC (and therefore firm value) is unrelated to capital structure. These results have been criticized by Weston [1963] because of non-homogeneity in the oil industry, and because of the model assumption that the cash flows are perpetuities that do not grow. When growth in earnings is added to the model, the empirical results indicate that firm value is an increasing function of leverage, consistent with the MM [1963] "Correction". One major shortcoming of both of these tests is the failure to adequately control for firm risk. The implicit assumption is that firms within the same industry have equal risk.

Masulis [1980] examines stock price reactions to debt-equity exchange offers. These events provide useful insight into the effects of leverage on firm value since they involve no change in the asset structure of the firm. He finds a positive (negative) reaction to leverage increasing (decreasing) exchanges, consistent with the MM [1963] interest tax shield valuation.

Mikkelson and Partch [1986] find an insignificant stock price reaction for industrial firms announcing public offerings of straight debt. In contrast, they find negative and significant stock price reactions to common stock offering announcements. While the first result is inconsistent with the MM [1963] interest tax shield theory, both results are

consistent with the Miller [1977] hypothesis and the Myers and Majluf [1984] prediction that the riskier the security being issued, the more adverse the stock price reaction.

In summary, the results of the empirical tests of capital structure theory are mixed. Some researches find support for the leverage irrelevance predicted by MM [1958] and Miller [1977]. Others find evidence that supports the MM [1963] prediction that firm value is an increasing function of leverage. The next important step in the analysis is to study the interaction of financing and investment decisions to determine their combined effect on firm value.

2.5 Empirical Tests of the Interaction of Financing and Investment Decisions

McConnell and Muscarella [1985] find a positive (negative) significant stock price reaction for industrial firms announcing increases (decreases) in capital expenditures, while no reaction is found for public utilities. These results are consistent with the hypothesis that managers seek to maximize the market value of the firm in making capital structure decisions. The lack of significant findings for utilities can be explained by the fact that their regulators control the rate of return they can earn on invested capital.

Eckbo [1986] finds an insignificant stock price reaction for both industrial firms and public utilities announcing new issues of straight debt for purposes of financing capital expenditures. He also finds no correlation between the abnormal return caused by a

straight debt issue and the riskiness of the bonds, a result inconsistent with the Myers and Majluf [1984] theory.

Based on the findings of the above empirical tests, the simultaneous effects of financing and investment decisions seem to offset one other, even though each event in isolation has a positive effect on firm value.

2.6 Empirical Tests of the Miller [1977] Hypothesis

Miller [1977] examines bond market supply and demand characteristics and derives a relationship between tax-exempt and taxable yields. The Miller hypothesis may be stated formally as:

H_0 : The ratio of tax-exempt to taxable bond yields is equal to one minus the (top marginal) corporate tax rate.

Several authors have empirically examined the pricing of tax-exempt versus taxable bonds. Trzcinka [1982] examines the yield of municipal bonds versus the yield of taxable corporate bonds of the same maturity, holding constant for relative default risk using bond ratings. He provides evidence that rating agencies do not attempt to make ratings comparable between corporate and municipal bonds, implying that equivalent ratings do not imply equivalent risk as perceived by investors. For each rating class and maturity, he performs the following time-series regression: $R_{Et} = \alpha_t + \beta R_{Tt}$, 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.

Skelton [1983] examines the ratio of short-term tax-exempt to taxable yields, noting that banks are 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 limit this opportunity to short-term instruments, so banks act 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. When short-term taxable rates exceed the Regulation Q ceiling on interest rates ("tight money periods"), banks find it difficult to arbitrage across short-term taxable and tax-exempt securities. When short-term taxable rates are below the Regulation Q ceiling ("loose money periods"), banks are expected to arbitrage across short-term taxable and tax-exempt securities. Skelton also finds that the yield ratio for longer maturities is related to the expectation of periods of tight money. This last finding, however, is disputed by later empirical research by Buser and Hess [1986] in their examination of the determinants of the relative yields on taxable and tax-exempt debt.

Ang, Peterson, and Peterson [1985] seek to avoid the differential risk premium between municipal and corporate debt of equivalent default ratings observed by Trzcinka [1982]. They compute the marginal personal tax rate implied by comparing the mean ratio of the yields of 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. To test for a differential risk premium bias, they regress the yield of the IRB in each matched pair on the yield of the taxable bond. They find that the intercept term is not significantly different from zero, indicating no differential risk premium between IRBs and taxables of the same Moody's rating class.

Jordan and Pettway [1985] examine the 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 prediction.

Yawitz, Maloney, and Ederington [1985] develop a model in which the yield on a risky non-taxable bond is expressed as a function of its probability of default, the return on a risk-free taxable bond, and the marginal personal tax rate. Their findings show little relationship between implied tax rates and bond ratings. However, implied tax rates decrease as maturity increases, indicating a possible segmentation of the municipal bond market.

Kim and Booth [1985] respecify Miller's model, taking into account the loss of tax deductibility of interest in the event of default. They regress the yield ratio each period on the period's failure rate for firms of each risk class and a dummy variable for each non-taxable bond risk class. The results imply a tax rate of about 49% for risk-free debt, close to Miller's prediction. The implied tax rate decreases as the non-taxable debt becomes more risky, and increases as the taxable debt becomes more risky. Finally, the implied tax rate decreases as maturity increases.

In summary, the empirical tests of Miller's [1977] hypothesis have provided mixed results. The existing literature on the yield ratio of non-taxable to taxable debt appears to support the Miller hypothesis when short-term debt is examined, but not when long-term debt is examined. Some authors (Trzcinka [1982], Kim and Booth [1985]) find support for Miller, while others (Ang, Peterson, and Peterson [1985]) find implied marginal tax rates to be much lower than Miller predicts, or believe there are conceptual problems with existing methodology (Skelton [1983]). This dissertation reexamines the yield ratio for both short-term and long-term debt using an improved methodology.

2.7 Segmentation of the Municipal Bond Market

One factor that could have an effect of the yield ratio of tax-exempts to taxables is a segmentation of the market for municipal bonds. Segmentation of the bond market occurs if market participants are unable or unwilling to alter the maturity structure of the debt instruments they buy or sell. For example, commercial banks prefer to buy short-term bonds because of the short-term nature of their deposit liabilities and their emphasis on liquidity. On the supply side, statutory regulations prohibit municipalities from substituting long and short maturity offerings in response to market conditions. If the tax-exempt market is segmented, the yield ratio could vary across maturities as well as over time. Thus, market segmentation is an alternative to the Miller [1977] hypothesis. The market segmentation hypothesis may be stated formally as:

H_2 : The market for tax-exempt debt is segmented by maturity.

This segmentation is reflected in the yield ratio of tax-exempt to taxable bonds.

Historically, three high tax bracket groups, commercial banks, property and casualty insurance companies, and high-income individuals, have purchased virtually all tax-exempts. Tax-exempt bonds are unattractive to low tax bracket investors because, for them, the yields are lower than the after-tax yields available on taxable securities.

A profit maximizing financial institution will invest in taxable securities until its income level places it in the highest tax bracket. Additional funds are invested in tax-exempt securities so as to minimize the total tax bill. Thus, the demand for tax-exempts by commercial banks and property and casualty insurance companies increases with expected income. Any supply of tax exempts in excess of the demand by these fully taxed institutions must be absorbed by individuals. The greater the excess supply, the greater must be the yield on tax exempts in order to entice individuals in increasingly lower tax brackets into the market. Individual investors are therefore the marginal investors in tax exempts. When the tax-exempt and taxable markets clear, the yield ratio reflects the tax bracket of the last individual investor.

Kidwell and Koch [1982] examine the the relative yields of municipal general obligation and revenue bonds. They argue that these securities are not perfect substitutes in supply or demand because of statutory regulations and risk characteristics. Thus, any change in the relative supply of and/or demand for either type of security should be reflected in the yield spread between the two. Their empirical test indicates that the yields on tax-exempts *are* a function of the demand for tax-exempts by commercial banks. This evidence is consistent with a segmentation of the market for tax-exempt securities.

Further testing by Kidwell and Koch [1983] examines the spread between municipal and U.S. Treasury yields. Again, they find evidence of segmentation by maturity in the market for municipal debt.

The segmentation of the municipal market observed by Kidwell and Koch must be accounted for when examining the yield ratio of tax-exempt and taxable debt. This is one of several shortcomings in previous research that is addressed in the empirical tests of this dissertation.

2.8 Bond Pricing Models

Empirical bond pricing models are used to determine the influence that various bond and market attributes have on yields. By the single price law of markets, if two securities are identical they must sell for the same price. This law is the foundation for empirical bond pricing models. In general, these models use the yield to maturity (YTM) of a Treasury bond as the basis for pricing other bonds. The YTM of the bonds to be priced, whether they are corporate or municipal issues, are regressed on the YTM of a Treasury issue of the same maturity. Corporate and municipal issues are not, of course, identical to Treasury issues. To account for the differences, additional independent variables are included in the regression. Furthermore, there is evidence that the yield spread between corporate and Treasury issues varies systematically over the business cycle.³ To control for this variation, some more recent models use the relative yield spread (yield spread divided by Treasury yield) as the dependent variable in the regression.

The most obvious difference between Treasury issues and others is the risk of default. Because they are backed by the full faith and credit of the U.S. government, Treasury issues are virtually default free. Corporate issues may either be secured by specific as-

³ Van Horne [1984, pp. 181-188].

sets, or unsecured. In the latter case, the investor stands in line with all other general creditors of the firm in the event of default. General obligation municipal issues are backed by the taxing power of the issuing municipality. Revenue municipals are backed only by the revenue generating ability of the assets financed by the issue. If these revenues are insufficient to meet the debt service requirements, the issue may default. The standard method of controlling for default risk when pricing corporate or municipal issues is to use zero-one variables for each rating class assigned by firms such as Moody's Investor Services, Inc. or Standard and Poor's Corporation.⁴ The estimated coefficients reflect the increase in YTM (or relative yield spread) due to the increased risk of default. This technique usually reflects the expected empirical result: lower rated bonds have higher yields, *ceteris paribus*.

Investors are exposed to risks other than the risk of default. Bond issues often contain a call provision that gives the issuer the option of redeeming the bond before maturity at a stated "call price," usually somewhat above par. This option is valuable to the issuer because it can lower its cost of capital if market interest rates fall. However, this is exactly what bondholders do not want to happen. In the event of a call, they must give up their bond and reinvest the proceeds in lower yielding issues. That is, the call provision exposes the investor to interest rate risk, and investors demand compensation in the form of higher yields for bearing this risk. Some empirical bond pricing models have used a zero-one variable to control for call provisions (Kidwell and Koch [1982], Kidwell, Marr, and Thompson [1984]), while more recent authors (Allen, Lamy, and Thompson [1987]) have used years of call protection, reasoning that investors prefer more call protection to less. Both methods have produced the expected empirical result: more call protection results in lower bond yields.

⁴ One rating class must be left out of the regression model to avoid the "dummy variable trap."

Many bond covenants also contain a sinking fund provision that requires the issuer to retire a stated portion of the outstanding bonds each year. For example, a typical sinking fund begins in the twentieth year for a thirty year bond. Privately held debt typically must be retired at par for the sinking fund. If interest rates have risen, the bondholder benefits. However, if rates have fallen, the bondholder suffers because the proceeds can only be reinvested at the lower rate.

Publicly held debt, in contrast, usually has a "delivery option" on the sinking fund. This means the issuer may either call bonds by lottery at par for the sinking fund, or optionally purchase the bonds in the open market and deliver them to the trustee. If interest rates fall, the issuer will call the bonds at par for the sinking fund, reducing the bondholders' realized yield and exposing him to interest rate risk. If rates rise, the issuer hopes to purchase the bonds in the open market at less than par. However, the value to the issuer of this option is diminished by evidence that hoarders buy up the floating supply of sinking fund bonds so that the issuer is unable to meet the sinking fund requirements by open market purchases (Jansson [1978], Laiderman [1980], Leader [1977], and Kalotay [1981]). This places an upward price pressure on the bonds, to the benefit of original bondholders. In summary, the effect of a sinking fund on the yield at issue is ambiguous. Allen, Lamy, and Thompson [1987] find that bond yields decrease with an increase in the number of years until the sinking fund commences. They attribute this result to the desire of bondholders to protect themselves from the bond being called for the sinking fund before maturity.

Some bonds also provide the investor with protection from refunding with lower cost debt beyond the call protection period. This provision is designed to protect the investor from a call in the event that interest rates decline. At the same time, the firm is able to

mitigate agency costs resulting from foregone future investment opportunities, information asymmetries, and the risk incentive problem.⁵ Since nonrefunding provisions benefit the issuer and protect the investor from interest rate risk, the expectation is that bonds with refunding protection have lower yields, *ceteris paribus*. Allen, Lamy, and Thompson [1987] test this agency cost mitigation hypothesis using a sample of long-term corporate debt. They include years of refunding protection beyond the call protection period as an explanatory variable for the relative yield spread. However, the estimated coefficient is insignificant, indicating a failure to find evidence consistent with the agency cost mitigation hypothesis. They suggest this failure might result because bondholders believe that firms will violate the spirit of the nonrefunding clause by temporarily using non-debt funds to refund the bond issue.

Risk averse investors will demand a higher bond yield, other things equal, the greater the level of uncertainty in market interest rates at the time of purchase. Several authors have shown new issue bond yields to be an increasing function of the volatility in yields during the time period just before issuance.⁶

The number of underwriter bids received for the bond issue is a potential factor affecting yields. Kidwell and Koch [1982] and Kidwell, Marr, and Thompson [1987] find that the yield of new bond issues decreases as the number of bids received increases, indicating that the intensity of competition among underwriters is a significant determinant of bond yields.

⁵ See Thatcher [1985] and Allen, Lamy, and Thompson [1987] for a discussion of these agency costs and how call provisions might be used to mitigate them.

⁶ See Allen, Lamy, and Thompson [1987], and Kidwell, Marr, and Thompson [1987].

Large issues are likely to be more marketable, and hence should have lower yields. Allen, Lamy, and Thompson [1987] and Kidwell, Marr, and Thompson [1984, 1987] find support for this when corporate debt is examined, but Kidwell and Koch [1982] find that yields *increase* with issue size for municipal debt. A possible explanation for this last finding is that for large tax-exempt issues, there may be an insufficient number of high tax bracket investors (firms or individuals) in the issuing state to fully absorb the issue. Thus, the issue may either have to be sold at a higher yield to entice lower tax bracket investors within the state of issue, or to investors in another state who must then pay state income taxes on the interest received.⁷

In summary, the empirical bond pricing models used in the literature explain a significant amount of the variation in bond yields. The evidence found is consistent with many factors that theoretical models predict to be determinants of bond yields. In this dissertation, the bond pricing model used to estimate the tax rate of the marginal investor is similar to those discussed above.

⁷ Thirty-seven states tax interest received from out-of-state municipal issues (Kidwell, Koch, and Stock [1984]).

3.0 Market Reaction to Issuance of Industrial Revenue Bonds

3.1 Theory

Consider a firm in a Miller [1977] world where capital markets are frictionless, all may lend and borrow at the risk free rate, no bankruptcy costs exist, firms issue only risk-free debt and risky equity, all firms are in the same risk class, and all cash flow streams are perpetuities. If the firm has no debt outstanding, the after-tax stream of cash flows to shareholders is:

$$(NOI)(1 - \tau_c)(1 - \tau_{ps}), \quad (1)$$

where NOI is the firm's perpetual Net Operating Income, τ_c is the (assumed constant) corporate tax rate, and τ_{ps} is the personal tax rate on equity income. Discounting this cash flow at the cost of equity for an all-equity firm, ρ , gives the value of the unlevered firm:

$$V^U = \frac{(NOI)(1 - \tau_c)(1 - \tau_{ps})}{\rho}. \quad (2)$$

If the firm has IRBs (with face value D and coupon rate R_{IRB}) and stock outstanding, then the after tax cash flows to stockholders are:

$$ATCF_{\text{stock}} = (NOI - R_{IRB}D)(1 - \tau_c)(1 - \tau_{ps}), \quad (3)$$

and the after tax cash flows to bondholders are:

$$ATCF_{\text{bond}} = R_{IRB}D. \quad (4)$$

Rearranging terms, the total after-tax cash flows to the firm's suppliers of capital are:

$$ATCF_{\text{stock}} + ATCF_{\text{bond}} = (NOI)(1 - \tau_c)(1 - \tau_{ps}) + R_{IRB}D[1 - (1 - \tau_c)(1 - \tau_{ps})]. \quad (5)$$

The first term on the right-hand side of Equation (5) is the same as the cash stream received by owners of the all-equity firm, and it can be discounted at the cost of equity for the all-equity firm, ρ . The second term is risk-free, and therefore can be discounted at the tax-exempt risk-free required rate of return, R_E . So, the value of the firm with tax-exempt IRB leverage is:

$$V_{IRB}^L = \frac{(NOI)(1 - \tau_c)(1 - \tau_{ps})}{\rho} + \frac{R_{IRB}D[1 - (1 - \tau_c)(1 - \tau_{ps})]}{R_E}. \quad (6)$$

Since:

$$R_{IRB}D/R_E = B = \text{market value of the IRB}, \quad (7)$$

then:

$$V_{IRB}^L = V^U + B[1 - (1 - \tau_c)(1 - \tau_{ps})] \quad (8)$$

Equation (8) shows the gain from tax-exempt leverage is always positive for $\tau_c > 0$ and/or $\tau_{ps} > 0$. The value of the tax-exempt levered firm from Equation (8) may be compared with the value of the taxable debt levered firm:

$$V_{\text{taxable}}^L = V^U + B \left[1 - \frac{(1 - \tau_c)(1 - \tau_{ps})}{(1 - \tau_{pb}^{\text{marginal}})} \right]. \quad (9)$$

Miller assumes that $\tau_{ps} = 0$ and his equilibrium shows that $\tau_{pb}^{\text{marginal}} = \tau_c$. If his assumption and equilibrium hold, then Equation (9) shows that firm value is independent of leverage from taxable debt. In contrast, given Miller's assumption and equilibrium, Equation (8) collapses to the value of the levered firm from the MM "Correction". The critical advantage to the use of tax-exempt versus taxable debt is that the tax savings at the corporate level due to the interest expense deduction are in no way offset at the personal level by taxes on interest income.

Previous authors have examined market reactions to the issuance of taxable corporate debt in an effort to test the tax shield hypothesis of the MM "Correction." However, the above arguments show they were in fact testing the Miller capital structure irrelevance hypothesis. It is therefore not surprising that they have failed to find support for the MM tax shield hypothesis. This dissertation tests the MM tax shield hypothesis using IRB announcements. These bonds provide a superior test because they have tax characteristics identical to the critical assumption of the MM "Correction" model.

The next section of this dissertation examines the stock price reaction of firms announcing the issuance of IRBs. The objective is to determine whether the market impounds the value of the interest tax shield in the firm's stock price. In addition, the non-debt tax shield implications of the DeAngelo and Masulis [1980] model and the risky security implications of the Myers and Majluf [1984] model are tested.

3.2 Empirical Tests of Market Reaction to Issuance of Industrial Revenue Bonds

3.2.1 Data Description

Recall that in order to issue an IRB, a firm must first obtain permission from the municipality. The firm submits an inducement resolution to the municipality's board of supervisors, which then votes on the flotation of the bond issue. Once the inducement resolution passes, the firm has the right, but not the obligation, to issue the bonds. The data for the test of a possible market reaction to IRB issues consists of announcements that inducement resolutions have been passed, as reported in the *Bond Buyer*, a daily specializing in tax-exempt issues.⁸ For each year from 1980 through 1985, two months were chosen at random, without replacement, and for each month a list of dates, firm names, and authorized bond amounts was compiled. Firms that are not listed on both the CRSP Excess Returns and COMPUSTAT tapes were deleted, leaving 72 announcements.

The excess returns for IRB announcements are also compared with those for announcements of ordinary taxable corporate debt. The taxable debt issues were taken from the Dow Jones News Service. For the years 1980 through 1985, a list was compiled

⁸ The passage of the inducement resolution is reported directly to the *Bond Buyer* by the municipality. Because the *Bond Buyer* is received by many subscribers on its dated date, a single day announcement period is used. On passage of the inducement resolution, the firm has an option to issue an IRB. Firms rarely make formal announcements over wire services or in the *Wall Street Journal* that the issue will actually be offered, even for public offerings of IRBs. Therefore, the point at which the bond will definitely be issued is not publicly available information. Since IRBs are issued by municipalities, they are not registered with the Securities and Exchange Commission.

of all announcements of straight debt offerings with proceeds specified for capital expenditures. This sample was constrained to firms for which returns are available on the CRSP Excess Returns tape. A total of 23 issues remain in the data set for taxable debt announcements.

3.2.2 Empirical Model

The market reaction to the issuance of IRBs is examined by computing the excess returns for firms around the announcement that an inducement resolution has been passed. Excess returns, also called residuals, are returns to firms in excess of that which can be explained by overall market movements. They represent the impact of firm specific information on the returns to the firm's common stock. The technique of residual analysis was developed by Fama, Fisher, Jensen, and Roll [1969] and has been rigorously tested by Brown and Warner [1980, 1985].

The average excess return on day t relative to the announcement is defined as:

$$AER_t = \sum_{j=1}^N \frac{ER_{j,t}}{N}, \quad (10)$$

where:

$ER_{j,t}$ = the excess return to shareholders of firm j on day t , from the CRSP Excess Returns tape, and

N = the number of firms in the sample.

The test statistic for the null hypothesis that the AER on day t is equal to zero is:

$$t_t = \frac{AER_t}{SER}, \quad (11)$$

where the standard deviation of the excess returns is computed using a 250 day period beginning 290 days before the announcement date:

$$SER = \sqrt{\sum_{j=-290}^{-41} \frac{(AER_j - \overline{AER})^2}{D-1}}, \text{ and} \quad (12)$$

D = the number of days in the estimation period = 250.

The cumulative excess return on day t is defined as:

$$CER_t = \sum_{k=-40}^t AER_k, \quad (13)$$

To prevent double counting, firms with two or more announcements in any 40 day period are excluded from the sample when computing cumulative excess returns.

The announcement day excess returns for IRB issues are next examined to determine if they can be explained by capital structure theory. If, as Miller [1977] assumes, the effective personal tax rate on equity income is zero, $\tau_e = 0$, then the value of the interest tax shield from Equation (8) is $\tau_d B$. This tax shield hypothesis is tested by regressing the announcement day excess return on the dollar value of the tax shield for each IRB in the sample, scaled by the value of stockholders' equity on the day prior to the announcement. The estimated coefficient for this term is predicted to be positive.

The DeAngelo and Masulis [1980] model predicts that firms will select a debt level negatively related to the level of available tax shield substitutes, such as depreciation, depletion, and investment tax credits. The reasoning is that in low earnings states, firms with large non-debt tax shields would not be able to capture the benefits of the interest tax shield on debt. To test this prediction, the announcement day excess return is regressed on the previous ten year's average ratio of non-debt tax shields to operating income. The higher this ratio, the less likely the firm will be able to capture the benefits of the tax shield on its debt. Therefore, the estimated coefficient for this term is predicted to be negative.

The interior optimal capital structure predicted by the DeAngelo and Masulis model will also be tested by regressing the announcement day excess return on a dichotomous variable that reflects whether the IRB issue moves the firm towards or away from its ten year average debt ratio. Marsh [1982] has shown the ten year average debt ratio to be a significant predictor of whether firms issue debt or equity, given that one of the two will be issued. That is, according to Marsh's results, firms behave as if they set target debt ratios, and move towards these targets over time. Since the true optimal capital structure cannot be observed, the ten year average debt ratio is used as a proxy. If the

IRB issue moves the firm towards its ten year average debt ratio, the dichotomous variable is assigned a value of one, otherwise it is zero. The estimated coefficient for this variable is predicted to be positive.

The IRB financing/investment decision is also examined in the context of the model of Myers and Majluf [1984]. Their model suggests that the more risky the financing instrument used, the more adverse the impact on the firm's stock price. *Ceteris paribus*, IRBs will be less risky than equity or taxable debt, because of the lower debt service requirements. Thus, firms may be willing to make capital structure changes using IRBs that would not be tenable with taxable debt. To test the Myers and Majluf hypothesis, the excess returns from IRB announcements will be regressed on a variable that reflects the riskiness of the issue. Many of the firms in the data sample do not have rated debt outstanding. Therefore, the coefficient of variation in operating income for the previous ten years is used as a proxy for the riskiness of the debt issue. If the estimated coefficient for this variable is negative, then the evidence is consistent with the Myers and Majluf hypothesis.

The specific form of the model to be tested is:

$$ER_{j,0} = \alpha_0 + \alpha_1 TAXSHIELD_j + \alpha_2 ABILITY_j + \alpha_3 TARGET_j + \alpha_4 RISK_j + \epsilon_j \quad (14)$$

where:

$ER_{j,0}$ = the excess return to shareholders of firm j on day 0, from the CRSP Excess Returns tape;

$TAXSHIELD_j = \frac{\tau_c B_j}{N_{j,t-1} S_{j,t-1}}$, = the value of the taxshield as a percent of shareholder wealth;

τ_c = the corporate tax rate = 0.46 for the test period;

B_j = the size of the authorized IRB, in dollars;

$N_{j,t-1}$ = the number of shares of common stock of firm j outstanding on day $t-1$;

$S_{j,t-1}$ = the common stock price of firm j on day $t-1$;

$ABILITY_j$ = the previous ten years' average ratio of non-debt tax shields to operating income, a proxy for the firm's ability to capture the interest tax shield on its debt;

$TARGET_j$ = 1 if the issue moves the firm towards its ten year average debt ratio, and zero otherwise; and

$RISK_j$ = the coefficient of variation in operating income for the previous ten years.

In addition to the above theoretical predictions regarding market reactions to the issuance of debt, there is another possible source of influence on shareholder wealth. Using a standard capital budgeting analysis, the net present value (NPV) of an investment project increases as the cost of capital decreases. The increase in the NPV of an in-

vestment project that results from using IRB financing instead of higher cost taxable debt financing presumably accrues to shareholders. Because of this, it has been argued that IRBs, are a "Federal subsidy to private corporations."⁹ The firm is assumed to use the lure of increased employment and tax bases to convince municipalities to issue the IRB financing. The municipality has little reason to refuse the issue, since it incurs no direct risk or cost. This subsidization hypothesis to be tested is:

H_2^1 : IRBs, despite their tax-exempt status and thus lower cost, do not result in an increase in shareholder wealth for those firms using IRBs.

Stock price reactions of firms issuing IRBs are examined around the announcement date to determine if the subsidization hypothesis holds. With the exception of refunding issues, IRBs involve a simultaneous financing and investment decision. As such it will be necessary to hold constant for their separate effects in testing the subsidization hypothesis. To this end, the stock price effect of IRB announcements will be compared with the stock price effect of the announcement of taxable debt issues (whose proceeds are targeted for capital expenditure purposes) by similar industrial firms.¹⁰

⁹ Letter from Stanley S. Surrey, Assistant Secretary of the Treasury to Wilbur D. Mills, Chairman Ways and Means Committee, January 23, 1968, reprinted in *Industrial Development Bonds, Tax Management, Inc.*, 1980, p. B-102.

¹⁰ Ideally, the subsidization hypothesis would be tested using the Myers Adjusted Present Value method to value the subsidy being received by the firm issuing the IRB. This method requires discounting the cash flows (interest and principal payments) of the IRB issue at the cost of taxable debt for the firm. The value of the subsidy would then be included in Equation (14) and tested simultaneously with the other theoretical predictions. However, at the announcement date, the specifics of the issue such as coupon rate and maturity are unknown. It is therefore necessary to first test the hypotheses given in Equation (14), and then separately test the subsidization hypothesis. The test of the subsidization hypothesis is not entirely independent of the hypotheses tested in Equation (14). If a positive reaction to the announcement of an IRB is found, and this reaction can be explained by the variables in Equation (14), then the subsidization hypothesis cannot be tested independently. This results from the inability to develop an explicit proxy for the value of the subsidy.

3.2.3 Results of the Empirical Tests

The announcement day excess returns for the portfolio of firms issuing IRBs and for firms issuing ordinary taxable debt are given in lines 1 and 2 of Table 1. The failure to find a significant announcement day return for ordinary taxable corporate (see Table 1, line 2) is consistent with the findings of Eckbo [1986] and Mikkelson and Partch [1986]. The announcement day excess returns for the IRBs (Table 1, line 1), in contrast, are positive and significant ($\text{PROB} > |T| = 0.0068$). A t-test for equality of means rejects the null hypothesis that the excess returns for the IRB announcements are equal the excess returns for the taxable debt announcements ($\text{PROB} > |T| = 0.0154$). This result is consistent with the subsidization hypothesis, i.e. investors are responding in a positive manner to the news that the firm is being allowed to issue tax exempt financing. The decreased cost of capital results in a higher NPV for the project being financed. Cumulative excess returns are computed for the 80 day period surrounding the announcement day, and are shown in Figure 1. In addition to the positive excess return observed on the announcement day, the graph presents further evidence that investors respond in a positive manner to IRB issues. The cumulative excess return increases by approximately 2% in the 30 day period following the announcement of passage of the inducement resolution. After this 30 day period, the cumulative excess return no longer increases. Thus, there appears to be a permanent reaction to IRB issues.

One possible explanation for this increase in cumulative excess returns is that passage of the inducement resolution gives the firm has the option to issue an IRB. Therefore, the announcement day excess return reflects the expected present value of the option when exercised. The uncertainty about whether the offer will actually be made is resolved at varying times across firms. Thus, the full value of exercising the option is

impounded in the stock prices of firms at different points in time after the announcement. This is consistent with the observed increase then leveling off of cumulative excess returns as shown in Figure 1.¹¹ The next step is to determine if the observed excess return can be explained by the variables described in Equation (14).

The results of the estimation of Equation (14) are presented in Table 2. The estimated coefficients of all the independent variables except ABILITY have the predicted signs, but none are significantly different from zero at any acceptable level. Thus, the empirical test has failed to find evidence consistent with the tax-shield hypothesis, the DeAngelo and Masulis non-debt tax shield model, an internal optimal capital structure for the firm, and the Myers and Majluf model.

Eckbo [1986] tests these the same theories using a similar technique on a large sample of straight debt issues. He finds an insignificant reaction to the announcement of a straight debt issue for the purpose of capital expenditure. He fails to find any relationship between the announcement day excess return and the interest tax shield, the firm's debt ratio, the debt rating, and issue size.

In summary, except for the subsidization hypothesis, the tests have failed to find evidence consistent with several important theories of capital structure.

¹¹ A better test would be to compare the cumulative excess returns for firms that actually issue the IRB with those that do not exercise the option to issue. Unfortunately, the Bond Buyer does not provide follow-up reports on which firms issue and which do not.

Table 1. Announcement day excess returns for IRBs and taxable corporate bonds.

Issue Type	N	Excess Return	T	PROB> T
IRB	72	0.0057653	2.53	0.0068
Taxable Debt	23	-0.0027633	-0.67	0.7452

t-test for difference in means

$$H_0: ER_{IRB,0} = ER_{taxable,0}$$

$$t = 2.21 \quad \text{PROB} > |T| = 0.0154 \quad (df = 76)$$

Where:

$$t = \frac{AER_{IRB,0} - AER_{taxable,0}}{\sqrt{\frac{S_{IRB,0}^2}{N_{IRB}} + \frac{S_{taxable,0}^2}{N_{taxable}}}}$$

$$df = \frac{\left[\frac{S_{IRB,0}^2}{N_{IRB}} + \frac{S_{taxable,0}^2}{N_{taxable}} \right]^2}{\left[\frac{\left[\frac{S_{IRB,0}^2}{N_{IRB}} \right]^2}{N_{IRB} - 1} + \frac{\left[\frac{S_{taxable,0}^2}{N_{taxable}} \right]^2}{N_{taxable} - 1} \right]}$$

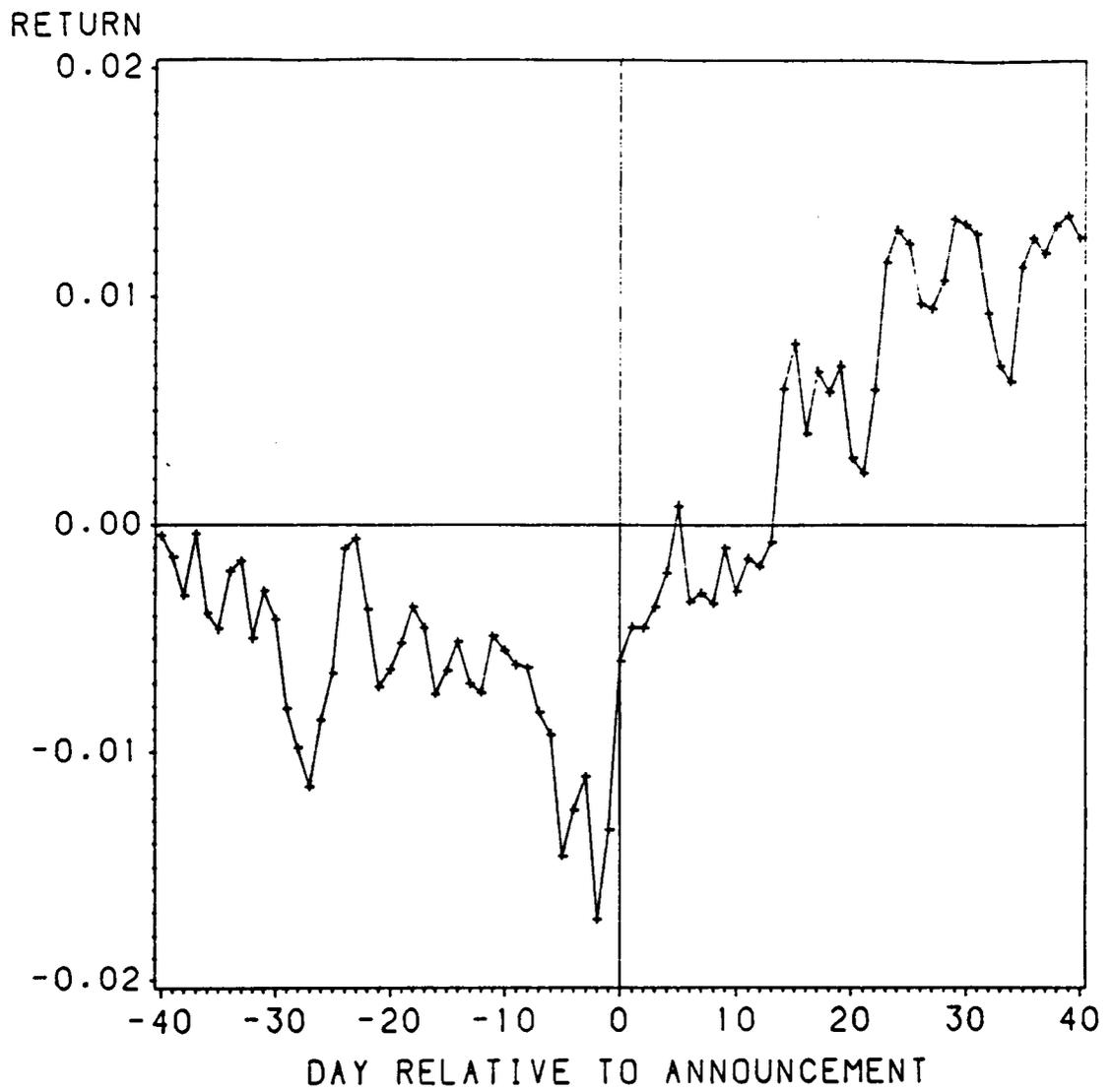


Figure 1. Cumulative excess returns for portfolio of IRBs.

Table 2. Results of OLS estimation of Equation 9.

VARIABLE	PARAMETER ESTIMATE	T FOR H0: PARAMETER=0	PROB > T
INTERCEPT	0.00158	0.158	0.8751
TAXSHIELD	0.00263	0.013	0.9898
ABILITY	0.01858	0.885	0.3794
TARGET	0.00505	0.823	0.4133
RISK	-0.00892	-0.715	0.4773
	N	= 70	
	F	= 0.6500	
	PROB>F	= 0.6286	
	ADJ R-SQ	= -0.0207	

4.0 Empirical Test of the Miller [1977] Hypothesis

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, $(1 - \tau'_{pb})R_T$.

Miller [1977] develops an equilibrium model of taxable and non-taxable bond yields that assumes all bonds are riskless, the personal tax rate on equity income is zero, and the personal tax rate on interest income, τ'_{pb} , is progressive. In order to entice taxable investors into the corporate bond market, the before-tax yield on taxable debt must be grossed up, to $R_E/(1 - \tau'_{pb})$, so that the after-tax yield is equal to the tax exempt yield, R_E . As more taxable bonds are issued, investors in increasingly higher tax brackets must be enticed into the market, and the demand curve for taxable debt can be traced out. The corporate supply of taxable debt is assumed to be inelastic, with the supply rate equal to $R_E/(1 - \tau_c)$. In equilibrium $R_E/(1 - \tau_c) = R_E/(1 - \tau'_{pb})$, so $\tau'_{pb} = \tau_c$. The marginal investor's tax rate is equal to the corporate tax rate, and the yield on taxable bonds is $R_E/(1 - \tau_c)$.

4.1 The Model

When the yield ratio of non-taxable to taxable short-term debt is examined, the existing literature provides support for the Miller hypothesis. However, the empirical results are mixed with respect to long-term debt. Trzcinka [1982], and Kim and Booth [1985] find support for Miller. In contrast, Ang, Peterson, and Peterson [1985] find implied marginal tax rates to be much lower than Miller predicts. This dissertation seeks to improve on previous empirical tests of the Miller hypothesis and will attempt to reconcile these 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. There is reason to believe that one can hold constant for the relative default risk of 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."¹² 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.

¹² Moody's Bond Survey, December 6, 1986, p. 4511.

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.” The empirical results of Ang, Peterson, and Peterson [1985] are at odds with Miller’s [1977] prediction that $\tau'_{pb} = \tau_c$. However, they do not test for market segmentation, nor do they account adequately for several factors that have been shown relevant to the pricing of debt, such as callability, issue size, and sinking funds.¹³ Their matched pairs technique implicitly assumes that IRBs and taxable corporate debt are poolable across the variables used for matching, but they fail to test for this explicitly. If the bonds in the matched pairs are not poolable, then the implied tax rate computed from the mean yield ratio is suspect.

As part of its primary market pricing investigation, this dissertation tests the Miller hypothesis and an alternative, the market segmentation hypothesis. Two bond pricing models are developed, one for IRBs and another for taxable corporate bonds, and their coefficients estimated using sample data. The IRB model is:

$$\begin{aligned}
 YTM_i &= \alpha_0 + \alpha_1 TRS_i + \alpha_2 RATING_i + \alpha_3 INTVOL_i + & (15) \\
 &\alpha_4 LNSIZE_i + \alpha_5 SINKPRO_i + \alpha_6 CALLPRO_i + \\
 &\alpha_7 DEMAND_i + \alpha_8 CREDIT_i + \varepsilon_i ,
 \end{aligned}$$

¹³ 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.

and the taxable bond model is:

$$\begin{aligned}
 YTM_j &= \gamma_0 + \gamma_1 TRS_j + \gamma_2 RATING_j + \gamma_3 INTVOL_j + \\
 &\quad \gamma_4 LNSIZE_j + \gamma_5 SINKPRO_j + \gamma_6 CALLPRO_j + \\
 &\quad \gamma_7 REFPRO_j + \varepsilon_j .
 \end{aligned}
 \tag{16}$$

A third model is also tested using pooled IRB and taxable bond data. It combines Equation (15) and Equation (16) and provides the ability to test whether individual variables have an equivalent effect on the yields of IRB and taxable issues. The pooled model is:

$$\begin{aligned}
 YTM_k &= \delta_0 + \delta_1 IRB_k + \delta_2 TRS_k + \delta_3 IRB_k \times TRS_k + \\
 &\quad \delta_4 RATING_k + \delta_5 IRB_k \times RATING_k + \delta_6 INTVOL_k + \\
 &\quad \delta_7 IRB_k \times INTVOL_k + \delta_8 LNSIZE_k + \delta_9 IRB_k \times LNSIZE_k + \\
 &\quad \delta_{10} SINKPRO_k + \delta_{11} IRB_k \times SINKPRO_k + \delta_{12} CALLPRO_k + \\
 &\quad \delta_{13} IRB_k \times CALLPRO_k + \delta_{14} REFPRO_k + \delta_{15} IRB_k \times DEMAND_k + \\
 &\quad \delta_{16} IRB_k \times CREDIT_k + \varepsilon_k ,
 \end{aligned}
 \tag{17}$$

where:

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

IRB = one if the issue is an IRB, and zero if it is a taxable corporate issue. This variable is used in an additive form to test for a differential intercept for IRBs as compared to taxable corporate debt, and then in a multiplicative form to test for differential slope coefficients;

TRS = the yield, on the issue date, on a U.S. Treasury index with the same maturity as the issue being priced. Daily Treasury rates are from

Federal Reserve Statistical Release H.15: Selected Interest Rates.

Linear interpolation is used when no matching maturity is available.

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. Several authors have found empirical evidence that more volatility in interest rates at the time of issue results in higher yields (see, for example, Allen, Lamy, and Thompson [1987]);

LNSIZE = the natural log of the size of the issue. The dollar size of debt issues has been shown to influence reoffering yields (see Kidwell, Marr, and Thompson [1984]). For taxable corporate issues, larger issues are more marketable and therefore should 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. The same may not hold true for IRBs. Larger IRB issues may find it necessary to go outside the state of issue to find a sufficient number of investors, with

the result that state income taxes (where applicable) would have to be paid on interest income. Thus, large IRB issues may demand a higher yield, *ceteris paribus*;

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;¹⁴

DEMAND = financial institution purchases of tax-exempts in the year of the issue divided by all purchases of tax-exempts in the year of issue, from the Federal Reserve Bulletin 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

¹⁴ None of the IRB issues in the sample has refunding protection periods beyond the call protection period. Therefore, in the estimation of equation of Equation (17), the value of REFPRO is set equal to zero for the IRB issues.

be enticed into the market to absorb the excess supply, increasing the yields that must be offered on tax-exempts.¹⁵ 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.¹⁶

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

$$YTM_{IRB} = (1 - \tau_{pb}^i) YTM_{\text{taxable corporate}} \quad (18)$$

Thus:

$$\frac{\partial YTM_{IRB}}{\partial YTM_{\text{taxable corporate}}} = (1 - \tau_{pb}^i). \quad (19)$$

¹⁵ The DEMAND variable is specific to the IRB issues in the model. In the pooled model, multiplying the DEMAND variable by IRB has the effect of setting DEMAND equal to zero for all taxable issues, so that the estimated coefficient reflects the influence of DEMAND of the yields of IRB issues only.

¹⁶ The CREDIT variable is specific to the IRB issues in the model. In the pooled model, multiplying the CREDIT variable by IRB has the effect of setting CREDIT equal to zero for all taxable issues, so that the estimated coefficient reflects the influence of CREDIT of the yields of IRB issues only.

Let γ_i represent the coefficients from the estimation of Equation (15) for IRB issues, and α_i represent the coefficients from the estimation of Equation (16) for taxable issues. Then, from Equation (15):

$$\alpha_1 = \frac{\partial YTM_{IRB}}{\partial YTM_{Treasury}}, \quad (20)$$

and from Equation (16),

$$\gamma_1 = \frac{\partial YTM_{taxable\ corporate}}{\partial YTM_{Treasury}}, \quad (21)$$

therefore:

$$\frac{\alpha_1}{\gamma_1} = \frac{\partial YTM_{IRB}}{\partial YTM_{taxable\ corporate}}. \quad (22)$$

From Equation (19) and Equation (22):

$$\frac{\alpha_1}{\gamma_1} = (1 - \tau_{pb}^i). \quad (23)$$

To test the market segmentation and Miller [1977] hypotheses, 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 (15) is estimated for IRBs and Equation (16) for taxables. The coefficients obtained for each group are then used with Equation (23) to estimate the marginal personal tax rate, τ_{pb}^i . 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_e , then Miller's hypothesis is supported. Miller [1977] shows that $\tau_{pb}^i = \tau_e$ when debt is riskless. When the 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'_{eb} , is less than τ_e . Thus, if the implied tax rates found above are equivalent across maturities, but less than τ_e , then the evidence is consistent with Miller's hypothesis adjusted for risk.

4.2 Data Description

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. 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, puttable, zero coupon, floating rate, and deep discount issues were deleted from the data set.

4.3 Results of 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 decision was made to include only non-sinking fund bonds in the 3 to 5 year and 10 year maturity groups, and to include only sinking fund bonds in the 20 or greater year maturity group.

Univariate statistics for the IRBs and taxable corporate issues in the 3 to 5 year, 10 year, and 20 year or greater maturity groups are given in Tables 3, 4, and 5, respectively. The most obvious difference between the two groups are the smaller size and lower yields for the IRBs. The ratio of the security yield to the same maturity Treasury yield (on the issue date) gives a better standard for comparison than absolute yields because of changes in market interest rates over the time period covered by the data. The taxable issues provide the investor with somewhat more call protection for the 3 to 5 year group, and somewhat less for the 10 year group. For the 20 year or greater maturity group, IRBs provide the investor with substantial call protection, whereas most taxable corporate issues have no call protection. Finally, the taxable issues provide the investor with some protection against refunding with lower cost debt, while IRB holders receive no such protection.

Table 3. Univariate statistics: 3 to 5 year maturity non-sinking fund bonds.

VARIABLE	MINIMUM VALUE	MAXIMUM VALUE	MEAN	STANDARD DEVIATION
IRB ISSUES (N = 72)				
YIELD	6.500	12.000	9.556	1.279
YIELD/TRS	0.567	0.858	0.683	0.078
SIZE	0.100	123.150	12.643	22.785
YRSMAT	3.000	5.000	3.306	0.725
YRSCALL	0.000	5.000	1.569	1.124
TAXABLE CORPORATE ISSUES (N = 28)				
YIELD	9.800	14.750	11.647	1.666
YIELD/TRS	1.016	1.199	1.067	0.041
SIZE	50.000	250.000	116.071	57.419
YRSMAT	3.000	5.000	4.536	0.793
YRSCALL	0.000	5.000	3.321	1.634
YRSREFUND	0.000	5.000	0.464	1.232
Where:				
YIELD	= the yield to maturity;			
TRS	= the yield (on the issue date) of a Treasury issue with the same maturity;			
SIZE	= the issue size in millions of dollars;			
YRSMAT	= the number of years to maturity;			
YRSCALL	= the number of years of call protection; and			
YRSREFUND	= the number of years of protection against refunding with lower cost debt beyond the call protection period.			

Table 4. Univariate statistics: 10 year maturity non-sinking fund bonds.

VARIABLE	MINIMUM VALUE	MAXIMUM VALUE	MEAN	STANDARD DEVIATION
IRB ISSUES (N = 137)				
YIELD	7.750	13.250	11.067	1.313
YIELD/TRS	0.658	0.978	0.836	0.053
SIZE	0.200	40.000	2.876	6.314
YRSCALL	1.000	10.000	7.547	2.149
TAXABLE CORPORATE ISSUES (N = 123)				
YIELD	9.875	16.650	12.503	1.598
YIELD/TRS	1.013	1.238	1.081	0.047
AMOUNT	10.000	400.000	110.325	60.482
YRSCALL	0.000	10.000	5.244	3.427
YRSREFUND	0.000	10.000	2.593	4.002
Where:				
YIELD	= the yield to maturity;			
TRS	= the yield (on the issue date) of a Treasury issue with the same maturity;			
SIZE	= the issue size in millions of dollars;			
YRSCALL	= the number of years of call protection; and			
YRSREFUND	= the number of years of protection against refunding with lower cost debt beyond the call protection period.			

Table 5. Univariate statistics: 20 year or greater maturity sinking fund bonds.

VARIABLE	MINIMUM VALUE	MAXIMUM VALUE	MEAN	STANDARD DEVIATION
IRB ISSUES (N = 66)				
YIELD	8.625	14.000	10.836	1.511
YIELD/TRS	0.812	0.954	0.873	0.031
SIZE	0.300	21.500	3.691	3.166
YRSMAT	20.000	30.000	27.652	3.944
YRSCALL	0.000	15.000	9.697	1.727
YRSSINK	4.000	27.000	20.924	6.692
TAXABLE CORPORATE ISSUES (N = 110)				
YIELD	10.200	18.000	12.411	1.424
YIELD/TRS	1.010	1.249	1.113	0.052
AMOUNT	13.750	500.000	146.554	85.908
YRSMAT	20.000	31.000	28.118	2.958
YRSCALL	0.000	10.000	0.173	1.074
YRSREFUND	0.000	29.000	9.618	2.968
YRSSINK	1.000	15.000	10.573	1.742
Where:				
YIELD	= the yield to maturity;			
TRS	= the yield (on the issue date) of a Treasury issue with the same maturity;			
SIZE	= the issue size in millions of dollars;			
YRSMAT	= the number of years to maturity;			
YRSCALL	= the number of years of call protection;			
YRSREFUND	= the number of years of protection against refunding with lower cost debt beyond the call protection period; and			
YRSSINK	= the number of years until the sinking fund commences.			

For each maturity group, Equation (15) is estimated for the IRB issues and Equation (16) is estimated for the taxable issues to test the general fit of the models and to see if the estimated coefficients of specific variables enter as predicted.

4.3.1 3 to 5 year maturity non-sinking fund bonds.

Tables 6 and 7 report the results of the estimation of Equation (15) and Equation (16) for the IRB issues and the taxable issues, respectively. The model explains 62% of the variation in the yield of the IRB issues, and 94% of the variation in the yield for the taxable issues. As expected, the yields on both issue types are strongly correlated with the yield on an equivalent maturity Treasury issue. The default risk proxies exhibit a monotonic increase in yields as the perceived risk increases. The interest rate volatility variable is significant in explaining yields of the IRB issues, but not of the taxable issues. Neither group's yield appears related to the size of the issue, or to the amount of call protection provided to the investor. The yields on the taxable issues appear unrelated to the amount of refunding protection beyond the call protection period. This is consistent with the result obtained by Allen, Lamy, and Thompson [1987] and suggests that the combination of call protection and refunding protection does not mitigate the agency problems discussed in Section 2.8. The yields of the IRB issues 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. The letter of credit coefficient is consistent with investors perceiving these issues riskier than equivalent rated issues without the letter of credit.

Table 6. IRB issues only, 3 to 5 year maturity non-sinking fund bonds.

VARIABLE	PARAMETER ESTIMATE	T FOR H0: PARAMETER=0	PROB > T
INTERCEPT	0.1082	0.072	0.9429
TRS	0.5753	7.521	0.0001
AA	0.0483	0.147	0.8833
A	0.7609	2.165	0.0343
BAA	1.3988	3.346	0.0014
INTVOL	229.3229	5.086	0.0001
LNSIZE	-0.0645	-0.907	0.3677
CALLPRO	0.3507	0.830	0.4096
DEMAND	-2.9729	-2.511	0.0147
CREDIT	1.4267	4.054	0.0001
	N	= 72	
	F	= 14.0790	
	PROB>F	= 0.0001	
	ADJ R-SQ	= 0.6238	

Table 7. Taxable issues only, 3 to 5 year maturity non-sinking fund bonds.

VARIABLE	PARAMETER ESTIMATE	T FOR H0: PARAMETER=0	PROB > T
INTERCEPT	-1.7900	-1.502	0.1495
TRS	1.1026	17.838	0.0001
AA	0.3683	1.164	0.2589
A	0.6140	1.945	0.0667
BAA	1.4966	3.084	0.0061
INTVOL	35.4440	1.192	0.2478
LNSIZE	0.1236	0.684	0.5021
CALLPRO	0.0645	0.191	0.8504
REFPRO	-0.3572	-0.733	0.4727
	N	= 28	
	F	= 56.9580	
	PROB>F	= 0.0001	
	ADJ R-SQ	= 0.9431	

4.3.2 10 year maturity non-sinking fund bonds.

Tables 8 and 9 report the results of the estimation of Equation (15) and Equation (16) for the 10 year maturity group. The model explains 88% of the variation in the yield of the IRB issues, and 93% of the variation in the yield for the taxable issues. Again, the yields on both issue types are strongly correlated with the yield on an equivalent maturity Treasury issue. The estimated coefficients for the default risk proxies are monotonically increasing in risk for both groups, and are significantly different from zero for both the IRB issues and the taxable issues. The interest rate volatility variable is significant in explaining yields of both IRB issues and taxable issues. Neither group's yield appear related to the size of the issue. The amount of call protection provided to the investor is significant in explaining the yields of the IRB issues, indicating that more call protection results in lower yields. For the taxable issues, neither call protection nor refunding protection are significant in explaining yields. As with the 3 to 5 year maturity group, the yields of the 10 year maturity IRB issues are strongly related to the demand for tax exempts by financial institutions. This result is further evidence consistent with a segmentation of the market for municipal securities. Finally, the letter of credit variable is significant in explaining the yields of IRB issues, reflecting the increase in risk that occurs when the letter of credit expires.

Table 8. IRB issues only, 10 year maturity non-sinking fund bonds.

VARIABLE	PARAMETER ESTIMATE	T FOR H0: PARAMETER=0	PROB > T
INTERCEPT	1.0952	1.813	0.0722
TRS	0.7761	18.308	0.0001
AA	0.8788	4.540	0.0001
A	1.3406	6.222	0.0001
BAA	1.3981	5.281	0.0001
INTVOL	101.6405	4.582	0.0001
LNSIZE	0.0198	0.380	0.7045
CALLPRO	-1.2847	-5.756	0.0001
DEMAND	-3.0091	-3.392	0.0009
CREDIT	0.5850	2.578	0.0111
	N	= 137	
	F	= 115.1640	
	PROB>F	= 0.0001	
	ADJ R-SQ	= 0.8831	

Table 9. Taxable issues only, 10 year maturity non-sinking fund bonds.

VARIABLE	PARAMETER ESTIMATE	T FOR H0: PARAMETER=0	PROB > T
INTERCEPT	-1.5871	-2.887	0.0047
TRS	1.1286	39.186	0.0001
AA	0.1881	0.921	0.3591
A	0.5279	2.650	0.0092
BAA	1.1414	5.239	0.0001
INTVOL	63.9337	4.422	0.0001
LNSIZE	0.0033	0.042	0.9667
CALLPRO	-0.0072	-0.025	0.9800
REFPRO	-0.2511	-0.937	0.3507
	N	= 123	
	F	= 220.6810	
	PROB>F	= 0.0001	
	ADJ R-SQ	= 0.9351	

4.3.3 20 year or greater maturity sinking fund bonds.

Tables 10 and 11 report the results of the estimation of Equation (15) and Equation (16) for 20 year or longer maturity issues. The model explains 98% of the variation in the yield of the IRB issues, and 93% of the variation in the yield for the taxable issues. As with the shorter maturity issues, the yields on both issue types are strongly correlated with the yield on an equivalent maturity Treasury issue. The estimated coefficients for the default risk proxies are significant in explaining the yields on IRB and taxable issues, and are monotonically increasing as the perceived default risk increases. The interest rate volatility variable is significant in explaining yields of taxable issues and IRBs. The yields of the taxable issues decrease as the size of the issue increases. This is consistent with the hypothesis that larger issues are more marketable. The amount of call protection provided to the investor is positively related to yields for both IRBs and taxable debt. This is counter to the predicted result. One possible explanation for this finding is that more call protection increases the expected holding period of the bond. If the yield curve is upward sloping, callable issues will have shorter effective maturities and yields. The relative amount of sinking fund protection is insignificant in explaining yields for IRB issues and taxable debt. For the taxable issues, refunding protection is not significant in explaining yields. This is consistent with the results for the shorter maturity issues. Finally, as with the shorter maturity groups, the yields of the 20 year or greater maturity IRB issues are strongly related to the demand for tax exempts by financial institutions.¹⁷

¹⁷ There were 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.

Table 10. IRB issues only, 20 year or greater maturity sinking fund bonds.

VARIABLE	PARAMETER ESTIMATE	T FOR HO: PARAMETER=0	PROB> T
INTERCEPT	-0.5963	-1.056	0.2955
TRS	0.8841	26.209	0.0001
AA	0.7495	3.465	0.0010
A	0.9036	4.706	0.0001
BAA	1.4995	7.667	0.0001
INTVOL	59.8332	2.269	0.0271
LNSIZE	-0.0564	-1.584	0.1189
CALLPRO	1.0617	2.648	0.0105
SINKPRO	-0.1564	-0.572	0.5694
DEMAND	-1.7863	-5.378	0.0001
	N	=	66
	F	=	341.4530
	PROB>F	=	0.0001
	ADJ R-SQ	=	0.9792

Table 11. Taxable issues only, 20 year or greater maturity sinking fund bonds.

VARIABLE	PARAMETER ESTIMATE	T FOR H0: PARAMETER=0	PROB> T
INTERCEPT	-1.9431	-3.040	0.0030
TRS	1.2362	32.366	0.0001
AA	0.2270	1.522	0.1311
A	0.7242	5.050	0.0001
BAA	1.0654	5.208	0.0001
INTVOL	54.8205	4.262	0.0001
LNSIZE	-0.1827	-2.436	0.0166
CALLPRO	3.0620	2.476	0.0150
SINKPRO	0.9455	1.311	0.1930
REFPRO	0.2123	0.583	0.5611
	N	=	110
	F	=	160.7790
	PROB>F	=	0.0001
	ADJ R-SQ	=	0.9295

4.3.4 Estimation of Equation (17) for combined data.

Equation (15) and Equation (16) are used to determine the effects of various market and issue specific factors on the pricing of IRBs and taxable corporate issues. However, to determine if these factors have a differential effect on the pricing of the two, it is necessary to pool the data and estimate the coefficients of Equation (17). The results are reported in Tables 12, 13, and 14 for the three maturity groups. These tables display several significant differences in the pricing of IRBs and taxable corporate issues. For all three maturity groups, the interactive term IRB*TRS is significantly different from zero. These reflect the tax-exempt status of the IRB issues, with the negative signs on the estimated coefficients indicating the interest expense savings when compared with taxable corporate issues.

Tables 12, 13, and 14 display other significant differences between IRBs and taxable issues. The short-term IRB issues exhibit a much higher degree of sensitivity to interest rate uncertainty than do the taxable issues. For the ten year maturity group, a given amount of call protection results in a significantly lower yields on IRBs than on taxable issues. In addition, the IRB*DEMAND and IRB*CREDIT coefficients are all significantly different from zero.

In summary, Tables 12, 13, and 14 exhibit factors that have a differential effect on yields and therefore yield ratios, but which have not been controlled for in previous studies. This provides evidence that the implied tax rates given in Table 15 are superior to those found in studies which do not control for these factors.

The results also support the argument that IRBs are superior to ordinary municipal debt when computing yield ratios because of the enhanced ability to hold constant for default risk. That is, the estimated coefficients for the rating class interactive terms, IRB*AA, IRB*A, and IRB*BAA, are not significantly different from the AA, A, and BAA coefficients 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 [1982] where the inability to hold constant for relative default risk was significant.¹⁸

¹⁸ Note that Equation (15) and Equation (16) allow for the possibility that a given rating may have different effects on the yields of IRBs and taxable issues. Thus, the finding that two of the estimated ratings coefficients are significantly different between IRBs and taxables does not introduce bias into the estimation of the marginal tax rate.

Table 12. Combined issues, 3 to 5 year maturity non-sinking fund bonds.

VARIABLE	PARAMETER ESTIMATE	T FOR H0: PARAMETER=0	PROB > T
INTERCEPT	-1.7900	-0.838	0.4048
IRB	1.8982	0.748	0.4564
TRS	1.1026	9.945	0.0001
IRB*TRS	-0.5273	-4.030	0.0001
AA	0.3683	0.649	0.5183
IRB*AA	-0.3200	-0.499	0.6190
A	0.6140	1.084	0.2814
IRB*A	0.1469	0.226	0.8218
BAA	1.4966	1.719	0.0894
IRB*BAA	-0.0978	-0.103	0.9183
INTVOL	35.4440	0.665	0.5081
IRB*INTVOL	193.8789	2.883	0.0050
LNSIZE	0.1236	0.381	0.7039
IRB*LNSIZE	-0.1881	-0.569	0.5708
CALLPRO	0.0645	0.107	0.9154
IRB*CALLPRO	0.2862	0.399	0.6908
REFPRO	-0.3572	-0.408	0.6840
IRB*DEMAND	-2.9729	-2.764	0.0071
IRB*CREDIT	1.4267	4.461	0.0001
	N	= 100	
	F	= 26.0330	
	PROB>F	= 0.0001	
	ADJ R-SQ	= 0.8199	

Table 13. Combined issues, 10 year maturity non-sinking fund bonds.

VARIABLE	PARAMETER ESTIMATE	T FOR H0: PARAMETER=0	PROB > T
INTERCEPT	-1.5871	-2.736	0.0067
IRB	2.6824	3.275	0.0012
TRS	1.1287	37.138	0.0001
IRB*TRS	-0.3525	-6.953	0.0001
AA	0.1881	0.873	0.3837
IRB*AA	0.6907	2.430	0.0158
A	0.5279	2.512	0.0127
IRB*A	0.8126	2.759	0.0062
BAA	1.1415	4.965	0.0001
IRB*BAA	0.2566	0.750	0.4541
INTVOL	63.9337	4.191	0.0001
IRB*INTVOL	37.7068	1.442	0.1505
LNSIZE	0.0033	0.040	0.9684
IRB*LNSIZE	0.0165	0.169	0.8660
CALLPRO	-0.0072	-0.024	0.9810
IRB*CALLPRO	-1.2774	-3.433	0.0007
REFPRO	-0.2511	-0.888	0.3754
IRB*DEMAND	-3.0091	-3.543	0.0005
IRB*CREDIT	0.5850	2.693	0.0076
	N	= 260	
	F	= 196.9520	
	PROB>F	= 0.0001	
	ADJ R-SQ	= 0.9297	

Table 14. Combined issues, 20 year or greater maturity sinking fund bonds.

VARIABLE	PARAMETER ESTIMATE	T FOR H0: PARAMETER=0	PROB> T
INTERCEPT	-1.9432	-3.487	0.0006
IRB	1.3469	1.320	0.1887
TRS	1.2363	37.122	0.0001
IRB*TRS	-0.3522	-5.779	0.0001
AA	0.2271	1.746	0.0828
IRB*AA	0.5224	1.483	0.1400
A	0.7242	5.793	0.0001
IRB*A	0.1794	0.567	0.5715
BAA	1.0655	5.974	0.0001
IRB*BAA	0.4340	1.256	0.2110
INTVOL	54.8205	4.888	0.0001
IRB*INTVOL	5.0127	0.121	0.9039
LNSIZE	-0.1828	-2.793	0.0059
IRB*LNSIZE	0.1263	1.490	0.1382
CALLPRO	3.0620	2.840	0.0051
IRB*CALLPRO	-2.0003	-1.617	0.1079
SINKPRO	0.9456	1.503	0.1348
IRB*SINKPRO	-1.1019	-1.464	0.1453
REFPRO	0.2123	0.669	0.5046
IRB*DEMAND	-1.7863	-3.554	0.0005
	N	= 176	
	F	= 220.4420	
	PROB>F	= 0.0001	
	ADJ R-SQ	= 0.9597	

4.3.5 Estimation of the marginal investor's tax rate.

The estimated coefficients on the TRS variable in Equation (15) and Equation (16) are used with Equation (23) to estimate the tax rate of the marginal buyer of tax-exempt debt. Table 15 reports the results of the estimation for all three maturity groups, and Appendix A shows the method used to determine the 95% confidence interval on the estimate.

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 tax rate is 48%. During the time period covered by the data, the top marginal tax rate of 46% for corporations was well within the estimated 95% confidence interval. and is consistent with most short-term tax exempts being purchased by fully taxed institutions such as commercial banks and property and casualty insurance insurance companies.

Financial institution holdings of tax exempts are concentrated in maturities of 5 years or less. In 1981, only 27% of bank holdings of tax exempts had maturities of 10 years or more.¹⁹ The estimated tax rates for the 10 year maturity group and 20 year or greater maturity group are 31% and 28.5%, respectively. The top corporate marginal tax rate of 46% is not within the estimated 95% confidence interval 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 evidence in Tables 6, 8, and 10 that the yields on IRBs are a function of the relative demand for tax-exempts by financial institutions, it provides further support for the market segmentation hypothesis.

¹⁹ See Fabozzi [1983], p. 100.

Table 15. Estimated marginal investor tax rates.

Maturity group	Estimated tax rate	95% confidence interval	
		Lower	Upper
3 to 5 years	47.8%	33.0%	62.7%
10 years	31.2%	23.4%	39.1%
20 or more years	28.5%	22.2%	34.8%

5.0 Summary and Conclusions

Industrial revenue bonds are unique among the financing instruments available to corporations. Because they are issued by municipalities, the interest investors receive from them is exempt from federal and state taxation (within the state of issue). At the same time, the payments made by the firm to the bondholders' trustee to service the debt are deductible from operating income in determining the tax bill. These characteristics provide a unique opportunity to test the interest tax shield hypothesis of Modigliani and Miller [1963]. The examination of the announcement day excess returns for IRB issues reveals a positive significant market reaction. However, this excess return is unrelated to theoretical predictions of tax shields on the debt, non-debt tax shields, an interior optimal capital structure, and the risk of the issue. The positive excess return is consistent with the argument that IRBs provide a subsidy to issuing firms.

Miller [1977] develops an equilibrium model of tax-exempt and taxable debt markets which predicts that the tax rate of the marginal buyer of debt will be equal to the corporate tax rate. Several authors have examined this hypothesis using the yield spread on municipal and corporate debt. One shortcoming in these tests has been the inability

to adequately control for the relative risk of the two security types. IRBs are used in this dissertation to overcome this problem. Because the firm's obligation to make the rent or lease payments on IRBs is unconditional, they are equivalent in risk to the senior unsecured debt of the issuing firm. Moody's Investors Service rates IRB issues the same as the senior unsecured debt of the issuing firm, providing a standard for comparison with ordinary taxable corporate debt. This dissertation tests the Miller hypothesis by comparing the yield spread between IRBs and taxable corporate debt. The yield spread test improves on earlier tests by using securities that are more comparable and by taking into account factors shown by previous research to be relevant in pricing bonds. 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, buy most of the short term tax-exempt debt on the market. For short-term issues, the implied tax rate is not significantly different from the corporate tax rate, consistent with Miller's prediction. For long-term issues, the implied tax rate is significantly lower than the corporate tax rate and decreases with maturity. This is consistent with the the excess supply of tax-exempts being purchased by individuals in increasingly lower tax brackets.

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Appendix A. Confidence interval on estimated tax rate.

The estimate of the marginal investor's tax rate is given by Equation (23):

$$\frac{\hat{\alpha}_1}{\hat{\gamma}_1} = (1 - \hat{\tau}_{pb}'). \quad (23)$$

The null hypothesis is:

$$H_0: 1 - \hat{\tau}_{pb}' = \frac{\hat{\alpha}_1}{\hat{\gamma}_1} = 1 - \tau_c, \quad (24)$$

which may be rewritten as:

$$H_0: \hat{\alpha}_1 - (1 - \tau_c)\hat{\gamma}_1 = 0. \quad (25)$$

The null hypothesis as stated in Equation (25) is a linear combination of normally distributed variables, so it is itself normally distributed:

$$\hat{\alpha}_1 - (1 - \tau_c)\hat{\gamma}_1 \sim N(\alpha_1 - (1 - \tau_c)\gamma_1, \text{var}(\hat{\alpha}_1 - (1 - \tau_c)\hat{\gamma}_1)), \quad (26)$$

where:

$$\text{var}(\hat{\alpha}_1 - (1 - \tau_c)\hat{y}_1) = \text{var}(\hat{\alpha}_1) + (1 - \tau_c)^2 \text{var}(\hat{y}_1) - 2(1 - \tau_c)\text{cov}(\hat{\alpha}_1, \hat{y}_1). \quad (27)$$

The covariance term in Equation (27) is assumed to be zero because $\hat{\alpha}_1$ and \hat{y}_1 are estimated independently. Using Equation (26) and Equation (27), a 95% confidence interval can be calculated for the estimate of the marginal investor's tax rate. The example shown below is for the 3 to 5 year maturity bonds. The same technique is used for the 10 year maturity and 20 year or greater maturity bonds. The results for all three groups are given in Table 16.

From Table 6 and Table 7:

$$\begin{aligned} \hat{\alpha}_1 &= 0.5753 & \text{var}(\hat{\alpha}_1) &= 0.00585 \\ \hat{y}_1 &= 1.1026 & \text{var}(\hat{y}_1) &= 0.00382 \\ \text{var}(\hat{\alpha}_1 + (1 - \tau_c)\hat{y}_1) &= 0.00585 + (1 - 0.46)^2(0.00382) \\ &= 0.00696 \end{aligned}$$

The null hypothesis is $H_0: \hat{\alpha}_1 - (1 - \tau_c)\hat{y}_1 = 0$.

For $\tau_c = 0.46$, $\hat{\alpha}_1 - (1 - \tau_c)\hat{y}_1 = -0.0201$.

So, a 95% confidence interval on $\hat{\alpha}_1 - (1 - \tau_c)\hat{y}_1$ is:

$$\begin{aligned} -0.0201 \pm t_{0.025, 72+28-(10+9)} \sqrt{0.00696} \\ -0.0201 \pm 1.96(0.08345) \end{aligned}$$

So, $-0.1837 \leq \hat{\alpha}_1 - (1 - \tau_c)\hat{y}_1 \leq 0.1435$.

For the estimation period, $\tau_c = 0.46$, so:

$$\begin{aligned} -0.1837 \leq \hat{\alpha}_1 - (1 - 0.46)\hat{y}_1 \leq 0.1435, \\ -0.1837 + (1 - 0.46)\hat{y}_1 \leq \hat{\alpha}_1 \leq 0.1435 + (1 - 0.46)\hat{y}_1, \end{aligned}$$

$$\frac{-0.1837}{\hat{\gamma}_1} + (1 - 0.46) \leq \frac{\hat{\alpha}_1}{\hat{\gamma}_1} \leq \frac{0.1435}{\hat{\gamma}_1} + (1 - 0.46),$$

$$0.3734 \leq \frac{\hat{\alpha}_1}{\hat{\gamma}_1} \leq 0.6701.$$

From Equation (23), the estimate of the marginal investor's tax rate is $1 - \frac{\hat{\alpha}_1}{\hat{\gamma}_1}$, so a 95% confidence interval on τ'_{pb} is:

$$0.329 \leq \tau'_{pb} \leq 0.627.$$

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