THE INFLUENCE OF INCOME TAX RATES
ON THE MARKET FOR TAX-EXEMPT DEBT

by

G. Marc Choate,

Michael L. Hand

and

Fred Thompson

Atkinson Graduate School of Management
Willamette University
900 State Street
Salem, Oregon 97301
ABSTRACT

Based on the indirect arbitrage opportunities afforded citizens by tax-exempt debt issue, this article presents a model establishing equilibrium in the market for tax-exempt debt. The model yields two predictions. Increases in Federal income tax rates increase the spread between taxable and tax-exempt interest rates, but have no effect on the equilibrium quantity demanded and supplied of tax-exempt debt. The latter prediction contrasts with a conventional point of view that increases in tax rates increase demand and supply of tax-exempt debt. The model’s predictions are supported by empirical evidence.
The Influence of Income Tax Rates on the Market for Tax-Exempt Debt

Miller and Modigliani (M&M) (1958) argue that in the absence of tax considerations, capital structure shouldn’t matter to a for-profit business: it will have the same value whether financed by a capital levy or by debt and should make the same investment/resource allocation decisions. However, this result fails when debt receives favorable tax treatment. In that case entities should prefer debt financing (Modigliani and Miller 1958, Miller 1977). In public sector finance, the issue that corresponds to the capital structure question in corporate finance is whether the form of finance of a public program (bonds versus current assessment) matters to a community (Baesel, Methe, and Shulman 1981), what we call the tax policy question.

The capital structure/tax policy question is intrinsically interesting for a variety of reasons. The notion that tax policy matters underlies, for example, all sorts of restrictions on governmental debt financing, both self denying ordinances and externally imposed restrictions, although as a matter of fact, these restrictions were largely driven by discrete historical events (Reinhart & Rogoff 2008). Moreover, because different kinds of entities face different tax incentives, studying the capital structure of governments, non-profits, and for-profits would effectively represent a natural experiment helping to isolate and measure the various effects of tax vs. non-tax capital structure incentives that entities face. It is not obvious how this would play out.

Spencer Banzhaf and Wallace Oates (2009) provide a simple multi-period proof that, where local fiscal differentials are capitalized into local property values, the form of finance of a public program (tax or debt finance) should have no effect on substantive outcomes (see also Breton 1977). Moreover, their proof is similar to M&M in that they conclude that income taxes matter: exempting interest income from state and local bonds from federal income taxation should lead to a preference on the part of electorate for bond finance over tax finance. They also present an econometric analysis of local referenda in the U.S. that seems consistent with this conclusion.¹
It is our view that Banzhaf and Oates give up on their proof too easily. Exempting interest income from state and local bonds from federal income taxation should lead to a preference on the part of electorate for bond finance over tax finance only when it has an effect upon supply and demand in the market for tax-exempt debt. Of course, there is a substantial body of work that suggests that variations in Federal income tax rates have major effects in the market for tax-exempt debt. Indeed, Peter Fortune (1984, 1992, 1998) argues that, as a practical matter, tax exemption creates an important subsidy to municipal spending that acts to increase the supply of tax-exempt debt. Presumably, given the exemption, increases in income tax rates increase the value of that subsidy and act to augment the supply of such debt. Holtz-Eakin (1991) and Metcalf (1991) also find that supply of tax-exempt debt reacts positively to increases in income tax rates. At the same time, Fortune argues that increases in income tax rates enhance the demand for tax-exempt debt by making it more attractive to investors. This facilitates investment in public infrastructure and school construction (PA Times, 1 May 1996: 1, 20).

Taken together, these views of supply and demand suggest that increases in income tax rates should increase the flow of funds through the market for tax-exempt debt. For convenience, we label this prediction as a conventional point of view. If it is correct, then the effect of changing Federal income tax rates on the market for tax-exempt debt is a policy issue. Increases in tax rates expand that market while reductions should reduce it.

We believe that the conventional view is a chimera. We reach this conclusion by use of a model constructed to explain the behavior of equilibrium total quantities of tax-exempt debt demanded and supplied. This approach contrasts with efforts that have centered on explaining demand or supply but not their interaction. The centerpiece of the model is the notion of indirect arbitrage, implicit in Adams (1977) and explicit in Gordon and Slemrod (1986) and Gordon and Metcalf (1991). As the latter papers have demonstrated, when state and local governments issue
tax-exempt debt, they are acting as intermediaries for citizens. Such debt issues provide immediate tax relief for citizens, in amounts equal to the proceeds from debt issue, in exchange for higher future taxes necessary to service the debt. Both low- and high-income citizens benefit from such transactions. Low-income citizens can purchase taxable debt (or reduce private borrowing) in amounts equal to their immediate tax savings and enjoy an after-tax return in excess of the tax-exempt rate governing their future tax liabilities. High-income citizens gain by purchasing tax-exempt debt with a return in excess of the after-tax return available to them from purchase of taxable debt.

To create our model of the market for tax-exempt debt, we have borrowed freely from the spirit of an earlier model of the market for corporate (taxable) debt devised by Miller (1977). Two predictions result from our model. The first is that the equilibrium tax-exempt interest rate declines with increases in income tax rates. This proves to be a useful but hardly novel finding (Poterba 1986, 1989). The second prediction is, perhaps, surprising: the equilibrium quantity of tax-exempt debt demanded and supplied is unaffected by changes in income tax rates. The reason for this is simple: whatever effect a change in tax rates has upon the demand for tax-exempt debt is exactly offset by the effect of the tax rate change upon supply. To achieve this result, the principal assumption required is that income tax rates have a progressive structure.²

The predictions of our model and those of the conventional view regarding the effect of changes in income tax rates on the quantity of tax-exempt debt bought and sold clearly differ. Resolution of these differences must take place at the empirical level. We provide empirical tests that support the notion that changes in income tax rates have no effect on the quantity of tax exempt debt bought and sold, these results being inconsistent with the conventional view. These results suggest that policy debates regarding the effect of tax rate changes on the scope of the market for tax-exempt debt are irrelevant.
The paper has three sections. In the first, we establish a model of equilibrium in the market for tax-exempt debt. In the second, the model’s predictions are developed. Empirical evidence is offered in the third section. A brief summary concludes the paper.

I. Equilibrium in the Market for Tax-Exempt Debt

What are the indirect arbitrage gains afforded the public by tax-exempt debt issue? The answer to this question is important because it underpins the aggregate demand and supply schedules for debt and the resulting equilibrium conditions in the market for tax-exempt debt.

A. Indirect Arbitrage Gains

We initially assume an absence of tax-exempt borrowing by state and local entities. In that setting, individuals and state and local governments (hereafter referred to as communities) confront a time horizon consisting of the present and a perpetual future. All present and future spending and taxation plans of communities are risk-free cash magnitudes and independent of changes in federal income tax rates. Given these plans, individuals are left with patterns of present and future incomes subject to taxation. Federal income taxes confronting individuals are progressive with $t_j$ being the marginal tax rate for the $j^{th}$ tax bracket. Individuals seek to optimize their patterns of present and future consumption over time by appropriate borrowing or lending in the market for taxable debt. For simplicity, it is assumed that marginal tax brackets for any individual are not changed by such transactions. Like Miller, we assume that all taxable debt is risk-free, taking the form of perpetuities with interest rate $r$. Interest returns from lending are taxable as income and interest expense from borrowing is deductible against taxable income.

Suppose now that a community issues risk-free perpetual tax-exempt debt bearing interest rate $r_e$. With spending plans unchanged, a resident of that community necessarily receives immediate tax relief in the pro rata amount $e_i$ for the $i^{th}$ individual and bears a higher future tax liability of $r_e e_i$ per year necessary to meet the pro rata debt obligation. Each citizen's optimal
consumption pattern over time is thus disturbed in favor of current consumption by tax-exempt debt issue. Utility of consumption over time is now no longer maximized. To restore an optimal consumption pattern, citizens must act in markets to increase future consumption. In doing so, consider the indirect arbitrage opportunity confronting a low income citizen of the community subject to marginal income tax rate \( \tau_j \). If that citizen, in pursuing an optimal consumption pattern over time, would otherwise have been a lender in the taxable market, with marginal after-tax annual return of \((1-\tau_j)r\), then the marginal gain from investing one dollar of immediate tax relief in taxable debt is:

\[
(1-\tau_j)r - r_c. \tag{1}
\]

Given tax-exempt interest rate \( r_c \), a sufficiently low marginal tax rate \( \tau_j \) will render (1) positive. Borrowing by the community on behalf of the individual at the tax-exempt rate enables that individual to increase future consumption by lending out the \textit{pro rata} proceeds at the higher after-tax taxable rate. This indirect arbitrage opportunity also extends to low-income citizens who would otherwise have been borrowers in the taxable market. The gain in (1) then represents savings achieved by using the \textit{pro rata} immediate tax relief to directly reduce private indebtedness or to purchase taxable debt to defease the citizen's private debt liability.

Consider now the situation for high-income citizens where, given \( r_c \), the marginal tax rate is sufficiently high such that (1) is negative; tax-exempt debt issue would then appear to make high-income citizens worse off since the tax-exempt interest rate is greater than the after-tax interest rate on taxable debt. But this would be the case for high-income citizens only if they allowed themselves be made worse off. However, they can easily prevent this outcome by using their tax relief allotments to purchase some of the newly-issued tax-exempt debt of their communities. This would \textit{neutralize} the unfavorable effect of tax-exempt debt issue by economically extinguishing the high-
income citizen’s pro rata tax-exempt debt liability. A high-income citizen who would otherwise have been a borrower in the taxable debt market continues (post neutralization) to be one with no ill effects from tax-exempt debt issue. As for the high-income citizen who would otherwise have been a lender, the (post-neutralization) marginal gain available from reducing lending in the taxable market in order to increase lending in the tax-exempt market is

\[ r_e - (1 - \tau_j)r. \]  

For a sufficiently high tax rate, (2) will be positive and high-income citizen lenders clearly gain from tax-exempt debt issue.

Tax-exempt debt issue thus enables the exploitation of indirect arbitrage gains for low-income citizens, whether lenders or borrowers, as well as high-income citizen lenders\(^5\). That such gains are relevant concepts for construction of demand and supply schedules for tax-exempt debt is supported by the empirical evidence offered by Gordon and Slemrod (1983).

B. Aggregate Demand, Aggregate Supply and Equilibrium

To reach equilibrium it is necessary to create conditions where all tax-exempt debt is the same, regardless of the issuing community. The previous assumption that all debt is risk-free facilitates reaching this goal. In addition, it is assumed that tax-exempt debt issued by any community is tax-exempt in all communities.\(^6\) Finally, since indirect arbitrage gains depend on a structure of progressive income taxes, the latter must be specified. Let the tax rate for the jth marginal income tax bracket be

\[ \tau(j) = t(j)\tau_{\text{max}} \]  

\(^5\)
where \( \tau_{\text{max}} \) is the maximum tax rate and \( t(j) \) is a monotonically increasing function across brackets \( j \) with minimum value \( t(j_{\text{min}}) = 0 \) and maximum value \( t(j_{\text{max}}) = 1 \). This causes the corresponding net taxable interest rate for bracket \( j \) to be

\[
r_{T(j)} = (1 - t(j)\tau_{\text{max}})r.
\]  

(4)

Given the indirect arbitrage gains afforded low-income citizens by tax-exempt borrowing, the aggregate supply function of tax-exempt debt is

\[
B_s = B_s[(1 - t(j)\tau_{\text{max}})r - r_e]\]

(5)

where \( \partial B_s/\partial r_e < 0 \) - i.e., supply decreases with higher tax-exempt interest rates. This supply is defined as a flow for time period zero. Such a schedule is depicted in Figure 1 as the line labeled \( B_s \), given some equilibrium taxable interest rate \( r \). To explain the shape of this schedule, consider the lowest tax bracket \( t(j) = 0 \). For individuals in this zero-bracket, the net taxable interest rate from (4) is \( r \). Since the condition \( r > r_e \) holds for such individuals, they can benefit from indirect arbitrage and would want their communities to issue (supply) such debt on their behalf. This lowest tax bracket establishes the intercept of the supply schedule at taxable interest rate \( r \). For the remaining low-income individuals subject to income taxation to benefit from tax-exempt debt issue the condition \((1-t(j)\tau_{\text{max}})r > r_e \) must hold. For this to happen, the tax-exempt interest rate \( r_e \) must decline in order to enable low-income individuals in successively higher (but still low) tax brackets to enjoy indirect arbitrage gains. Thus, the supply schedule \( B_s \) slopes downward in Figure 1.
Figure 1 Supply and Demand for Municipal Debt
The aggregate demand schedule for tax-exempt debt, also defined as a flow for time zero, is

\[ B_d = B_d \left[ r_e - (1 - t(j)\tau_{\text{max}})r \right]. \]  

(6)

where \( \partial B_d/\partial r_e > 0 \). This schedule is portrayed in Figure 1 by the upward sloping schedule labeled \( B_d \). Explaining its shape, note that in order to induce purchase of tax-exempt debt, the condition \( r_e > (1 - t(j)\tau_{\text{max}})r \) must hold. Then consider the situation for high-income individuals in the maximum tax bracket where \( t(j) = 1 \) and, from (3), \( \tau(j_{\text{max}}) = \tau_{\text{max}} \). In order for such individuals to gain from purchase of tax-exempt debt, the tax-exempt interest rate must be \( r_e > (1 - \tau_{\text{max}})r \). Thus, the intercept for the demand schedule is \((1 - \tau_{\text{max}})r\). The positive slope of the demand schedule arises because in order to induce additional demand from individuals in high (but successively lower) brackets than the maximum \( \tau_{\text{max}} \), tax-exempt interest rate \( r_e \) must increase.  

Determining results at equilibrium, we equate the supply and demand schedules in (5) and (6) to obtain the equilibrium tax-exempt interest rate

\[ r_e^* = (1 - t(j^*)\tau_{\text{max}})r. \]  

(7)

The last dollar of tax-exempt debt demanded and supplied occurs at tax bracket \( (j^*) \) with tax rate \( \tau(j^*) \) from (3) being \( 0 < \tau(j^*) < \tau_{\text{max}} \). Note that we have here not only an equilibrium tax-exempt interest rate, but an equilibrium tax bracket \( (j^*) \). This is obvious because taxable interest rate \( r \) is given in (7) and \( r_e^* \) depends on that equilibrium tax bracket. Thus, a progressive tax structure that drives both supply and demand is central to this outcome. Without progressive taxes, there are no gains from indirect arbitrage. Equilibrium tax-exempt interest \( r_e^* \) is indicated in Figure 1 along with the associated equilibrium quantity of debt \( B^* \).
Before proceeding to the invariance property, it is worth noting the extent of the indirect arbitrage gains at equilibrium. All individuals in tax brackets \((j) < (j^*)\) are defined as low-income and receive gains as indicated in (1). Their total gain is, in effect, a form of producer surplus. This gain is shown in Figure 1 by the area bounded by the supply curve and the horizontal line indicating equilibrium tax-exempt interest rate \(r_e^*\). Similarly, all individuals in tax brackets \((j) > (j^*)\) are defined as high-income. Their total gain is a form of consumer surplus and is shown in Figure 1 by the area bounded by the demand schedule and interest rate \(r_e^*\).

II. Predictions of the Model

The effects of an increase in income tax rates on equilibrium conditions in the market for tax-exempt debt can now be pursued. Let an increase in income tax rates be specified as an increase in maximum rate \(\tau_{\text{max}}\). Given \(t(j)\), it follows from (3) that tax rates \(\tau(j)\) will thus increase across all brackets, save the zero-bracket where \(t(j_{\text{min}}) = 0\). With such an increase in tax rates the model predicts that the equilibrium tax-exempt interest rate will decline. To see this consider the equilibrium tax-exempt interest rate \(r_e^*\) in (7). Letting \(\tau_{\text{max}}\) increase, we have

\[
\frac{\partial r_e}{\partial \tau_{\text{max}}} = -t(j^* \tau_{\text{max}})r.
\]

Accordingly, given taxable interest rate \(r\), the spread, \(r - r_e\) between taxable and tax-exempt interest rate also increases. What happens is that the increase in tax rates reduces net taxable interest rate \((1 - t(j)\tau_{\text{max}})r\). Looking at the supply schedule in (5), this makes indirect arbitrage opportunities less attractive to low-income individuals. In order to maintain the same level of supply in the face of higher tax rates, a lower tax-exempt rate is required and bond supply shifts downward (this is a rotating shift, pivoting on intercept \(r\)). For high-income individuals, the reduced net taxable interest rate increases the gains available from purchasing tax-exempt debt. To maintain the same demand
in (6) in the face of higher tax rates, a lower tax-exempt interest rate is required and the bond demand schedule shifts downward.

If the equilibrium tax-exempt interest rate declines with an increase in income tax rates, as the above shows, then the second prediction of the model, that the equilibrium quantity of tax-exempt debt is unaffected by changes in income tax rates, follows at once. For, while the tax-exempt interest rate falls with higher tax rates, the marginal tax bracket \( j^* \) that clears the market remains the same. The supply and demand schedules merely shift down by identical magnitudes and the equilibrium quantity of tax-exempt debt \( B^* \) is unchanged. High-income individuals still demand and communities still supply the same total quantity of tax-exempt, and therefore, taxable debt.

Using (8), this may be verified by differentiating the arguments of (5) and (6) with respect to \( \tau_{\text{max}} \). For both supply and demand, evaluated at equilibrium bracket \( j^* \), the result is:

\[
-t(j^*)r - (-t(j^*)r) = 0
\]

An increase in \( \tau_{\text{max}} \) leaves the arguments in (5) and (6), and therefore of supply and demand, unchanged. The equilibrium quantity of tax-exempt debt is unaffected by changes in tax rates even though the equilibrium tax-exempt interest rate has decreased.

The insensitivity of the equilibrium quantity of tax–exempt debt to changes in tax rates just established is not sensitive to the way in which taxes are assumed to increase. Instead of increasing \( \tau_{\text{max}} \), as was just done, we could increase \( t(j) \) for \( 0 < t(j) < 1 \) so as to increase progression in intermediate brackets without changing \( \tau_{\text{max}} \). Using (7), the marginal reduction in the equilibrium tax-exempt interest rate is

\[
\frac{\partial r_e}{\partial t(j^*)} = -\tau_{\text{max}} r.
\]
As before, the marginal change in bond supply and demand are offsetting. Using (10) and differentiating the arguments of (5) and (6) with respect to \( t(j) \), the result in both cases, evaluated at tax bracket \( (j^*) \), is:

\[
-\tau_{\text{max}} r - (-\tau_{\text{max}} r) = 0. \tag{11}
\]

The predictions derived rest upon the existence of progressive income taxes. Given that, the ensuing question is whether this result is sensitive to our remaining assumptions, especially the assumption that interest expense on taxable debt is deductible against taxable income of citizen-borrowers. We think it is not, this assumption being conservative in nature. For, if interest is not deductible, then taxable borrowing is even more costly and the size of the indirect arbitrage gain for low-income individuals in (1) (with \( \tau_j = 0 \) for borrowers) is even larger.

**III. Empirical Evidence**

Although our model’s construction is simple, its validity rests not on its assumptions, but on whether or not there is empirical evidence to support its predictions. To establish such evidence we used, as the basis for our analysis, annual data for the period 1963-1997. To capture the behavior of income tax rates we employed a measure of effective tax rates (ETR), total personal income tax as a percentage of taxable income, the data being obtained from the Internal Revenue Service (1998). The effective tax rate, while not the same as the marginal tax rate (a fiendishly difficult variable to obtain in time series) called for in the conceptual formulation of the model, serves as a reasonable proxy for the changes over time in marginal tax rates brought about by changes in personal income and by changes in legislation that either alter tax rates or changes in deductions against taxable income. ETR will serve as an independent variable, or predictor, in all of the empirical tests to follow.
The first prediction of the model, that increases in income tax rates lower the tax-exempt interest rate, was tested by using a statistical linear regression model with a measure of the rate differential between taxable and tax-exempt interest rates as the response and ETR as predictor. The rate differential (RDIFF) was obtained by subtracting the market interest rate for A-rated municipal debt from the market interest rate for 20-year maturity U.S. Treasury securities, both interest rate series being obtained from the Federal Reserve. The relationship between the rate differential and effective tax rate is depicted graphically, as a scatter plot, in Figure 2 and a regression summary of the model is displayed in the first row of Table 1. As predicted, there is a statistically significant (p = 0.031) positive relationship between RDIFF and ETR. This finding is important, not only because it supports a prediction of our model, but also because it corroborates, for this study’s data set, similar findings from other previously-cited work.
Figure 2 Rate Differential (Treasury – A-Rated Municipal) versus Effective Tax Rate
<table>
<thead>
<tr>
<th>Model</th>
<th>Dependent Variable</th>
<th>Constant</th>
<th>ETR</th>
<th>LEADING</th>
<th>85</th>
<th>95</th>
<th>R^2</th>
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<tr>
<td>(1)</td>
<td>RDIFF</td>
<td>-2.84</td>
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<td>p</td>
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<td>(2)</td>
<td>TEF</td>
<td>92.4</td>
<td>-303.0</td>
<td>-0.54</td>
<td>0.590</td>
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<td>t</td>
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<td>(3)</td>
<td>TEF</td>
<td>-138.2</td>
<td>-25.1</td>
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<td></td>
<td>VIF</td>
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<td>107.3</td>
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<td>-95.05</td>
<td>-9.26</td>
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</table>
Because of the multi-period nature of the tests, the second prediction of the model, that the total quantity of tax-exempt debt is unaffected by changes in tax rates, must be restated for empirical purposes. For example, the time period zero total quantity of tax-exempt debt demanded and supplied in the model is established under the assumption that community spending plans are unchanged. But community spending plans do typically change over time and must be accounted for in the tests. Thus, we restate the second prediction of the model: there should be no statistically significant relationship between the behavior of the quantity of tax-exempt debt over time and changes in tax rates. Note that this prediction is in direct opposition to that held by the conventional point of view: that increases in income tax rates should be associated with increases in demand and supply of tax-exempt debt.

To test the prediction of our model, we fit the simple linear regression model of the response, tax-exempt debt (TEF), on the predictor, effective tax rate (ETR). We defined TEF as the quantity, the flow, of tax-exempt debt issued per year as specified in the model. It is measured by the quantity of municipal debt issued in years 1963-1997 as reported by the Federal Reserve System. A time-series plot of TEF is provided in Figure 3 and a scatter plot of TEF versus ETR is included in the Data Analysis Appendix. As predicted, we found no statistically significant relationship, as can be seen in Row (2) of Table 1 where \( p=0.590 \). Moreover, this outcome supports one of the assumptions of the model – that community spending plans are invariant to changes in income tax rates. For we know that the relationship between rate differential \( \text{RDIF} \) and effective tax rate \( \text{ETR} \) is positive. But if there is no significant relationship between TEF and ETR, then communities do not increase spending through issue of tax-exempt debt merely because an increase in tax rates has reduced tax-exempt interest rates relative to taxable interest rates.
Figure 3 Tax-Exempt Financing, 1963 - 1997
This simple initial test is consistent with the prediction of the model and is contrary to the prediction of the conventional point of view. However, this test, by neglecting the possible influence of other sources of changes in spending plans (to which the flow of tax exempt financing might be adapted) is not, by itself, conclusive. It is possible that in the presence of other independent variables, a significant relationship between TEF and ETR could emerge. We first controlled for this potential effect by including MUNET, a measure of total annual municipal expenditures for 1963-1997 as taken from Federal Reserve System data previously cited, in addition to ETR, as a predictor. The Data Analysis Appendix includes a scatter plot of TEF against MUNET. This regression of TEF on MUNET and ETR (full results not reported here) revealed no significant relationship between tax-exempt debt (TEF) and either actual municipal spending (MUNET, \( p = 0.370 \)) or effective tax rate (ETR, \( p = 0.755 \)). The absence of a significant relation between TEF and ETR continues to hold in this expanded version of our tests.

Finding no relationship between tax-exempt debt and actual municipal spending, we then considered measures of planned spending, to which TEF might be better adapted. As a proxy for the unobservable planned spending we employed the index of leading economic indicators, LEADING.\(^{12}\) This substitution assumes that planned spending is adapted, at least to some extent, to forecasts of economic activity, as is indeed the case in most jurisdictions. That LEADING serves as a reasonable proxy for planned municipal spending is supported by data plots (along with discussion) in the Data Analysis Appendix. Row (3) of Table 1 reports regression summaries obtained for the model of TEF as a function of ETR and LEADING. Once again there is no significant relationship between the flow of tax-exempt financing and changes in tax rates (\( p = 0.964 \)). However, a positive and marginally significant (\( p = 0.067 \)) relationship exists between the flow of tax-exempt financing and planned spending as proxied by LEADING. The latter result is
consistent with expectations and the second prediction of the model is once again upheld by this more generalized test.

For models that include more than just the single predictor ETR, we must take some care in assessing the impact of the individual predictors. Multicollinearity, or correlation among the predictors, can distort regression coefficient estimates and inflate their variances, rendering individual tests of significance tenuous if not meaningless. The variance inflation factor (VIF) described in Belsley, Kuh and Welsch (1980) provides a useful and widely used measure for the detection of multicollinearity. The VIFs for the TEF model including the predictors ETR and LEADING (reported in Row (3) of Table 1) are both 1.1, near their minimum values of 1, indicating that there is essentially no evidence of multicollinearity in the model. This observation supports the robustness of our empirical findings -- that the issuance of new tax-exempt debt does not vary with tax rates, even after adjusting for variation in planned municipal spending (as proxied by LEADING.)

In all the tests described thus far, we have found no empirical evidence to suggest that the issuance of tax-exempt debt varies systematically with tax rates – neither by itself nor after adjusting for actual or planned municipal spending. To round out the body of evidence, we considered the influence of tax rates in the context of a more completely specified model. That is, we sought to develop a multiple regression model, to explain as large a portion of the variation in the issuance of new tax-exempt debt, while maintaining suitably low levels of multicollinearity.

In the search for a model with higher explanatory power, a number of candidate predictive measures were considered. More specifically, we tried alternative measures of interest rates and rate differentials, various economic indicators, personal income as well as lags and combinations thereof. In the end, mirroring the most pronounced features of the tax-exempt debt data, the most influential predictors turned out to be indicator variables to account for the apparent effects of major
tax code changes. We continue by describing our final statistical regression model and the rationale for the inclusion of the identified indicator variables.

In our preliminary analysis of the time-series plot of tax-exempt debt (TEF, shown in Figure 3,) we were struck by the greatly increased issuance of tax-exempt debt in 1985 and the sharp reduction of same in 1994 and 1995. These were years immediately preceding major tax reforms in 1986 and 1996, the first reform acting to reduce taxes and the latter reform to increase them. It is possible that these dramatic but transitory movements in tax-exempt debt offerings demanded and supplied are explained by the anticipated impacts of pending tax reforms. The hypothesized effects of these anticipations were accounted for by using two indicator variables, 85 and 95, that are set to one in the years immediately preceding the tax reforms and are zero otherwise. Row (4) of Table 1 shows the results of the regression of TEF on ETR, LEADING and 85 and 95. As expected, 85 enters with a significant positive relationship to TEF while the estimated regression coefficient for 95 is significantly negative. The explanatory power of the regression is dramatically increased, the $R^2$ increases from 11.2% to 85.6% (see Table 1, Rows (3) and (4)), by the inclusion of these adjustments for significant tax reforms. Moreover, the significant positive relationship between TEF and LEADING continues to hold as does, once again, the absence of any significant relationship between TEF and ETR.

The question then becomes one of identifying what is being anticipated that would lead to large changes in quantities of debt demanded and supplied in 1985 and 1995. This is a separate inquiry from the indirect arbitrage motivation underlying our model. Any systematic consequences of tax reform for indirect arbitrage should be captured by changes in effective tax rates. But we have already seen that as long as income taxes are progressive, changes in tax rates do not change the marginal tax bracket ($j^*$) or the equilibrium quantity of debt needed for the purpose of effecting indirect arbitrage gains. The explanation must lie elsewhere.
For the 1986 tax reform, a possible explanation may concern the notion of direct arbitrage gains. Prior to the 1986 reforms communities were able to engage in direct arbitrage by issuing tax-exempt debt and investing the proceeds in investment taxable to ordinary citizens but not to the communities. The 1986 reform acted to restrain such arbitrage opportunities. Anticipation of these pending limitations may have induced many communities to accelerate debt issue in 1985 in order to exploit the arbitrage opportunities prior to the changes in tax law coming in 1986. This explanation is supported by Connor and Gasparino (1998) in which many of the abuses in the tax-exempt bond market “have come in the arbitrage area, including the issuance of ‘build-nothing’ bonds in the period leading up to the 1986 Tax Reform Act”.

While this direct arbitrage argument would serve to explain increased debt issue in 1985, it would not appear to be capable of explaining reduced debt issue in 1995. To do so, there would have to have been an easing of arbitrage restrictions in the 1996 tax reform and this was not the case. But an explanation for variations in debt issue in both 1985 and 1996 may lie in the widely-held view that increases in tax rates increase the spread between taxable and tax-exempt interest rate. Thus, anticipation of lower tax rates and the consequent reduced spread between taxable and tax-exempt interest rates to come once the 1986 reforms were in place may have caused communities to accelerate debt issue in 1985 in an attempt to capture the spread while it was still more favorable than it would later be. This would make sense even if proceeds of such issues had to be temporarily stockpiled with or without the benefit of direct arbitrage gains. Also, some planned expenditures could have been accelerated because of the increased rate of debt issue. Similarly, and in a symmetrical manner, anticipation of higher taxes to come by tax reform enacted in 1996, with the implication for a forthcoming higher spread, might have caused communities to defer debt financing in 1995. Such behavior is consistent with the view of
Poterba (1989, p. 543) that expected changes in tax policy play a central role for tax-exempt debt. Because the validity of our statistical conclusions rests on certain standard model assumptions, we conclude our examination of the empirical evidence with a quick graphical analysis of the final model (Row 4, Table 1) residuals. The collection of residual plots shown in Figure 4 confirm the independence (including lack of serial correlation) and normality assumptions. There is a hint of nonconstant variance apparent in both the time-series plot of the residuals (labeled “I Chart of Residuals” in Figure 4) and in the “Residuals versus Fits” plot. However, the apparent nonconstant variance proved to be mild, not statistically significant, and not substantially improved by standard variance-stabilizing transformations (like the logarithm) on the response variable TEF.
Figure 4 Model (4) Residual Diagnostics
In the tests here reported, as well as in additional tests not shown, the findings were uniformly consistent with our model’s predictions. The relationship between the spread between taxable and tax-exempt interest rates and effective tax rates was found to be positive. And, in a comprehensive series of statistical tests, there was never once revealed any significant relationship between the quantity of tax-exempt debt issue and the effective tax rate\textsuperscript{14}. In contrast, the conventional point of view, which predicts that increases in tax rates should increase the equilibrium quantity of tax-exempt debt, is not supported by the empirical evidence.

\textit{IV. Summary}

We make no claim that a model of the market for tax-exempt debt based on indirect arbitrage constitutes the only reason such debt would be issued. However, considering the many alternative statistical approaches used to test the model and the consistent finding that there is no significant relationship between the quantity of tax-exempt debt and income tax rates, the model enjoys substantial support in the available empirical evidence. If the model’s predictions are correct then, save for the transitory influence of substantial anticipated shifts in tax policy, changes in tax rates have no systematic impact on the vitality of the tax-exempt debt market.
DATA ANALYSIS APPENDIX

The results of regression analysis alone can be, and often are, less than conclusive or fully persuasive. The varying effects of different predictors, included or not included, can lead to dramatically different conclusions, depending on which predictors are selected for inclusion in the model. It is thus important to ground, support, and confirm analysis results with reference to actual data plots whenever possible. To guide in the statistical analysis of available empirical data and to provide visual support for statistical findings, we provide a scatter plot matrix depicting the variation over time and the relationships among the variables of interest, tax-exempt debt and selected candidate predictors – ETR, MUNET, and LEADING. The scatter plot matrix comprises an array of miniature two-variable scatter plots, arranged in the form of a right upper triangular matrix with variable labels down the diagonal. In each scatter plot, the variable plotted on the y-axis is identified by the label at the left end of each row. The variable plotted on the x-axis is identified by the label at the bottom of each column. The top row of plots shows TEF against candidate predictors -- ETR, MUNET, LEADING, and YEAR. The rightmost column of plots shows the variation of each of the selected variables over time. The scatter plots are enhanced with the addition of a smooth curve computed using a locally-weighted sum of square or LOWESS scatter plot smoother.
Scatter Plot Matrix: Tax-Exempt Financing versus Key Predictors
Of particular interest in scatter plot matrix is the plot of tax-exempt debt TEF versus effective tax rate ETR (first row, first column.) The flatness of the LOWESS scatter plot smooth adds emphasis to the apparent absence of any relationship between these two variables. Tax-exempt debt appears to be generally increasing over time (first row, fourth column) at least through about 1986 where the LOWESS smooth suggests that debt levels begin to fall off, though this perception may be largely influenced by two extremely low levels of new debt observed in 1994 and 1995. The year-to-year variation in tax-exempt debt also appears to be greater post-1986. The temporal variation in tax-exempt debt can be seen in greater detail in Figure 3. The apparent relationships between other pairs of variables tend to be weak and ill-defined, save for the close relationship between MUNET and LEADING both of which increase steadily over time. This observation supports the notion that the index of leading indicators may be useful as a proxy for planned municipal spending.
1. In contrast, Stephanie Cellini, Fernando V. Ferreira, and Jesse Rothstein (2008) make an equally conclusive empirical case for the opposite position: that bond funds have no effect on current expenditures or other revenues and that reliance on bond financing leads governmental entities to under-invest in facilities.

2. Choate and Thompson (1996) argue that tax-exempt debt issue has no effect on the wealth of citizens. But this conclusion was reached with a proportional income tax rate and, as will be seen, must be altered under a progressive tax regime.

3. This assumption is for simplicity but also seems consistent with the empirical evidence. Holtz-Eakin (1991) has found that increases in income tax rates do increase the spread between taxable and tax-exempt interest rates but that spending levels are not much affected. However, we will also provide empirical evidence leading to this same conclusion and supporting our use of this assumption.

4. We return to the latter assumption at a later point.

5. There is no satisfactory a priori definition of high and low income. Given some equilibrium tax-exempt interest rate $r_e^*$ and taxable rate $r$, any tax rate $\tau_j$ low enough to make (1) positive defines low income; any tax rate high enough to make (2) positive defines high income.

6. This rules out communities having income tax policies in which interest receipts on their own obligations are tax-exempt but those of others are not. Failure to make this assumption would introduce potential variation in tax-exempt rates having nothing to do with the issues under investigation here.

7. The assumption of monotonicity is for simplicity. The alternative, a schedule of tax rates featuring discrete increments, is much less tractable for our purposes.
8. The condition \( r > r_e \) will be formally established below. It must hold, of course, given that both taxable debt and tax-exempt debt are risk-free and one confers a tax benefit while the other does not.

9. Three additional points may be made. First, the demand for tax-exempt debt by high-income citizens portrayed in (6) is net of the amounts of such debt purchased solely to neutralize the earlier-noted unfavorable effects upon them caused by debt issue by their communities. Second, there is no "money machine" present here. Communities are constrained in the amount of tax-exempt debt issue by the wealth of their citizens and supply is limited; so too is demand in that high-income citizen-lenders seek optimal consumption patterns over time. Third, it might seem that high-income individuals could do even better than the model allows by shorting tax-exempt debt up to their wealth constraints. The problem is that markets for many tax-exempt debt issues are thin with many issues featuring serial maturities. The ability of a short-seller to cover the short position is thus rendered hazardous.

10. We also employed the spread between interest rates on U.S. Treasury 20-year securities and B-rated tax-exempt debt. Both series were positively related to ETR. However, the spread measure using A-rated debt exhibited superior predictive power. All interest rate data came from the Federal Reserve Bulletin (various issues).


12. We evaluated data for indices of leading, coincident, and lagging economic indicators taken from The Conference Board, Business Cycle Indicators [World Wide Web url: http://www.tcb-indicators.org/]. The leading indicator proved to be superior, in explanatory power, to coincident and lagging indicators and was thus selected for inclusion in modeling efforts.

13. Apart from the data on actual municipal expenditures referred to in the text, we experimented with several variations to see if explanatory power could be increased. These included use of lead
and lagged predictors, testing of alternative coincident and lagging economic indicators of the business cycle, and using a log-transformed response. Working with log-transformed values of the flows of tax-exempt debt yielded results consistent with analyses conducted using untransformed data, but failed to improve either the explanatory power of models or residual diagnostic measures. For simplicity of exposition, we have elected to report the results using the original untransformed flows. Results of all alternative analyses are available upon request. No statistically significant relationship was found between the quantity of tax-exempt debt and tax rates in any of the analyses. 14. Again, test results are available from the authors.
REFERENCES


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