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TAXABLE AND TAX-EXEMPT INTEREST
RATES: THE ROLE OF PERSONAL
AND CORPORATE TAX RATES

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Taxable and Tax-Exempt Interest Rates:
The Role of Personal and Corporate Tax Rates

ABSTRACT

This paper investigates empirically the effects of personal and corporate taxes on taxable interest rates and on the spread between taxable and tax-exempt rates. Two main sets of results emerge. First, we establish that the effective marginal investors in the Treasury bill market are households, as opposed to tax-exempt institutions or corporations. We find no evidence of corporate tax rate effects on Treasury bill yields. The study is then extended to an examination of the tax-exempt market. The results there contradict the hypothesis that commercial bank arbitrage generally ensures that the taxable-tax-exempt interest rate spread is determined by the corporate tax rate. Our estimates decisively reject the corporate in favor of the personal income tax rate as being the relevant tax rate of the marginal investor in this market as well.

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Personal and Corporate Tax Rates,

Taxable and Tax-Exempt Interest Rates

Recently, a number of papers, both theoretical and empirical, have argued that marginal income tax rates are an important determinant of interest rates. They focus primarily on how these tax rates are embedded in the expected inflation rate coefficient in equations explaining the nominal interest rate. While theoretical studies have incorporated corporate as well as personal tax rate effects (e.g., Feldstein, 1976; Hamada, 1979), most empirical studies have only included proxies for marginal personal income tax rates (e.g., Tanzi, 1980; Peek, 1982; Peek and Wilcox, 1983, 1984). Peek (1982) established that personal income taxes do play a significant role in interest rate determination. Furthermore, Peek and Wilcox (1984) and Mehra (1984) have provided evidence that interest rates respond completely to changes in personal income tax rates.

Here we consider corporate as well as personal income tax rate effects. The extended model presented in Section I yields an interest rate specification that allows testing for corporate tax rate effects, with personal income tax rate effects either included or excluded. Section II presents the results of estimating that specification and testing various tax rate hypotheses. We examine the role of personal and corporate tax rates, and other factors, in determining the spread between taxable and tax-exempt yield spreads in Section III. Section IV offers some concluding remarks.

I. The Model

The macro model we use is similar to that of Peek and Wilcox (1983), augmented with corporate tax effects. The IS, LM, wage, and aggregate supply relations (deflated by Y^N) can be expressed as:

$$(1) \quad Y - Y^N = a_0 - a_1 r_H^* - a_2 r_F^* + a_3 \Delta Y_{-1} + a_4 (X - Y^N) + a_5 (M - P - Y^N)$$
$$- a_6 LIQ - a_7 SS - a_8 FB$$

$$(2) \quad M - P - Y^N = b_0 + b_1 (Y - Y^N) - b_2 i_H^* - b_3 i - b_4 FB$$

$$(3) \quad W = c_0 + P^e - c_1 SS$$

$$(4) \quad P = d_0 + W + d_1 (Y - Y^N) + d_2 SS,$$

where the coefficients of all the variables are assumed to be positive and:

Y = the logarithm of actual real output,

Y^N = the logarithm of natural real output,

ΔY_{-1} = the percentage change in real output lagged one period,

X = the logarithm of the sum of real exports and real government expenditures,

LIQ = the previous quarter's growth rate of the nominal money supply relative to its recent trend growth,

M = the logarithm of the nominal money supply,

P = the logarithm of the actual price level,

P^e = the logarithm of the expected price level,

W = the logarithm of the nominal wage,

SS = the supply shock variable,

FB = the domestic bonds held by foreigners,

i = the nominal interest rate,

i_H^* = the after-personal-tax nominal interest rate,

r_H^* = the after-personal-tax real interest rate,

r_F^* = the after-corporate-tax real interest rate (the real

rental cost of capital for firms).

The three after-tax interest rates are related to the nominal interest rate (i) by (5)-(7):

(5) $i_H^* = i(1-t)$

(6) $r_H^* = i^* - p^e = i(1-t) - p^e$,

(7) $r_F^* = \dfrac{((1-\tau)i + \delta - p^e)(1 - k - \tau z)}{(1 - \tau)}$,

where t is the marginal personal income tax rate on interest income, τ is the marginal corporate income tax rate, p^e is the anticipated inflation rate, δ is the rate of economic depreciation, k is the effective rate of the investment tax credit, and z is the expected real present value of the tax depreciation allowance associated with a dollar of current investment. The formula for r_F^* assumes that in equilibrium the cost to the firm of equity is equal to its cost of debt. That is, all financial arbitrage possibilities on the part of the firm are eliminated. Consequently, we use $(1-\tau)i$ as the nominal opportunity cost of

funds. This reflects the deductibility of nominal interest payments. For simplicity, we have also assumed no taxation of accrued nominal capital gains on the investment goods and that the prices of capital goods change at the same rate as the general price level.

Real expenditures depend on the real after-personal-tax interest rate, which is relevant for the household consumption-saving decision, as well as on the real user cost of capital, which is relevant for firms' investment decisions. They also depend on an investment accelerator term, real exogenous export and real government demand, a real balance effect, real shocks emanating from the supply side, and financial effects arising from the supply shocks.

The presence of the liquidity variable (LIQ) allows us to capture the difference between short-run and long-run IS curves. This difference follows from the assumed differential adjustment speeds in real and financial markets. Since real variables (such as output) adjust more slowly than financial variables (such as interest rates), we hypothesize a steeper (e.g., vertical) short-run IS curve. The liquidity term represents accelerations (or decelerations) in nominal money growth relative to its own recent trend growth. An acceleration in nominal money growth shifts the LM curve to the right and moves the economy from point A to point B along the vertical short-run IS curve in Figure 1. This movement down the short-run IS curve is captured by a temporary downward shift of the flatter long-run IS curve to IS'. Thus, this

FIGURE 1

IS (Short-run)

LM

LM'

i^*, r^*

A

C

IS (Long-run)

B

IS'(Long-run)

Y
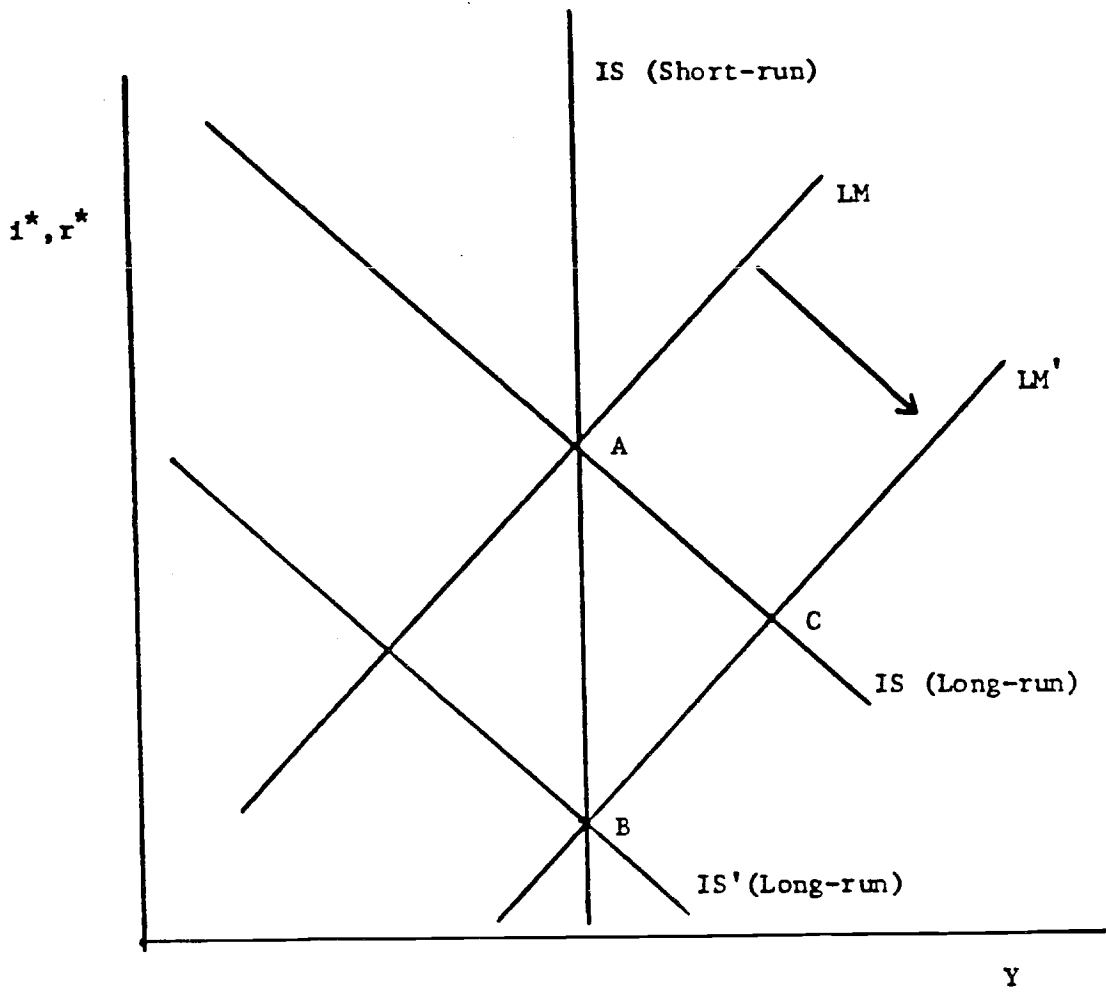
term allows us to capture the well known liquidity effect. If this higher money growth rate persists, LIQ gradually returns to its long-run value of zero. This moves the economy from B toward C as the IS curve returns to its original position.

Money demand is hypothesized to depend on output, the after-personal-tax nominal interest rate, which represents the opportunity cost to individuals when interest income is taxed, and the before-tax nominal interest rate, which represents the opportunity cost for both firms and tax-exempt entities. If money is included in the firm's production function, the pre-tax rather than the after-tax nominal interest rate is the relevant opportunity cost variable. For firms, the return to holding (using) money is pecuniary; both the increased revenues and decreased costs to a firm achieved by holding additional money balances result in higher pecuniary income. These profits, unlike the nonpecuniary services of money to the individual, are taxed. Since the returns to both money and bonds are taxable in this instance, in equilibrium the marginal product of money is equated to the before-tax, rather than the after-tax, nominal interest rate. Consequently, a change in the corporate tax rate has no effect on the opportunity cost measure relevant for firms in the LM relationship.

The wage and price equations embody the natural rate hypothesis and incorporate supply shock effects. A supply shock, e.g., a sudden increase in the relative price of imported oil, shifts the aggregate supply equation by raising the cost of production,

reduces the equilibrium real wage, and in addition, lowers the IS curve through its effect on the demand for capital, and hence investment demand (see Wilcox, 1983). The FB variable is included to isolate the financial effects arising from the supply shocks. In the IS curve, FB serves as a proxy for the decline in expenditures on U.S. goods due to any increase in the world saving rate that develops as real income is transferred to countries (e.g., OPEC) with higher saving propensities. Similarly, FB enters the LM equation to allow for the possibility that the demand for money will be reduced as wealth is transferred to agents who desire a wealth portfolio with a much higher proportion of U.S. government securities than do domestic wealth-holders (see Peek and Wilcox, 1983).

Equations (1)-(7) can be combined to yield the reduced-form equation for the nominal interest rate:

$$(8) \quad i = \beta_0 + \underset{(+)}{\beta_1} P^e + \underset{(-)}{\beta_2}(1-k-\tau z)/(1-\tau) + \underset{(+)}{\beta_3}\Delta Y_{-1} + \underset{(+)}{\beta_4}X' + \underset{(?)}{\beta_5}M' +$$

$$\underset{(-)}{\beta_6}LIQ + \underset{(?)}{\beta_7}SS + \underset{(-)}{\beta_8}FB$$

where M' and X' are $(M-P^e-Y^N)$ and $(X-Y^N)$, respectively, and:

$$\beta_0 = \frac{a_0(b_1+d_1)+b_0(1+a_5 d_1) + (c_0+d_0)(1-a_5 b_1)}{D} = \frac{\alpha_0}{D},$$

$$\beta_1 = \frac{(b_1+d_1)a_1+(b_1+d_1)a_2(1-k-\tau z)/(1-\tau)}{D} = \frac{\gamma_1+\gamma_2(1-k-\tau z)/(1-\tau)}{D}$$

$$\beta_2 = \frac{-(b_1+d_1)a_2 \delta}{D} = \frac{-\gamma_2 \delta}{D}$$

$$\beta_3 = \frac{(b_1+d_1)a_3}{D} = \frac{\alpha_3}{D}$$

$$\beta_4 = \frac{(b_1+d_1)a_4}{D} = \frac{\alpha_4}{D}$$

$$\beta_5 = \frac{b_1 a_5 - 1}{D} = \frac{\alpha_5}{D}$$

$$\beta_6 = \frac{-(b_1+d_1)a_6}{D} = \frac{\alpha_6}{D}$$

$$\beta_7 = \frac{(1-a_5 b_1)(d_2-c_1)-a_7(b_1+d_1)}{D} = \frac{\alpha_7}{D}$$

$$\beta_8 = \frac{-(b_4(1+a_5 d_1)+(b_1+d_1)a_8)}{D} = \frac{\alpha_8}{D}$$

$$D = \{a_1(b_1+d_1) + b_2(1+a_5 d_1)\}(1-t) + b_3(1+a_5 d_1)$$

$$+ a_2(b_1+d_1)(1-k-\tau z) = \gamma_3(1-t)+\gamma_4+\gamma_2(1-k-\tau z).$$

The real balance and LM effects of money have conflicting impacts on the interest rate resulting in an ambiguous sign for β_5. Likewise, the sign of β_7 is indeterminate a priori. An adverse supply shock reduces investment and real wages and thus the interest rate, while at the same time increasing input costs operating through the aggregate supply equation which raises the interest rate. The investment-real wage effect might be expected to dominate, suggesting a negative value for β_7. Our earlier work (e.g., Wilcox, 1983; Peek and Wilcox, 1983) can be so interpreted.

Personal and corporate tax rates enter the reduced-form

equation (8) in a complicated manner. The reduced-form coefficients (the β's) in (8) are not constants. Rather, they are a function of the four tax series (t, τ, k, z), which vary over time. Having a common denominator that depends on these tax series, the reduced-form coefficients will all have the same movement over time (up to a scale factor) with the exception of β_1. An increase in any of the four tax variables will reduce the denominator (D) and cause all of the reduced-form coefficients to increase (except β_1). Because τ, k, and z also appear in its numerator, β_1 will not change in proportion to the other β's. Assuming that (1 - k - z) > 0 (which is consistent with the data for the period under consideration), an increase in τ will raise β_1 more than proportionally to the remaining β's because, in addition to D declining equally for all β's, the numerator of β_1 rises. An increase in k or z will decrease the numerator of β_1, tending to offset the upward effect on β_1 operating through the denominator. For reasonable structural parameter values (τ > t is sufficient), the net effect of such a change will be to decrease β_1.

II. Empirical Results

   A. Data

The reduced-form estimates are based on semiannual observations corresponding to the Livingston survey data collected each June and December. The sample covers June 1952 through June 1979. This sample period avoids both the pre-1952 pegging of interest rates by the Federal Reserve and the period following the October 1979 change in Federal Reserve operating procedures (including the

temporary imposition of credit controls in 1980). Monthly averages of the one-year Treasury bill yield (on a bond-equivalent basis) during June and December are used as the nominal interest rate measure to match the maturity of the Livingston one-year anticipated inflation rate data.[1] The anticipated inflation rate series, PE12, is the percentage change in the CPI expected over the next twelve months derived from the Livingston survey. This series was provided by the Federal Reserve Bank of Philadelphia. This measure of anticipated inflation has the advantage of being truly _ex ante_ and of embodying whatever sophistication agents actually use to form their expectations. The remaining variables are measured with second and fourth quarter data (except for the four tax variables) to correspond with the end-of-quarter dating of the interest rate variable. We use the M1 measure of the nominal money supply. P^e is the price level expected six months ahead, again based on the Livingston survey data. Y^N, natural real output, is from the Council of Economic Advisors. $(M-P^e-Y^N)$ has been detrended by regressing it on a linear time trend and using the residual as M'. LIQ is the difference between the annualized growth rate of M1 measured from the current to the previous quarter and its four-quarter growth rate up to that previous quarter. X' is the logarithm of the ratio of real government expenditures plus real exports to real natural output. ΔY_{-1} is the four-quarter growth rate of real GNP up to the preceding quarter. SS is the ratio of the import deflator to the GNP deflator, adjusted for exchange rate changes. FB is the ratio of

foreign holdings to the sum of private domestic and foreign holdings of U.S. government short-term marketable securities.

Our measure of t is the average marginal tax rate on interest income constructed from data contained in annual editions of Statistics of Income, Individual Income Tax Returns (see Peek, 1982). The tax rate is calculated as a weighted average of the marginal personal income tax rate for each adjusted gross income class. The weight for each class is equal to its share of the total interest received by all income classes. We use the effective marginal corporate tax rate from Seater (Table 2, column 6, 1982) for τ.

The calculation of the effective rate of the investment tax credit (k) and the present value of tax depreciation gained from a dollar of current investment (z) is more complicated.[2] Our measure of z is based on data provided by Robert S. Chirinko (1982). It is calculated as a weighted average of the present value of tax depreciation from a dollar of current investment in structures and in three categories of equipment (production machinery, office equipment, and transportation equipment). The weights are based on investment shares. Our measure of k is similarly calculated as a weighted average of the same categories. The underlying effective investment tax credit rates are based on Corcoran and Sahling (Table 11, 1981). These data recognize that the effective investment tax credit rate differs from the statutory rate (in particular, on structures) as noted by Corcoran (1979). To check the robustness of our estimates, we also con-

sidered alternative measures presented by Jorgenson and Sullivan (Table 6, column 1 and Table 10, column 1, 1981). To convert the annual tax series to semiannual data, we use the actual value for the June observation and the average of the tax rates for the current and upcoming calendar years for the December observation.

B. Test Specification

Nonlinear least squares can be used to estimate equation (8) while imposing the across-coefficient restrictions. Because of the form of (8), we can estimate the α's and γ's only up to a scale factor. To obtain a unique set of estimates of the α's and γ's, we arbitrarily fix one of the coefficients (or alternatively, divide the numerators and denominators of all of the β's by one of the parameters). Since we are most interested in the coefficients of the explanatory variables, we have chosen to use the constant term, α_0, as the scale factor. The reduced-form coefficients are:

$$(9) \quad \beta_0 = \frac{\alpha_0/\alpha_0}{D} = \frac{1}{D}$$

$$\beta_1 = \frac{\gamma_1/\alpha_0 + (\gamma_2/\alpha_0)(1-k-\tau z)/(1-\tau)}{D} \quad ,$$

$$\beta_2 = \frac{-(\gamma_2/\alpha_0)\delta}{D} \quad ,$$

$$\beta_3 = \frac{\alpha_3/\alpha_0}{D} \quad ,$$

$$\beta_4 = \frac{\alpha_4/\alpha_0}{D} \quad ,$$

$$\beta_5 = \frac{\alpha_5/\alpha_0}{D} \quad ,$$

$$\beta_6 = \frac{\alpha_6/\alpha_0}{D} \quad ,$$

$$\beta_7 = \frac{\alpha_7/\alpha_0}{D} \quad ,$$

$$\beta_8 = \frac{\alpha_8/\alpha_0}{D} \quad ,$$

$$D = (\gamma_3/\alpha_0)(1-t) + \gamma_4/\alpha_0 + (\gamma_2/\alpha_0)(1-k-\tau z).$$

We can now obtain point estimates of the ratios of the α's and γ's to α_0.[3] While we cannot perform marginal significance tests for the α's and γ's with the resulting estimated coefficient standard errors, the summary statistics for the equation itself (S.E.E., S.S.R., D.W., and so on) as well as the estimated time series of the β's are uniquely determined; that is, they are invariant with respect to the scale factor used. Consequently, a chi-square test statistic can be used to perform likelihood ratio tests of the restriction that each of the relevant coefficients (the α's and γ's) is zero. This produces the desired measures of marginal significance.

Here, we are primarily interested in the contribution of the corporate tax parameters to the determination of the interest rate. Our earlier work did not allow for these corporate tax rate effects. Those studies essentially set a_2 and b_3 equal to zero (and hence $\gamma_2 = \gamma_4 = 0$). To assess the effects of corporate taxes, we impose various restrictions on the coefficients associated with the tax effects and test whether these restrictions can be rejected. We test for corporate tax effects in equations

that exclude, as well as include, personal tax rates. In addition, we test the restriction that the coefficient on τ is unity, i.e., whether there is no "fiscal illusion" with regard to corporate tax rates.

C. Estimation

In estimating equation (8), it is assumed that the rate of economic depreciation (δ) is equal to .1. This makes the numerator of β_2 (the coefficient on $(1-k-\tau z)/(1-\tau)$) equal to $-.1\gamma_2$. Our estimate of (8) incorporating the normalization in (9) for the 1952:06-1979:06 period is:

$$(10) \quad i = (1.0 + (.133 - .0582(\frac{(1-k-\tau z)}{(1-\tau)})p^e + .0582(0.1)(\frac{(1-k-\tau z)}{(1-\tau)})$$
$$\quad (1.80) \quad (0.97) \qquad\qquad\qquad\quad (0.97)$$

$$+ .144\Delta Y_{-1} + .271X' + .214M' - .0112LIQ - .316SS - .642FB)/$$
$$\quad (0.61) \qquad (1.60) \quad (0.86) \quad (4.15) \qquad (5.09) \quad (3.49)$$

$$(.182(1-t) - .0582(1-k-\tau z) - .0252)$$
$$\quad (2.47) \qquad (0.97) \qquad\quad (0.35)$$

$$R^2 = .9316 \quad SSR = 19.15 \quad SEE = 0.65 \quad D.W. = 1.86$$

The numbers in parentheses below the coefficient estimates can be interpreted approximately as t-statistics. They are calculated as the square root of the chi-square test statistic used to perform the likelihood ratio tests of the restriction that each of the relevant coefficients was zero.[4] The estimates of the parameters associated with corporate tax rates (γ_2/α_0 and γ_4/α_0) are both negative, contrary to what might be expected, and are both statistically insignificant; their pseudo t-statistics are 0.97 and 0.35, respectively. The coefficient on the personal tax rate, on the other hand, has the expected sign and is statistically

significant. Similar results were obtained when we used the Jorgenson-Sullivan (JS) measures of k and z. Estimates of both γ_4/α_0 and γ_2/α_0 were again negative and statistically insignificant. Their pseudo t-statistics were 0.86 for γ_2 and 0.49 for γ_4. Thus, we find no evidence that corporate tax rates affected the (taxable) one-year Treasury bill yield. Furthermore, it appears that neither corporations nor tax-exempt entities are the relevant marginal investors in the associated LM relationship (we cannot reject the hypothesis that b_3 and hence γ_4 equals zero). When we omitted the insignificant γ_4/α_0 term and reestimated the equation, we again obtained an insignificant negative coefficient on the corporate tax proxies (with a pseudo t-statistic of 0.35; 0.49 with the JS data). The other estimated coefficients have the hypothesized signs (although the sign on the M' coefficient is theoretically ambiguous) and the coefficients on LIQ, SS and FB are statistically significant.

This specification assumes the absence of fiscal illusion. In an earlier study (Peek and Wilcox (1984)), the hypothesis of fiscal illusion with respect to the personal income tax was rejected. However, assuming no corporate tax fiscal illusion might be too restrictive and be contributing to our rejection of statistically significant corporate tax effects. Consequently, we replaced $(1-k-\tau z)$ and $(1-\tau)$ with $(1-\theta k-\theta\tau z)$ and $(1-\theta\tau)$, respectively, where the deviation of θ from unity measures the degree of fiscal illusion. A value of one for θ implies that agents respond to after-tax, rather than pre-tax, magnitudes and therefore do not

suffer from fiscal illusion. At the other extreme, a value of zero for θ would imply that agents disregard taxes entirely; that is, they suffer from complete fiscal illusion. When we re-estimated the interest rate equation that includes the corporate tax fiscal illusion parameter, the estimated value of θ was 0.72 with a t-statistic of 0.27. While it is in the predicted range (between zero and unity), this parameter is not measured precisely. With a standard error of 2.69 the data reject neither $\theta = 1$ nor $\theta = 0$.[5] Similarly, the JS data provided an estimate for θ of 0.64 with a t-statistic of 0.22. Our estimates of γ_2/α_0 were still negative and insignificant. Finally, we tested for significant corporate tax effects in the absence of personal tax effects. We re-estimated the interest rate equation setting $\gamma_3 = 0$. Again, we obtained negative and insignificant coefficient estimates for γ_2/α_0. The pseudo t-statistics were 1.40 and, for the JS data, 1.28.

III. Evidence from the Tax-Exempt Market

The statistical evidence presented in the previous section favored the personal income tax rate, and not the corporate tax rate, as a determinant of taxable nominal interest rates. Here we examine the role of personal and corporate tax rates in the relative pricing of taxable and tax-exempt assets over time. In contrast to our finding above that personal rates dominate corporate rates in the pricing of taxable financial assets, it is often argued that the corporate tax rate is the rate that determines the spread between short-term municipal and Treasury yields.

Table 1 shows that the commercial banking sector and the household sector each hold large fractions of both taxable and tax-exempt government bonds. Though this table does not suggest which tax rate is relevant to either market, it does indicate that, by share, banks historically have been relatively more important holders of municipal bonds, especially shorts, whereas households have been relatively larger holders of Treasury issues.

To the extent these tax-exempt instruments act as substitutes for (taxable) Treasury issues of the same maturity, the after-tax yields of taxable and tax-exempt instruments should move together. If these tax-exempt assets are sufficiently closer substitutes (for taxables) for corporations than they are for households, the corporate rate may be relevant in determining the taxable-tax-exempt spread. Fama (1977) argues for the near-perfect substitutability of these taxable and tax-exempt short-term instruments on the part of corporations. The ability to hold tax-exempt and issue taxable, interest-deductible, short-term debt confers an arbitrage opportunity on commercial banks. Their exercise of that opportunity could be expected to drive the implied tax rate for this maturity to the corporate tax rate.

If these taxable and tax-exempt instruments are close substitutes for both households and corporations, we might expect the same tax rate to operate in both markets. Miller (1977) argues that, if the effective tax rate on dividends is zero (as proposed by Miller and Scholes (1978)), the tax rate implied by the taxable-tax-exempt yield spread will be the corporate rate. Even

Table 1

Share of Taxable and Tax-Exempt Public Debt
Held by Various Sectors[a]
(as of 1979:06)

	U.S. Treasury Issues	Municipal Bonds
Households	0.357	0.254
Commercial Banking	0.237	0.423
Other	0.406	0.323
	1.000	1.000

[a]These shares are shares of holdings of the private, domestic
sector. Corporations do not hold large shares of either bond
category. "Other" major holders of Treasury issues include
state and local governments and nonbank financial institu-
tions, which include public and private pension funds, money
market and mutual funds, insurance companies, savings and
loans, and so on. Property and casualty insurance companies
and mutual funds are the largest "other" holders of muni-
cipals. A breakdown by maturity is not available from the
Flow of Funds Accounts. Source: Flow of Funds Accounts,
Tables 620 (lines 12, 20, and 31) and 740 (lines 6, 7, and
10).

if individual investors regard these instruments as perfect substitutes, the yield spread would be driven to the corporate rate by firms' issuing taxable bonds. If the effective equity tax rate is positive, other factors, like the relative supply of tax-exempts, will also influence the spread.[6]

The yields of tax-exempt municipal (i_M) and taxable Treasury (i_T) bonds of similar maturity (here one year) and risk characteristics deliver the implied tax rate imbedded in this market, t:[7]

(11) $t = 1 - (i_M/i_T)$.

Figure 2 plots the implied, the corporate (t_c), and the personal (t_p) tax rates. The one-year U.S. government and one-year prime municipal yields from Salomon Brothers <u>Analytical Record of Yields and Yield Spreads</u> are used to calculate t.

Both t_p and t_c reflect the major tax law changes over this period: the 1954 tax cut, the 1964-65 tax cut and the 1968-70 temporary tax surcharge. The personal tax series also reflects the steady rise in per capita nominal income starting in the mid-1960's. A notable feature of t is its volatility compared with that of t_p and t_c. While changes in the personal and corporate tax series may account for some of the fluctuations in t, a substantial portion of its movement must be due to other factors.

Some recent econometric studies point to corporate-rate-payers as the marginal investors in these markets. Skelton (1983) obtains predicted values of the implied tax rate during the 52 and 48 percent corporate tax regimes which are almost exactly 52 and 48 percent, respectively. He concludes that his results illustrate "the behavior of commercial banks as tax arbitrageurs" (p. 350)

FIGURE 2

The Implied, Corporate, and Personal Tax Rates

1952:06 – 1979:06, semiannually
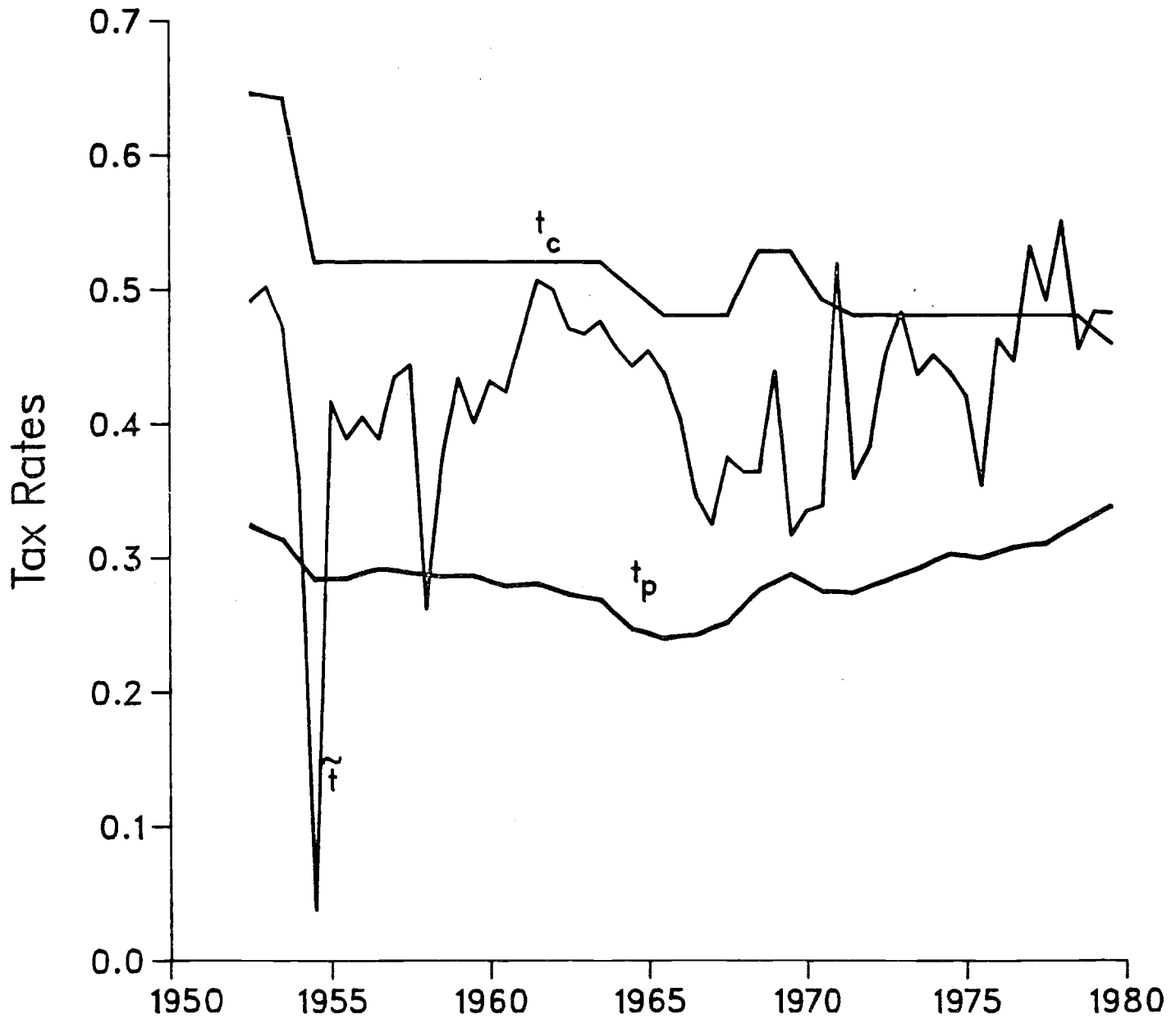
and that they confirm the importance of the corporate tax rate in the relative pricing of tax-exempt and taxable debt. Poterba (1984) likewise points to the importance of corporate tax rate changes and suggests that changes in personal tax rates have small effects on short-maturity yields.

Table 2 shows the relation of the implied tax rate to the personal rate, the corporate rate, and other factors. The 1952-1979 sample period is chosen to maintain comparability with that used in Section II and with the sample periods used to gather evidence regarding the corporate rate reported elsewhere. Since 1979, banks have acquired atypically small shares of municipal offerings, perhaps due to changes in tax laws regarding the deductibility of interest costs of carrying tax-exempts (see Poterba (1984)). The dependent variable in the first five rows is the tax rate implied by one year yields; the last two pairs of rows use the tax rate implied by five year and twenty year yields, respectively. Row 1 relates $\tilde{t}$ solely to t_p and t_c. The low Durbin-Watson statistic associated with the ordinary least squares (OLSQ) results (not shown) led to the use of the Cochrane-Orcutt technique. $\hat{\rho}$ is the estimated autocorrelation-correction factor. Row 2 adds the dependent variable lagged one period (six months) to show that our results do not stem solely from failure to allow for dynamics.[8] Durbin's h provides a valid statistic for testing for autocorrelation in the lagged dependent variable specification. Neither of these simple specifications deliver significant estimated coefficients on either personal or corporate rates. The

Table 2
The Relation of the Implied Tax Rate to Personal and Corporate Tax Rates
sample period: 1952:06 - 1979:06, semiannually
(t-statistics in parentheses)
dependent variable: t

ESTIMATION TECHNIQUE	CONSTANT	$\tilde{t}_1$	t_p	t_c	MGR	D5406	DSEAS	FLOW (x100)	$\hat{\rho}$	R^2	S.E.E.	D.W.	h
maturity: 1 year													
1. CORC	0.11 (0.41)	—	1.045 (1.64)	0.022 (0.05)	—	—	—	—	0.303 (2.34)	0.1527	0.075	2.05	—
2. OLSQ	0.12 (0.73)	0.281 (2.10)	0.765 (1.62)	-0.076 (-0.29)	—	—	—	—	—	0.1540	0.075	—	-0.20
3. CORC	0.11 (0.59)	—	0.944 (2.11)	0.102 (0.32)	0.96 (2.29)	-0.30 (-5.59)	0.021 (2.01)	-0.190 (-1.14)	0.337 (2.63)	0.6507	0.050	2.13	—
4. OLSQ	0.04 (0.35)	0.192 (2.02)	0.782 (2.44)	0.182 (0.92)	1.01 (2.45)	-0.29 (-4.72)	0.026 (1.87)	-0.244 (-1.46)	—	0.6481	0.051	—	0.57
5. OLSQ	0.04 (0.27)	—	0.806 (2.11)	0.419 (1.78)	1.05 (2.09)	—	0.031 (1.85)	-0.072 (-4.27)	—	0.4532	0.062	1.86	—
maturity: 5 years													
6. CORC	0.20 (0.82)	—	0.787 (1.42)	-0.118 (-0.30)	0.75 (1.95)	-0.10 (-2.10)	0.013 (1.53)	-0.033 (-0.21)	0.522 (4.50)	0.4450	0.047	2.03	—
7. OLSQ	-0.04 (-0.36)	0.389 (5.55)	0.639 (1.98)	0.165 (0.82)	0.84 (2.06)	-0.04 (-0.67)	0.019 (1.40)	-0.089 (-0.55)	—	0.4279	0.050	—	1.37
maturity: 20 years													
8. CORC	0.27 (0.84)	—	0.963 (1.32)	-0.606 (-1.18)	0.24 (0.63)	-0.10 (-2.10)	0.002 (0.24)	-0.154 (-0.98)	0.655 (5.37)	0.5449	0.049	2.05	—
9. OLSQ	0.02 (0.16)	0.619 (5.55)	0.468 (1.43)	-0.105 (-0.52)	0.44 (1.08)	-0.05 (-0.85)	0.006 (0.44)	-0.133 (-0.79)	—	0.5471	0.050	—	-0.44

point estimates do, however, convey the flavor of the subsequent rows. The (long-run) personal tax rate coefficient is very close to one; that for the corporate tax rate is very close to zero.

The third row adds four other factors that may also affect the implied tax rate. DSEAS is a dummy variable that is zero for June and one for December observations. D5406 is a dummy variable that is one during June 1954 and zero otherwise. In that period, $\tilde{t}$ fell to an unheard-of low (0.04, sample mean = 0.42; see figure 2) and the tax-exempt share of the flow supply of debt was vastly larger than for any other period (32 percent, sample mean = 11 percent). FLOW is the percentage of the total flow of debt issued over the previous three months that is state and local debt. Including this variable permits testing whether the relative supply of tax-exempt debt affects the implied tax rate.

Skelton (1983) argues that when taxable interest rates rose above the Regulation Q ceiling, banks found arbitrage "difficult, if not impossible" (p. 347). If banks were ordinarily the marginal investors, these "tight money" periods would then coincide with departures of the implied tax rate from the corporate rate. Banks typically held sizeable portfolios of both taxable and tax-exempt bonds. In tight money years, like 1966, they absorbed few of the newly issued tax-exempts (see Poterba (1984)) and $\tilde{t}$ fell noticeably. MGR is included here, then, to capture this liquidity effect. MGR is defined as the annualized growth rate of M1 over the last six months minus its annualized growth rate over the last three years. Skelton captured this effect with a dummy variable.

To allow for varying degrees of tightness, we use a quantitative, rather than a qualitative, proxy. Presumably the tighter are credit conditions, the smaller is the share of tax-exempts that banks will acquire. Given the progressive personal income tax system, this larger supply of tax-exempts to the household sector will drive down the implied tax rate.

Row 3 contains the results of estimating the complete specification. The personal tax rate carries a significant and near-unity coefficient, while the corporate rate coefficient is low and insignificant. With the exception of FLOW, the remaining coefficients are each significant, though sometimes barely. As might be expected, D5406 has a very large coefficient. Its estimate indicates that the implied tax during June 1954 is 30 percentage points below what conditions would otherwise warrant. Including D5406 renders FLOW insignificant; the correlation between them is 0.51. Omitting D5406 in row 5 produces a negative and very significant FLOW coefficient.

Since D5406 is a one period dummy, including it produces the same estimates as if we had omitted that period from the sample. To the extent that this observation should be treated like any other, the results then support the view that the relative supply of tax-exempt debt affects the implied tax rate. That conclusion is inconsistent with banks driving the implied tax rate to the corporate rate. If June 1954 is judged atypical for some reason other than that there was a large flow of tax-exempts (and we know of none), row 3 suggests that the relative supply of tax-exempts

has not significantly influenced the implied tax rate. In sum, the significance of FLOW is extremely sensitive to that one period.[9]

Tighter money does reduce the implied tax rate.[10] This is consistent with banks altering their relative holdings of tax-exempts by more than an amount that would preserve their no-arbitrage position. Rows 3, 4 and 5 each contain significant personal and insignificant corporate tax rate coefficients. Those coefficients are usually close to one and to zero, respectively. If the arbitrage hypothesis is correct, we would not expect to see significant personal rate, relative supply (FLOW), or seasonal effects. If individuals are generally the marginal investors, the other factors might well be expected to still exert discernible effects because of the progressive nature of the individual income tax system. This supports the hypothesis that the relevant supply curve for tax-exempts generally intersects the demand curve, not in a horizontal portion at a height equal to the corporate tax rate, but in the negatively sloped portion, which is generated by the fact that different investors face different marginal personal income tax rates.

Rows 6 and 7 display the results of re-estimating rows 3 and 4, using the implied tax rate derived from the respective five-year yields of tax-exempt and taxable instruments. Rows 8 and 9 are generated using the tax rate implied by 20-year yields. Neither Skelton nor Poterba contend that the corporate rate is likely to be the operative rate at these longer maturities. But,

in fact, the estimates for these longer maturities are quite similar to those for the shorter maturities. The size and confidence levels of the short-run coefficients generally decline with increasing maturity, but the estimated long-run responses differ little across maturities. None of the tax coefficients in the last four rows has a t-statistic as large as two. The earlier finding of long-run responses of one and zero, respectively, to personal and corporate tax rate changes is basically reaffirmed, however.

IV. Concluding Remarks

The empirical evidence presented here suggests the importance of personal income tax rates and the irrelevance of the corporate tax rate in determining both taxable interest rates and the spread between taxable and tax-exempt interest rates. The dominance of personal over corporate tax rates in taxable interest rate equations is robust. Using alternative corporate tax proxies, including or excluding personal tax rates, and even relaxing the assumption of no corporate tax fiscal illusion, each support the irrelevance of corporate tax rates.

Recent theoretical and empirical studies suggest that the corporate tax rate will determine the short-term taxable-tax-exempt yield spread. When we include both personal and corporate tax rates, the data overwhelmingly favor the personal rate at the expense of the corporate rate. Their respective point estimates, again over various specifications, are approximately one and zero. The significance of money growth and the relative supply of tax-

exempt bonds also argues against the hypothesis that the tax rate implied by the taxable-tax-exempt yield spread will be driven to the corporate tax rate. Thus, the evidence consistently points toward an important response of interest rates to personal income tax rates. Major personal rate changes, like those recently enacted and currently under consideration, are likely to have substantial effects on interest rates.

FOOTNOTES

1. Before December 1959, when one-year Treasury bills were introduced, the interest rate measure is the yield on Treasury bills with maturities of 9 to 12 months.

2. Unfortunately, the tax depreciation series will be correlated with interest and inflation rates due to its construction.

3. The resulting t-statistics will be for these ratios, not for the 's and γ's themselves. Both the point estimates and their associated t-statistics will depend upon which of the parameters is chosen as the scale factor. If, for example, we chose to scale by α_8 instead, we would obtain estimates of (and t-statistics for) a different set of coefficients (for example, α_4/α_8 instead of α_4/α_0). Because of this problem, we will not be able to obtain the relevant statistics for significance tests of the 's and γ's from the estimated standard errors of the coefficient estimates (i.e., the estimates of α_4/α_0, γ_1/α_0, etc.).

4. The sample size is 55. The square root of the critical values for the chi-square distribution and (the absolute value of) the critical values for the t distribution coverage as the sample size grows. These likelihood ratio tests reject the insignificance of the individual coefficients (at the 5 percent level) in (8) when the calculated chi-square test statistics exceed 3.84 or, equivalently, when the statistics in parentheses in (9) exceed 1.96.

5. This parameter is identified. Its estimated standard error

can therefore be obtained directly.

6. Poterba (1984) provides a lucid and detailed description of these and other explanations of the implied tax rate.

7. Historically the default rate on one-year prime-grade municipal bonds has been almost zero. Buser and Hess (1984) argue that the default risk premium in these instruments is small and stable, citing the "trivial" (p. 6) variation in the yield spread between good- and prime-grade municipal bonds.

8. Skelton includes two lagged dependent variables in his specification which uses monthly observations.

9. Poterba (1984), whose sample period starts in 1955, finds significant or nearly significant relative (tax-exempt-taxable) supply effects for 1, 5, 10, and 20 year maturities.

10. Hendershott and Koch (1980) find a negative effective of a 1969-70 credit crunch variable on bank holdings of tax-exempts.

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