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The Pricing of Short-Term Debt and the Miller Hypothesis: A Note

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IN 1977, MILLER [2] CHALLENGED conventional wisdom concerning the gain from corporate leverage. Introducing an equilibrium model of the municipal and corporate debt markets and arguing that the effective personal tax rate on equity is negligible, Miller concluded that the relevant marginal tax rate operating across the two markets would be the corporate rate and, as a result, the marginal value of the tax shield to an individual firm would be zero. The purpose of this paper is to present additional evidence regarding implied marginal tax rates on interest income. Taxable and tax-free money market funds are compared, making it possible to avoid difficulties in previous studies involving long-term bond yields. The results support the Miller hypothesis. When these short-term rates are compared, when there is little term structure impact, and when risk differences are small, observed returns on taxable and tax-free investments imply a tax rate almost exactly equal to the corporate rate.

I. Previous Research

The relationship between taxable and tax-free rates in the same risk and maturity class was described by Miller as

$$R_0 = BR_t \tag{1}$$

where the tax-free return, R_0, is equal to the taxable return, R_t, times a tax adjustment factor, B. An investor will be indifferent between the two when B equals $(1.0 - t_{pb})$, where t_{pb} is the personal tax rate on interest income. Miller argues that t_{pb} equals the corporate rate, t_c, in equilibrium, and taxable rates are "grossed up" to $R_0[1/(1 - t_c)]$.

Despite the intuitive reasonableness of the argument, empirical studies based on long-term yield ratios find implied tax rates on the order of 30%, with the estimates varying over time [3, 9]. This has been attributed to market segmentation and, specifically, to the cyclical demands and short-term maturity preferences of commerical banks and other financial intermediaries. If municipalities prefer to issue long-term maturities, an extra inducement must be offered to attract investors in lower tax brackets [4, 9]. However, this argument ignores supply adjustments in the corporate debt market. If it were true, corporations would find it advantageous to offer long-term debt at higher rates

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to these same investors. Thus, segmentation of the municipal debt market alone cannot explain the discrepancy.

An alternative to segmentation is that the bonds used in computing the tax rates are not comparable. Trzcinka [8] argues that there are risks in addition to default which are not captured by bond ratings and that municipals will have greater average risk than corporates of the same rating. Trzcinka's results generally support the Miller hypothesis, but the estimated equilibrium tax rates vary from 38 to 57%. Also, Skelton [5] has presented evidence which suggests that municipals and corporates have quite similar risks.

II. Data and Methodology

To properly test the Miller hypothesis, Equation (1) must be applied to instruments which are as identical as possible in all attributes except their tax liability. This is not easily accomplished with long-term securities. Even par value corporates and municipals have differences beyond the Federal tax treatment of interest. For example, if the term structure is not flat and the marginal investor's holding period is less than the maturity on the bonds being compared, then there are capital gains implications for both securities. Also, under uncertainty, capital structure decisions would be based on expected future tax liabilities. For this reason, implied tax rates inferred from long-term yield ratios may represent a complex average of expected future tax rates, not just current rates. These types of problems would tend to increase with maturity, and comparisons using long-term instruments may be misleading as a result.[1]

In addition to the data problem, the appropriate specification must be addressed as well. With well-matched data, a test of the Miller hypothesis would involve fitting (1) with a suppressed intercept and testing whether the implied tax rate differs from the corporate rate.[2] Since the Miller hypothesis should be tested with a no-intercept model and since there may be problems with risk mismatches and term structure impacts in previous tests, the major advantage of this study is that it uses only short-term money market funds. These returns are less affected by differences in maturity, duration, liquidity, tax treatment, and credit risk. There is a drawback, however. Although the Miller hypothesis is not specific to long-term debt, results obtained from short-term debt can be generalized only if the expectations hypothesis holds. If municipal and corporate debt markets are both segmented, then different tax brackets may prevail for different maturities.

The initial data used in this study are the annualized weekly average returns of general purpose money market funds. The primary data source, the weekly

[1] A test of the Miller equilibrium using long-term debt involves several joint hypotheses. Rejection could occur because the bonds are not comparable and expected future tax rates (personal and corporate) are unknown, or because markets are segmented. Thus, the power of such tests would seem low. We believe that the difficulty in finding proper comparisons is the major factor; hence, this study concentrates on obligations where this problem is not as severe.

[2] Note that this is not the same as fitting the model with an intercept and testing whether the intercept is zero. A suppressed intercept is a particular specification of the model. See Aigner [1, pp. 85–90] for a discussion.

Donoghue's Money Fund Report, lists six separate categories of taxable general purpose money market funds available to the public and one category of tax-free funds.[3] Since these classifications are associated with different investment policies, an initial test will be performed to determine the impact of the various investment restrictions on the returns from these funds. The time period for study is February 15, 1982 to July 25, 1983 or 76 weeks.[4]

In addition to potential risk differences, the maturities of the underlying assets of taxable funds tend to be shorter than those of tax-free funds. To avoid this problem, the final data set used in this analysis is selected to reduce any effect of maturity differences. This final data set consists of ten taxable interest rate series and ten tax-free series. In each of the 76 weeks, the returns on the ten tax-free funds with the *shortest* maturities were collected along with the returns on the ten taxable funds with the *longest* maturities.[5] Then, within each week, the ten returns for both groups were sorted by maturity from shortest to longest. The first series was created by taking the first pair of observations from each week. The second series consists of the second pair, and so on for a total of ten matched series. Since these criteria result in a new group of funds being selected each week, the set of funds included is not constant across the data set or through time.

With the ten paired series, Equation (1) is first estimated using ordinary least squares (OLS). However, because the investments of the funds used are quite similar, we expect the disturbances to be cross-sectionally correlated. This being the case, more efficient estimates are obtained using a seemingly unrelated regressions (SUR) routine.[6]

III. Results

The initial unmatched data set, consisting of the returns on the tax-free and taxable money market funds, was first analyzed to determine the impact of investment policy on the returns offered. There are six investment classifications of taxable funds with an average return over the 76-week study period of 9.470% versus a tax-free return over the same period of 5.477%. The use of these averages provides a crude ratio of 0.578 and an implied tax rate of 42.2%, lower than the prevailing corporate tax rate of 46%. The return series are highly correlated. The

[3] *Donoghue's* six categories of taxable funds are: U.S. Treasury; U.S. Government and Agencies; Domestic Prime; Domestic Prime and Eurodollar; Domestic Prime, Eurodollar and Yankeedollar; and Aggressive. There is only one category for tax-free funds: General Purpose and Stockbroker. There is an Institutions Only classification for both taxables and tax-free. These were excluded from this study, as we want to compare returns on funds available to the public. See Smith [6] for detailed definitions of these classifications.

[4] The beginning of the period coincides with the first listings of the returns on tax-free funds.

[5] Even after using this selection process to reduce maturity mismatches, the maturities of the tax-free funds had slightly longer maturities than did the taxable funds. Over the study period, the range of average maturities for the tax-free funds selected for study was 49.4 to 75.1 days. The average maturity of the tax-free funds chosen was 62.7 days. The range of average maturities of the taxable funds was 42.5 to 65.5 days, and the average maturity was 47.8 days.

[6] There are a number of standard econometric textbooks which have details of this methodology, e.g., Theil [7, pp. 295–317].

lowest correlation, 0.857, was between the tax-free series and the taxable rates on funds which restricted their investments to U.S. Treasury securities. The next lowest correlation, 0.921, was between two taxable funds. Despite the correlation between the returns, the aggressive classification had an average return one percentage point higher than that of the U.S. Treasury classification. Therefore, it appears that there is an impact on the returns due to investment policy.

The tax-free series was then regressed on each of the taxable series using (1).[7] The resulting average B-value of all six regressions is 0.5427, a value close to that implied by the Miller hypothesis. Even so, the initial data still have the potential for maturity mismatches. For the study period, the average maturity of the investments underlying the tax-free funds is about 30 days longer than those of the taxable funds. Therefore, all subsequent analyses are based on the ten maturity matched series.

Summary statistics for the ten series are reported in Table I. Column (5) contains the average maturity differences between all the matched pairs. These range from 1.86 to 22.47 days with an average difference of 14.89 days. The average implied tax brackets are reported in Column (6). These estimates are similar to each other and average 43%.

The data summarized in Table I were then placed into the form of Equation (1) and a separate regression was run on each of the ten series over the 76 weeks. The B-values of each of these OLS equations with a suppressed intercept are found in Column (1) of Table II. All of these values are statistically significant (all of the t-statistics are in excess of 50) and the average of the ten B-values is 0.55148, providing an average implied tax rate of 44.85%.

The B-values from the SUR procedure are shown in Column (2) of Table II. The average of these values is 0.53974 and the implied tax rate is 46.03%, very close to the corporate tax rate during this period. At the bottom of Column (2), the F-value for the test of the equality of the SUR estimates indicates no evidence of significant differences between the ten coefficients.

To examine the impact of a maturity mismatch on the B-values, the ordering form of the matches was reversed. This was accomplished by ranking the tax-free returns in each week with the longest maturity first. These returns were compared to the taxable returns ranked in each week from shortest to longest.[8] The results of using the SUR procedure are found in Column (3) of Table II. The average of these ten B-values from the mismatched data is found to be 0.54032, implying a tax rate of 45.97%. However, there is greater variation in the individual

[7] The first-order autocorrelation coefficient was close to unity in all six regressions. Higher order coefficients were small. The standard autoregressive transformation was employed iteratively to each equation. Owing to the severity of the problem, convergence typically required three iterations. The autocorrelation stems from the relative certainty of the returns and the weekly reporting interval. The Durbin-Watson statistic and conventional measures of goodness of fit lack meaning when the model has a suppressed intercept and are not reported. This problem is less severe in the final data set because the funds used are not constant through time.

[8] The maturity differences ranged from −21.1 to +32.7 days. Recall, however, that the data have already been screened to reduce maturity mismatches; therefore, even these mismatched data are closer in maturity than is likely for a random sample. The average maturity difference in our sample is 15 days, versus 30 days for all funds.

Table I

Comparison of Tax-Free Versus Taxable Interest Returns on Money Market Funds with Matched Maturities

Match Number	(1) Average Interest Tax-Free Funds (%)	(2) Average Maturity Tax-Free Funds (days)	(3) Average Interest Taxable Funds (%)	(4) Average Maturity Taxable Funds (days)	(5) Average Maturity Difference (2) − (4) (days)	(6) Average Implied Tax Rate 1 − (1)/(3)
1	5.7479	44.38	10.2250	42.53	1.86	0.42943
2	5.8232	51.22	10.3053	43.04	8.18	0.42626
3	5.7913	55.82	10.3434	43.72	12.09	0.43531
4	5.8053	59.30	10.4711	44.28	15.03	0.43357
5	5.7167	62.76	10.1711	44.99	17.78	0.42617
6	5.7903	66.05	10.4329	45.83	20.22	0.42952
7	5.8191	68.43	10.3500	47.07	21.37	0.43123
8	5.8071	70.67	10.3197	48.20	22.47	0.42967
9	5.8407	72.78	10.2474	52.57	20.21	0.42320
10	5.8380	75.21	10.4382	65.53	9.68	0.43651
Averages	5.7980	62.66	10.3304	47.78	14.89	0.43009

Table II

Miller Hypothesis Applied to Tax-Free and Taxable Interest Returns of Money Market Funds with Matched and Mismatched Maturities

Match Number	(1) OLS Betas Matched Maturities	(2) SUR Betas Matched Maturities	(3) SUR Betas Mismatched Maturities
1	0.554535	0.545548	0.535682
2	0.557214	0.545464	0.542536
3	0.544403	0.531070	0.546675
4	0.540813	0.528937	0.543082
5	0.550445	0.534903	0.537642
6	0.540213	0.523991	0.553481
7	0.556557	0.550185	0.515952
8	0.555410	0.543290	0.522773
9	0.562034	0.551161	0.555986
10	0.553182	0.542804	0.549421
Average Beta	0.551481	0.539735	0.540323
Implied Tax Rate	0.448529	0.460265	0.459677
F-Statistic for Differences in Beta Values, 9/750 d.f.		1.5116	1.9551
Significance Levels		0.1387	0.0416

estimates, and the hypothesis of the equality of the slope coefficients can be rejected at the 5% level. Even so, the average implied investor tax rate which results from the best maturity matches found in Column (2) (46.03%) is virtually identical to the implied tax rate from the deliberately mismatched maturities (45.97%). Finally, both rates are extremely close to the marginal corporate tax rate of 46% as hypothesized by Miller. In summary, when risk differences are not large and there is little maturity mismatch, the evidence strongly supports the hypothesis that the relevant tax rate operating across short-term taxable and tax-free investments is the corporate rate.

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