TREASURY BILL YIELD REACTIONS TO THE
1997 CAPITAL GAINS TAX RATE REDUCTION

by

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DEDICATION

This work is dedicated to:

My wife, May, who endured my time in graduate school so that I could earn my doctoral degree – without her love and continued support I would have been unable to complete either the program or this dissertation;

And also to

My parents, who made all of this possible by making me the lucky beneficiary of an excellent education, and who always encouraged me to ask questions.

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ABSTRACT

This study tests the equilibrium of after-tax rates of return described in Miller (1977) by investigating whether a change in tax rates affects the return of an investment asset that is not directly taxed by the rate being changed. Using a model of after-tax investment returns I predict the yields of Treasury bills, which are subject only to ordinary tax rates, have an inverse reaction to changes in the capital gains tax rate. In a sample of daily Treasury bill data, yields appear to increase in response to the surprise reduction in capital gains tax rates on May 7, 1997. While small, this increase is statistically significant and is robust to other macroeconomic determinants.

These findings contribute to the accounting literature on taxes and investment pricing by providing evidence of Miller's after-tax equilibrium in a potentially cleaner setting than is used in previous studies. Evidence that a financial instrument subject to ordinary rates alone may be affected by the announcement of a change in the capital gains tax rate suggests that shareholder-level taxes are capitalized into prices in ways not investigated by existing research.

Accounting researchers will find these results useful because they suggest that the effects of changes in tax rates on asset prices are likely misstated in studies using settings where both the ordinary and capital gains tax rates change. Since the Treasury bill yield forms the basis of many consumer contracts, such as credit card agreements, policy makers should also be interested in these findings because they suggest changes to the capital gains tax rate may have unintended market consequences.

1. INTRODUCTION

The equality of after-tax rates of return described by Miller (1977) has formed the foundation for research seeking to document both the existence of implicit taxes and the effects that shareholder-level taxes have on the pricing of investments.¹ Accounting research in this area has concentrated on the impact of taxes on investments that are *directly* subject to the tax rate being studied. For example, the income from investments in both stocks and bonds may be subject to both ordinary and capital gains income taxes, making these investments a natural setting for studies examining the effects of both ordinary and capital gains taxes on investment pricing.² Similarly, the income from Treasury bills is only taxed at ordinary income rates, which makes these instruments ideal for research into the effects of ordinary tax rates on their yields.³

Recent studies have used these settings to document the existence of implicit taxes and provide evidence that shareholder-level taxes affect investment returns. Shackelford (1991) and Guenther (1994b) document implicit taxes in the market for ESOP loans and in Treasury bills, respectively. Erickson and Maydew (1998) show that a proposed change in the corporate dividends received deduction affected high-yield

¹ Implicit taxes are defined by Scholes, Wolfson ET. al. (2002) as those “taxes paid indirectly in the form of lower before-tax rates of return on tax-favored investments.”

² Investors pay taxes at ordinary rates on dividend income from stocks and on interest income from bonds, and at capital gains rates on the difference between the sale proceeds and the tax basis for both stocks and bonds. If the bond’s purchase price differs from its face value (e.g. original issue discount bonds and those purchased at a premium or discount) then the taxpayer’s basis is adjusted accordingly. This may cause a portion of the gain on sale to be ordinary in nature while the remainder is taxed at capital gains rates.

³ It is possible to generate *short-term* capital gains and losses on Treasury bill transactions when the sale price differs from the holder’s adjusted basis. However, the short-term nature of Treasury bills guarantees that the preferential *long-term* capital gains rate will never be applied to Treasury bill income because the one year holding period will not be satisfied. Any short-term capital gains resulting from Treasury bill transactions that survives the short-term capital gains and losses netting process will be taxed at ordinary income tax rates.

preferred stocks. Lang and Shackelford (2000) discuss the effects of changes in capital gains tax rates on common stock. Dhaliwal, Li and Trezevant (2002) present results consistent with stock returns increasing with dividend yield and find this return premium decreases as institutional and corporate ownership increases.

Collectively, these studies demonstrate that taxes affect investment pricing when the tax is applied by statute to income from these investments. In Miller's (1977) equilibrium, however, it is also possible that an investment's return will respond to changes in tax rates even if those rates are not applied directly to the income from that investment. This *indirect* influence of changing tax rates on investment income is suggested by Miller's (1977) description of the nature of the equilibrium:

...investors hold securities for the "consumption possibilities" they generate and hence will evaluate them in terms of their yields net of all tax drains. If, therefore, the personal tax on income from common stocks is less than that on income from bonds, then the *before-tax* return on taxable bonds has to be high enough, other things equal, to offset this tax handicap. Otherwise, no taxable investor would want to hold bonds. (Miller 1977, p. 267)⁴

It is the investor's evaluation of available returns "net of all tax drains" that implies an investment's price may be dependant not just on those shareholder tax rates under which its income is subject by statute, but may also be dependant on those rates which are applied to competing investments. This study attempts to determine whether investment returns behave as if this is indeed the case.

Starting from an equilibrium model of investment returns I predict that changes in the capital gains tax rate will affect inversely the yield of an asset subject only to the ordinary income tax rate. This prediction is tested using the daily yields from a sample of

Treasury bills surrounding the May 7, 1997 decrease in the capital gains tax rate. Using multivariate regressions I document a statistically significant increase in Treasury bill yields in response to the decrease in capital gains taxes. This response is robust to controls for a variety of macroeconomic and institutional influences.

This equilibrium model also predicts that the yield of an ordinary income asset will move in the same direction as changes in the ordinary income tax rate, consistent with the findings of Guenther (1994b). This prediction is tested using the same regression models used to test for the effects of changes in the capital gains tax rate. Specifically, I am able to replicate Guenther's (1994b) univariate analysis of the decrease in Treasury bill yields in response to the decrease in ordinary tax rates in a multivariate setting. The replication of these univariate results using multivariate regressions supports the use of the regression models during the 1997 sample period.

This research setting has several advantages. First, it allows the separation of tax effects from risk effects because Treasury bills are considered to be free of default risk and relatively homogenous. The differences in yields between Treasury bills are caused by their individual maturity dates and day-to-day changes in the economy, for which controls are included. Second, the May 7, 1997 reduction in the capital gains tax may be less subject to confounding effects found in the other major tax acts because the ordinary tax rate remained constant and because the decrease occurred before passage of the final bill in August 1997. Finally, since the income from Treasury bills is taxed only at ordinary income rates it will be more difficult to find an effect caused by changes in the

⁴ Quotes and Italics are as published originally.

capital gains tax, which biases against the prediction and provides a cleaner research setting.

These findings contribute to the accounting literature on taxes and investment pricing because they suggest that shareholder-level taxes are capitalized into prices in ways not investigated by existing research. These findings are also important to researchers because they indicate that the effects of changes in ordinary tax rates on asset prices may be misstated in studies using settings where both ordinary and capital gain tax rates change. Since Treasury bill rates form the basis for many contractual rates (such as credit card interest rates) policy makers should be interested in the finding that changes to the capital gains tax rate may cause unanticipated distortions in these markets.

2. BACKGROUND

2.1 Miller's Address to the American Finance Association

In his presidential address to the Annual Meeting of the American Finance Association in 1976, Merton Miller challenged the prediction of the "tradeoff model" that an optimal capital structure exists for a firm. The tradeoff model had arisen as a response to the original Miller and Modigliani (1958) finding of no optimal capital structure, and the subsequent "correction" paper (1963), which added corporate taxes to the analysis, and he proceeded to discuss the lack of empirical evidence for it and present theoretical reasons for why no optimal capital structure exists.

The tradeoff model specifies that a firm may utilize additional debt to increase its value because of the tax deductibility of interest payments, but it does so at the risk of decreasing its value due to increased costs of bankruptcy. In balancing the benefits of

additional debt against the costs of bankruptcy the firm reaches an optimal capital structure. Miller (1977) addresses this by arguing that the costs of bankruptcy are much smaller than assumed by the tradeoff model, and much smaller than the benefits of additional debt. He cites empirical evidence of bankruptcy costs of 5.3 percent of the firms' market values at the time of bankruptcy, while the benefits of additional debt are assumed to be 50 cents for each extra dollar of debt issued. In addition, Miller (1977) undermines the tradeoff model through a discussion of the static nature of capital structures across time even in the face of changing tax rates. As he notes, the debt ratio of the 1920's was similar to that of the 1950's despite an increase in tax rates from 10% to over 50%. The apparently small nature of bankruptcy costs and the seeming indifference of debt ratios to tax rates drew Miller to the conclusion that the tradeoff model must be flawed and that debt financing must provide less of a tax advantage than currently thought.

Instead Miller (1977) proposes that it is the existence of shareholder-level taxes that reduces the gains to a company of debt financing. The reason for this is that debt forces the company to pay out cash in the form of interest payments to the shareholder rather than maintaining it in the company for growth. When the shareholder receives interest payments they will be subject to the shareholder's personal income tax rate on interest income. If instead the firm retains the cash for growth purposes the shareholder will recognize no gains until the shares are sold, at which time the appreciation in share price will create capital gains which the investor will pay taxes on at the personal income tax rate for capital gains. As Miller (1977) notes, "[t]he advantage of deductibility at the

one level thus merely serves to offset the disadvantages of includability at the other.”

(Miller 1977, p. 268) Thus when all of the relevant tax rates are taken into account, both those of the corporation and those of the investor, some of the apparent tax advantages of the tax deductibility of interest payments disappear because the investor must in turn pay shareholder level taxes on the income.

The subsequent model of the gain to a firm of one additional dollar of debt that is set forth by Miller (1977) to explain this disparity includes not just the tax effects of the corporate tax rate but those of the individual investors, as well:

$$G_L = \left[1 - \frac{(1 - \tau_c)(1 - \tau_{ps})}{(1 - \tau_{pb})} \right] B_L \quad (\text{Miller 1977, eq. 1})$$

where τ_c is the corporate tax rate, τ_{ps} is the personal income tax rate applicable to income from common stock (the capital gains tax rate), τ_{pb} is the personal income tax rate applicable to income from bonds (the ordinary income tax rate) and B_L is the market value of the levered firm's debt. When the personal income tax rates on income from stocks and bonds are equal there is a gain equal to the corporate tax rate times the amount of debt issued, or $\tau_c B_L$. However, when the personal income tax rate on stock is below that of bonds the gain for a levered firm will be less than $\tau_c B_L$.

Once shareholder-level taxes are included in the analysis Miller (1977) shows that in order to attract taxable investors a firm issuing debt would need to compensate them for the shareholder-level taxes they must pay. Therefore, the investing public will demand an interest rate equal to that of a tax-exempt bond grossed up by the tax rate on interest income for individuals. The market equilibrium will be reached at the point

where the investing public's demand equals the corporate supply for debt, which will be level at a rate equal to the tax-exempt bond grossed up by the corporate tax rate (i.e., the maximum at which a corporation will want to borrow). He concludes that while there is an equilibrium level of aggregate debt in the economy there will not be an optimal amount for any individual firm, and that companies with little debt would find a market with high-tax-bracket investors while those with high debt ratios would find a clientele in low-tax-bracket investors. Market equilibrium forces will prevent the company from manipulating its capital structure to its advantage:

Any situation in which the owners of corporations could increase their wealth by substituting debt for equity (or vice versa) would be incompatible with market equilibrium. Their attempts to exploit these opportunities would lead, in a world with progressive income taxes, to changes in the yields on stocks and bonds and in their ownership patterns. These changes, in turn, restore the equilibrium and remove the incentives to issue more debt... (Miller 1977, p. 268)

In this equilibrium the returns on firms' stocks and bonds compete on an after-tax basis that includes the shareholder-level taxes as well as the corporate rates. Therefore, in an environment of progressive individual income tax rates the returns on the bonds will adjust to compensate the shareholders for the taxes they will have to pay on the investment's income stream. In the case of a firm that issues excessive debt, the return on this debt will become progressively higher to offset progressively higher tax rates paid by the marginal shareholders until it is no longer worthwhile to the firm.

Miller's (1977) use of an after-tax equilibrium of returns suggests that a preferentially taxed investment will bear a lower pre-tax rate of return than a similar investment that enjoys no tax preference. It also recognizes that certain investors will form portfolio preferences based on their tax status and the treatment of the investment's

income under the tax code. Since accurate estimates of the after-tax return of an asset are critical in calculating its price, and therefore in making an investment decision, understanding the degree to which taxes affect returns is a necessary part of valuation.

2.2 Theories of the effects on asset pricing of shareholder taxes

Erickson & Maydew (1998) provide a useful description of the different ways researchers have studied the influence of taxes on asset pricing. Research into “implicit taxes,” or the degree to which tax-favored assets bear lower pretax returns than do tax-disfavored assets of similar risk, examines the effects of tax preferences on equilibrium pretax returns. The research into implicit taxes is closely related to the research into “tax clienteles,” which are caused by investors with different marginal tax rates preferring some investments to others based on the treatment of the investment’s income under the tax code. They note that data on investment ownership is more difficult to obtain than data on yields, causing most researchers to estimate implicit taxes rather than investors’ marginal tax rates. However, the two ideas represent the same basic concept, and knowing the size of the implicit tax tells one the cut-off points for the tax clienteles (e.g. investors will buy municipal bonds if the implicit tax rate is less than or equal to their marginal tax rate).

Both of these concepts are similar to the concept of “tax capitalization,” which refers to the extent to which market prices of securities reflect future taxes that must be paid by investors on returns. If the income from an investment is expected to be taxed disadvantageously compared to other investments than it will sell at a discount compared to investments that are tax-favored. In general, studies of implicit taxes refer to research

into the effects of tax preferences on equilibrium pretax returns, while tax capitalization refers to research into the effects of tax burdens on equilibrium prices.

Ayers, Cloyd and Robinson (2002) also describe tax capitalization as the extent to which equity prices impound future shareholder taxes and further describe two theories of how firms' individual dividend policy might influence the degree of capitalization. In the "new view" all firm value is assumed to be eventually distributed as dividends so dividend policy does not affect share price. In the "traditional view" (or tax penalty view) dividend payout affects the degree to which shareholder taxes are impounded into price because shareholders pay taxes on dividends received and because payout affects the amount of internally generated cash retained within the company. While both the new and traditional views predict that an increase in the ordinary tax rates will cause share price to decrease, only the traditional view predicts that the payout policy of the firm will influence these effects.

An interesting alternative to the theory of tax capitalization is the "lock-in" effect model (Klein 1999) that treats taxes as transactional costs. In this model share prices will move in the same direction as changes in tax rates, rather than in the opposite direction as predicted by the tax capitalization theory. This is because a decrease in the tax rate, for example, lowers transactional costs and causes investors holding appreciated stock to rush to the market to sell shares, depressing prices.

The presence and magnitude of any implicit taxes are shown by Erickson & Maydew (1998) to be an empirical question. For example, in the presence of two differentially taxed assets (e.g. taxable corporate bonds and tax-free municipal bonds)

and two differentially taxed investors (e.g. taxable individuals and tax-exempt entities) it will be impossible to predict the implicit tax rate that equates the after-tax returns of the two kinds of bonds. For taxable individuals to be indifferent between the taxable and tax-free bonds Miller's (1977) equilibrium implies that the following condition must maintain:

$$R_c(1 - \tau_p) = R_e \quad \text{EM 1998, eq. 1}$$

where R_c is the pretax return on the corporate bond, R_e is the pretax return on the tax-free municipal bond and τ_p is the marginal tax rate faced by the individual investors.

However, while this condition is maintained for the taxable investors the following must simultaneously maintain for the tax-free investors:

$$R_c = R_e . \quad \text{EM 1998, eq. 2}$$

Except when $\tau_p=0$, Erickson & Maydew's (1998) Equations 1 and 2 cannot hold at the same time. Additional investors and investments only increase the number of conditions which must be satisfied. Therefore, the degree to which taxes affect pretax rates of return is an empirical question, although bounds may be put on the amount of implicit tax formed. For example, if the marginal investor is an individual, the yield on a tax-free municipal bond should be reduced by a maximum of the individual's tax rate. If the marginal investor pays no taxes then no implicit taxes should arise and the pretax yield on a corporate bond should equal that of a tax-free municipal bond.

The documentation of implicit taxes, clientele effects and tax capitalization is an important contribution to the literature examining the effects taxes have on asset pricing. The implicit null hypothesis of this literature is described by Shackelford and Shevlin

(2001) as “the marginal investor does not pay taxes.” The documentation of the existence of shareholder-level tax effects rejects this null hypothesis and provides evidence that the marginal investor is taxable. Since many analytical and empirical valuation models ignore shareholder-level taxes the finding of a taxable marginal investor indicates these models are specified incorrectly.

Erickson & Maydew (1998) use the 1995 proposed decrease in the corporate dividends-received deduction as a setting in which to look for implicit taxes. Corporate taxpayers are allowed to exclude from their taxable income a portion of the dividends they receive from stock held in other corporations. At the time of the proposal this exclusion was 70% of the dividends received. The proposed decrease in the exclusion percentage from 70% to 50% would have increased the taxes corporate shareholders pay on dividend income by including more of the dividends in their taxable income. The unexpected nature of this proposal mitigates the problems cross-sectional studies of asset returns have in distinguishing between risk and tax effects by essentially comparing shares of stock with themselves before and after the proposal.

Preferred shares of stock generally have high dividend yields and are thought to be held by corporate investors. Erickson & Maydew (1998) examine a sample of preferred stocks to investigate whether or not the proposed decrease in the dividends-received deduction affected their returns. They find the preferred shares exhibited a negative price reaction to the proposed change, which is consistent with the shares becoming implicitly taxed as their tax treatment becomes less favorable and indicates that the marginal shareholder in preferred shares is a tax-paying corporation.

Erickson & Maydew (1998) then form another sample consisting of high-yield common stocks and examine their returns for evidence of a reaction to the proposed change. They find that the returns of the common shares did not appear to react to the proposal, which is consistent with these shares not impounding an implicit tax based on less favorable tax treatment and their marginal shareholder not being a corporate taxpayer. Their study is especially informative because it not only documents the implicit taxes in the price of shares of preferred stock but also indicates that the marginal shareholder of preferred stocks is a taxable corporation.

Lang & Shackelford (2000) develop a model in which they show how capital gains taxes can become capitalized into share prices. Capital gains are the result of investors selling their shares after prices have increased. If a firm does not distribute its internally generated cash in the form of dividends its share price will rise. The effect of a change in the capital gains tax rate on share prices will therefore be inversely related to the firm's dividend payout since the lower the payout the more cash is retained, the higher the share price and the greater the effect of any change in the capital gains tax rate. To form their prediction Lang & Shackelford (2000) equate the firm's value as expressed in terms of its discounted cash flow and its dividend payout, where F is the free cash flow, D is the shareholder distributions, r is the discount rate and γ is the distribution growth rate that equates the two expressions for price:

$$FirmValue = \sum_{n=1}^{\infty} \frac{F}{(1+r)^n} = \sum_{n=1}^{\infty} \frac{D_1(1+\gamma)^{n-1}}{(1+r)^n}. \quad \text{LS 2000, eq. 1}$$

The firm's share price at time t can be expressed as the sum of its dividend stream and resulting capital gains at time of sale, once shareholder taxes of τ^d and τ^g on the dividends and capital gains, respectively, have been taken into account:

$$P_t = E_t \left[\frac{D_{t+1}(1 - \tau_{t+1}^d) + P_{t+1} - (P_{t+1} - P_t)\tau_{t+1}^g}{1 + r} \right]. \quad \text{LS 2000, eq. 2}$$

Since the share price at $t+n$ is a function of the price at $t+n+1$ for all n the current share price can be expressed as the following:

$$P_o = \sum_{n=1}^{\infty} \frac{D_1(1 + \gamma)^{n-1}(1 - \tau_n^d) \prod_{m=1}^{n-1} (1 - \tau_m^g)}{\prod_{m=1}^n (1 + r - \tau_m^g)}. \quad \text{LS 2000, eq. 3}$$

When Equation 1 is rearranged and substituted into Equation 3, and assuming that the tax rates are constant over time, the current share price may be expressed as:

$$P_o = \frac{D_1(1 - \tau^d)}{r \left[\tau^g + \frac{D_1}{F}(1 - \tau^g) \right]}. \quad \text{LS 2000, eq. 4}$$

The partial derivative of Equation 4 with respect to τ^g generates the following:

$$\frac{\partial P_o}{\partial \tau^g} = -P_o \left[\frac{F - D_1}{(F - D_1)\tau^g + D_1} \right]. \quad \text{LS 2000, eq. 5}$$

When $F > D_1$ Equation 5 is negative, consistent with an inverse response in share prices to changes in the capital gains income tax rate. Therefore, when there is an increase in the capital gains tax rate the current price of shares are predicted to rise.

Lang & Shackelford (2000) also propose an alternative share price reaction to the decrease in capital gains tax rates using Klein's (1999) lock-in effect model. In this

explanation of share price reactions a decrease in the capital gains tax rate will actually cause share prices to decrease. This is because the decrease in the tax rate lowers transactional costs and causes investors holding appreciated stock to rush to the market to sell shares, depressing prices. This is illustrated assuming the investor has a tax basis of C and a reservation price of R at which he is indifferent between selling and holding:

$$P = \frac{R - C\tau^c}{1 - \tau^c}. \quad \text{LS (2000), eq. 7}$$

When the share's price is below P the shareholder will refuse to sell and instead will hold the share. Taking the derivative of this with respect to τ^c generates the following:

$$\frac{\partial P}{\partial \tau^c} = \frac{R - C}{(1 - \tau^c)^2}. \quad \text{LS (2000), eq. 7}$$

Provided that the reservation price, R , exceeds the tax basis, C , a decrease in the capital gains tax rate causes the derivative to be negative.

As their setting Lang & Shackelford (2000) use a week in May 1997 during which Congress proposed and passed a surprise reduction in the capital gains tax rate but left the ordinary tax rate untouched. If capital gains taxes are capitalized, then stock prices should increase during the week the capital gains tax rate is reduced, particularly for those firms that pay lower dividends and retain more of their cash internally. They use the following model to investigate this:

$$\begin{aligned} \text{return}_{it} = & \beta_1 \text{Dividend}_i + \beta_2 \text{Week}_t + \beta_3 \text{Dividend}_i * \text{Week}_t \quad \text{LS (2000), eq. 8} \\ & + \sum \beta_{4i} \text{SP500}_{it} + \varepsilon_{it}. \end{aligned}$$

A negative regression coefficient on the interaction term indicates that non-dividend-paying firms outperformed dividend-paying firms during the week of the budget accord.

This suggests that the returns of those firms with higher expected capital gains benefited more from a decrease in capital gains taxes because dividend yields are a proxy for the amount of internally generated cash distributed by each firm and any subsequent impact of this reduction on individual stocks. They find the mean return for non-dividend-paying stocks significantly exceeded that of those paying dividends during the week of the tax rate change. In addition, they find stock returns during the week did not vary with the percentage change in stock prices during the months proceeding the event period.

Their results are not supportive of the lock-in effect, but ruling out such an effect is not possible in this experimental setting. Since the decrease in tax rates was, for all purposes, permanent, investors were not required to sell shares immediately to take advantage of the lower transaction costs. Therefore it's possible investors sold appreciated shares they would have otherwise held at the higher tax rate, but did so over a long period of time. This reaction would not be detectable in Lang & Shackelford's (2000) setting. They conclude that this is consistent with two different scenarios: either investors discounting share prices for expected capital gains taxes or the marginal shareholder in the affected shares being an individual subject to the capital gains tax rate. Since many companies pay no dividends at all, tax capitalization of expected capital gains taxes may be an important component of stock prices.

Further evidence of tax capitalization is provided by Ayers, Cloyd and Robinson (2002) who are also able to differentiate between the traditional and new views of tax-capitalization. Specifically, they provide evidence that a firm's dividend payout affects the degree to which changes in ordinary tax rates affect share prices. They examine

firms' stock reactions using an event study during the two weeks in August 1993 that ordinary tax rates for individuals were increased. In addition, they find that the tax status of the marginal investor in the shares affects the degree to which share prices change.

Ayers, Cloyd & Robinson (2002) are able to do this by including the level of institutional holdings as a proxy for the marginal shareholder's tax status in their regression model:

$$CAR_{it} = \gamma_0 + \gamma_1 Event_t + \gamma_2 Div_i + \gamma_3 Inst_i + \gamma_4 Div_i * Inst_i + \gamma_5 Div_i * Event_t + \gamma_6 Div_i * Inst_i * Event_t + \gamma_k X_{ki} + \varepsilon_{it} \quad \text{ACR (2002), eq. 1}$$

They find a negative stock price reaction conditioned on dividend yield that is moderated by institutional and corporate ownership. Their results indicate that dividend tax capitalization depends upon the dividend policy of the firm and the tax status of the marginal investor.

In a long-run cross-sectional study of common stock returns, Dhaliwal, Li and Trezevant (2002) find results that also support the traditional view. They find that firms' dividend yield has a positive impact on common stock returns that is decreasing in the level of institutional and corporate ownership. They use a sample of returns from 1989 to 1998 to study the following regression model:

$$R_i - PORTR_i = \gamma_0 + \sum_{k=1} \gamma_k IND_{ki} + \gamma_{10} DUM_i + \gamma_{11} \beta_{MKTi} + \gamma_{12} d_i + \gamma_{13} d_i^2 + \gamma_{14} INST_i + \gamma_{15} DUM_i * INST_i + \gamma_{16} d_i * INST_i + u_i \quad \text{DTL (2003), eq. 8}$$

where $R - PORTR$ is the firm's annual return less the return on the market capitalization portfolio into which that firm falls; IND is an industry-membership indicator; DUM is a dummy variable indicating whether the firm pays dividends; β_{MKT} is an estimate of the

sensitivity of the firm to the market's return; d is dividend yield and $INST$ is the level of the firm's institutional and corporate ownership.

This model includes firms' dividend yield, d , to capture tax-disadvantaged dividend income and institutional ownership, $INST$, to proxy for the marginal shareholder in the firm's common stock. Results show that the coefficients on d and $d*INST$ are positive and negative, respectively. The positive coefficient on d suggests that firms' stock returns impound the tax shareholders will have to pay on expected dividend distributions (i.e. return increases with payout). The negative coefficient on $INST$ suggests that this effect is moderated by the tax status of the marginal shareholder in the firms' common stock (i.e. the stock return increases less the lower the marginal tax rate of the shareholder).

Fewer studies have examined the effects of taxes on the prices of non-equity assets. Shackelford (1991) documents implicit taxes in the market for ESOP loans. The Tax Reform Act of 1984 excludes half of the interest income on ESOP loans from taxation. Since the usability of this exemption by the lender is uncertain most ESOP loans specify two interest rates: the first assumes the lender will be able to use the exemption, the second assumes the interest income will be fully taxable. Miller's (1977) hypothesis would predict that the after-tax return to the lender would be the same for both interest rates, but Shackelford (1991) finds that approximately 75% of the tax benefits from the exclusion are passed through to the borrower as lower rates. Guenther (1994b) uses adjacent pairs of Treasury bills maturing in December and January to show that decreasing ordinary tax rates will cause pre-tax returns on Treasury bills to decrease.

While prior research shows the Treasury bill yield curve to be normally upward sloping he demonstrates it is negative across the 1981/82, 1986/87 and 1987/88 yearends when ordinary tax rates decreased. Bills maturing in the first week of January do so under lower ordinary tax rates and, since they are tax-favored, become implicitly taxed compared to those maturing in the last week of December. This causes the tax-favored yields to be lower than the yields of bills maturing in December and creates a downward sloping yield curve across the affected yearends.

Collectively these studies provide support for the effects of shareholder-level taxes on an asset's return in settings where income from that asset is taxed directly under the tax rate being studied. For example, since stock and bond investments are subject to both ordinary and capital gains income taxes they make a natural setting in which to look for the effects of both ordinary and capital gains taxes on the prices of these investments. In an identical fashion Treasury bills provide a setting in which to look for the effects of ordinary income taxes because their income is only taxed at ordinary rates. However, the after-tax equilibrium described by Miller (1977) is defined such that investors consider returns "net of all tax drains," not just those taxes the investment is subject to by statute. In this broader sense the after-tax return of an investment would also depend on those tax rates which are applied to investments other than the one being studied.

The purpose of this study is to investigate whether investment returns behave as if they do react to changes in those tax rates which are not applied directly to the asset's income. Specifically, this study examines whether changes in the capital gains tax rate affects the price of an ordinary income asset indirectly. Starting with an equilibrium

model of investment returns, I predict that decreases in the capital gains tax rate will cause the price of the ordinary income asset to fall and its yield to rise. Using a sample of daily Treasury bill prices from 1997, I document that Treasury bill yields appear to increase in response to the May 7, 1997 decrease in capital gains taxes. While this response is small it is statistically significant and robust to a variety of macroeconomic and institutional explanations.

2.3 Treasury bills

As Erickson & Maydew (1998) note, empirical studies seeking to document the existence of implicit taxes in stocks must separate tax effects from cross-sectional differences in risk. Treasury bills make an attractive setting for research into the effects of tax rate changes because they are essentially risk-free and trade with almost no liquidity premium. Treasury bills are nearly homogenous and differ only in their measurement dates and their days-to-maturity. By including variables for the bills' maturities and the macroeconomic differences between measurement dates the differences in risk among them may be controlled, thus providing a potentially cleaner environment than tests using stock prices do. Treasury bills also provide a more difficult setting in which to investigate the price effects of changes in the capital gains tax rate because the interest earned on a Treasury bill is taxed to a cash basis taxpayer in the year of maturity as ordinary income.

The liquidity of the Treasury bill markets decreases the chances that market frictions will delay a price response, and their institutional details are so well known that there is little uncertainty for market participants. Since 1972 three- and six-month

Treasury bills have been auctioned weekly (one-year bills are auctioned monthly but are not included in this sample). These auctions are announced on Tuesdays, conducted the following Monday, and closed the following Thursday. In the ten days between the Monday announcement and the Thursday delivery there is an active forward market in the bills called the “when-issued” market. These when-issued yields increase the liquidity of the primary Treasury bill market by decreasing participants’ uncertainty of the eventual clearing price.⁵

As in Guenther (1994b) a necessary condition for changes in the capital gains tax rate for individuals to affect Treasury bill yields is that the marginal investor be an individual. Table 1 in Guenther (1994b, p.384) presents Federal Reserve Board data that indicates individuals held 10.5% of all marketable public debt (including Treasury bills, bonds and notes) in 1981 and that this number fell to 4.4% in 1986. More recently the Board of Governors of the Federal Reserve System reported that the household sector’s share of outstanding Treasury issues (including Treasury bills, bonds and notes but excluding savings bonds) was approximately 16% in 1997 and ranged from 15% to 19% in the period from 1995 to 1999.⁶ Cook (1998) cites Treasury bills’ low denomination, their exemption from state and local taxes and the ease of purchase without service fees (none is charged through purchases at Federal Reserve Bank branches) as reasons why individuals hold Treasury bills more than any other money market instrument. Guenther’s (1994b) finding that changes in ordinary tax rates for individuals affected the Treasury

⁵ Cook 1998 cites evidence that up to 40% of the positions closed on the Thursday delivery days have already been “cleared” in the when-issued market.

bill yield curve suggests the marginal investor in Treasury bills is an individual. Although this does not guarantee capital gains tax rate changes have an effect it makes the use of Treasury bill yield data in the search for such an effect reasonable.

2.4 The 1997 decrease in the capital gains tax rate

The May 1997 decrease in the capital gains tax rate is a useful research setting because rates on ordinary income for individuals remained unchanged and because the announcement of the decrease was unexpected. This suggests that any corresponding response by Treasury bill yields to the tax decrease is concentrated on the day of the change. If instead the market anticipated the rate change then the impact on yields would be more difficult to detect, biasing against a significant finding.

Lang & Shackelford (2000) use this same week for their event study and provide important details on the rate decrease. Although the original 1998 budget did not include a decrease in the capital gains tax rate, speculation about such a decrease surfaced in the press when the Congressional Budget Office released new figures on April 30, 1997 showing that the Federal deficit for 1997 would be much lower than expected, and that similar reductions were in order for the years 1998 to 2002. On May 2 the President announced an agreement with congressional leaders to balance the budget and reduce the capital gains tax rate by an unspecified amount. On May 7 congressional leaders announced that the lower rate, although not yet specified, would be effective as of that same day. Speculation about the new tax rate ranged from 15% to 20%. In August 1997

⁶ Guenther (1994b) cites Tables 1.41 and 1.42 of the *Federal Reserve Bulletin* from June of 1982 and 1987. The 1995-1999 range cited here is based on Table L.209 from the September, 2002 *Flow of Funds Accounts of the United States*.

the Taxpayer Relief Act of 1997 (TRA97) was passed and included a drop in the capital gains tax rate from 28% to 20%. Lang & Shackelford (2000) find that stock returns increased significantly in the period around the announcement, consistent with the effect of the announcement being concentrated in a short period.

In the days preceding the May 7 announcement there were indications in the press that the Treasury markets were responding to various economic events. *The New York Times* reported on May 3 that the announcement of a balanced budget had affected the Treasury markets because the unimagined size of the deficit reduction implied the government would need to sell fewer debt instruments. This anticipated scarcity of supply drove prices up and yields lower. Partly in response to this, *The New York Times* reported that the Treasury auction on May 5 of new three- and six-month bills went better than expected, with prices increasing and rates decreasing because of strong investor demand. These reports suggest an environment of decreasing yields on Treasury bills, biasing against finding an increase in yields due to the announcement.

Earlier in the year the Federal Reserve Open Market Committee (FOMC) took the unusual step of increasing the Federal Funds Rate between meetings (from 5.25 to 5.50 on February 5, 1997). Since Treasury bills are sensitive to FOMC actions there was some uncertainty in the market about what the Committee would do at the May 20, 1997 meeting. However, *The New York Times* reported on May 6, 1997 that bond prices climbed the week before because of new statistics suggesting that consumer prices were in check and that the economy might be slowing down. A slowing economy decreases the chance of action by the FOMC, and in fact the rate remained constant for the rest of

1997. This suggests that during the week of the announcement the market was relatively secure in its anticipation of no future action by the Federal Reserve Bank.

3. HYPOTHESIS DEVELOPMENT AND DATA PREPARATION

3.1 Hypothesis development

Miller's (1977) equality of after-tax returns suggests an equilibrium model of returns between equity securities and other investments. The taxable return for an individual stock, R , is made up of its dividends, d , and any capital gains, g , such that $R = g + d$. Now assume r is the taxable return on an ordinary income investment, t_d is the marginal tax rate on dividend income and t_g is the effective tax rate on capital gains. The equality of after-tax returns would require that:

$$(1 - t_g)g + (1 - t_d)d = (1 - t_d)r. \quad (1)$$

By substituting R into Equation (1) and rearranging terms the return on the ordinary income investment can be expressed as:

$$r = \frac{(1 - t_g)R}{(1 - t_d)} - \frac{(t_d - t_g)d}{(1 - t_d)}. \quad (2)$$

When the derivative of (2) with respect to t_g is taken the following obtains:

$$\frac{\partial r}{\partial(t_g)} = \frac{(d - R)}{(1 - t_d)} < 0. \quad (3)$$

Which generates the following hypothesis:

H₁: The yield on an ordinary income investment will move inversely with changes in the capital gains tax rate.

It may seem counterintuitive that a change in the capital gains tax rate can influence the yield of an investment that only generates ordinary income. However, a

decrease in the capital gains rate makes capital gains more attractive and could shift investor preferences away from ordinary income. In the case of Treasury bills this would cause demand to decrease and their price to drop, causing higher yields. Therefore, even though capital gains do not affect Treasury bill yields *directly* they could affect them *indirectly* because investment returns compete on an after-tax basis.

An initial estimate of the Treasury bill yield response to the 1997 change in capital gains tax rates can be obtained by solving Equation (3) for known values. During 1997 the average dividend yield was 1.56% while overall the market return was 27.79%.⁷ The ordinary tax rate was 39.6% while the capital gains tax rate decreased from 28% to 20%. When Equation (3) is solved using these values a 0.43% decrease in yield is predicted in response to a 1% increase in the capital gains tax rate.⁸ For the 8% decrease in the capital gains tax rate on May 7, 1997 this would suggest a 5.44% increase in the May 6 average yield of 5.14%, or an increase of approximately .2896%. However, given that a significant relationship exists it is unlikely to be a first order effect and any documented increase in yields is likely to be much smaller than this.

3.2 Sample description

The data used in this study to examine the May, 1997 change in the capital gains tax rate for individuals was collected from the *Wall Street Journal* and consists of *daily* bid and ask quotes for each of 26 Treasury bills and their associated maturity dates. The

⁷ Yields include both dividend and non-dividend paying stocks and are obtained from Dhaliwal, Li & Trezevant (2003, Table 1).

⁸ Calculated as $(1.56\% - 27.79\%) \div (100\% - 39.6\%) = -0.43\%$.

sample period includes the 84 days from March through June 1997, resulting in a total of 2,184 Treasury bills.

Figure 1 illustrates the average of the Treasury bill yields during the period surrounding the May 7, 1997 change in capital gains tax rates. Generally the yields are decreasing, consistent with news reports during this time period. On May 2, the date of the budget agreement announcement, the average yield flattens somewhat but then continues its downward trend. On May 7, the effective date of the capital gains rate decrease, yields spike sharply. This indicates that prices decreased suddenly and is consistent with H_1 . The average of the 26 one-day differences for May 7 is 0.034%, which is less than the .2796% increase suggested by Equation (3). This is consistent with the relationship between capital gains taxes and Treasury bill yields being less than first-order. Whether the cause of this increase in yields is the decrease in capital gains rates or other known determinants of yields is the subject of the univariate and multivariate analyses in this study.

Treasury bill bid/ask quotes were also collected from the *Wall Street Journal* to create two samples that are used to examine the same yearends studied by Guenther (1994b). The first of these two samples is used in a replication of Guenther's original univariate results and consists of *weekly* quotes collected as of the market's closing each Friday from June through December for the years 1979 through 1993. The second includes the months of November, December and January in 1981/82 (60 days), 1986/87 (60 days) and 1987/88 (62 days). This results in a total sample of 4,729 *daily* yields. The same regression models run on the 1997 sample to test H_1 are run on this second sample

in order to test whether they are successful in replicating Guenther's results in a multivariate setting.

3.3 Calculation of yield variables

Yield equals the annualized yield to maturity of an individual Treasury bill as measured on a specific date. *Yield* is calculated using bid/ask quotes collected from the *Wall Street Journal*, which publishes Treasury bill bid/ask yields as of the market's closing the prior day. As in Guenther (1994b), this market closing date is referred to as the "measurement date." An example of this data is shown in Panel A of Table 2 for four days in April 1997. On each measurement date, shown in the first column of Panel A, Treasury bill bid/ask quotes are available for bills of several different maturities, five of which are shown in Panel A. Each bid/ask quote is published in percentage points (R) and represents an annual yield calculated using a 360-day year, where the quoted yield for a bill with n days to maturity is R_n . Each of the bid/ask pairs is converted to bid/ask prices using Roll's (1970) formula, $P_n = 100 - (n/360)R_n$, where P_n is the current price of a \$100 (at maturity) Treasury bill that matures in n days. The mean of each bid/ask yield pair (P_n^*) is then used to find a continuously compounded annualized yield (Y_n) for that maturity as measured on that day, using the following formula adapted from Roll (1970): $Y_n = (365/n)\ln(100/P_n^*)$. Table 2, Panel B, shows an example of these annualized yields for the same four measurement days in April, 1997 that are shown in Panel A. Each annualized yield is then expressed as basis points.⁹ The first difference of *Yield* is taken to

⁹ One basis point is equal to .01% or .0001. This is the same method used by Guenther (1994b).

create $\Delta Yield$ (e.g., in Table 2, Panel B, the first difference of the April 10, 1997 Treasury bill on April 2, 1997 would be equal to $0.049 - .049613$).

4. UNIVARIATE STATISTICS

4.1 Replication of Guenther's (1994b) results¹⁰

Since this study follows Guenther's (1994b) analysis of the behavior of the Treasury bill yield curve, in which he concludes that pretax returns reflect changes in tax rates, replicating his original results is a useful exercise. Guenther (1994b) examines the Treasury bill yield curve as it crosses those calendar yearends where there were decreases in the ordinary tax rate for individuals. Table 1 lists these yearends along with the specific tax rates in effect before and after December 31 of the affected year.

Specifically, Guenther (1994b) studies the 1981/82, 1986/87 and 1987/88 yearends. He calculates the yield curve for each of the measurement days in his sample, which requires that some of the points on the yield curve will be based on adjacent Treasury bill yields that mature in different tax regimes. For example, Table 2, Panel B, shows ten successive Treasury bills on four different measurement days. The yield curve for each measurement day is calculated as the difference in yields between each adjacent pair of yields, so that a new yield curve is calculated on each measurement day. Since there are 26 Treasury bills for each measurement day the yield curve itself stretches out from the measurement date. Normally this yield curve is upward sloping because the market demands a higher interest rate for longer maturity debt, holding risk constant.

¹⁰ I thank David Guenther for his help in replicating his original univariate results.

When there is a change in tax rates that becomes effective at some date after the measurement date, however, the yield curve will be calculated using Treasury bills that will mature under varying tax rates. For example, in Table 2, Panel B, if taxes changed on April 20, 1997, the Treasury bills maturing April 3, 10 and 17 would mature under one rate while the remaining matured under the new rate. So for each measurement date in the sample the yield curve would have a point at which a tax regime became effective, even though the effective date of that tax regime was still far in the future.

Guenther (1994b) exploits this feature of the yield curve to show that a decrease in the ordinary tax rate for individuals will cause the otherwise upward sloping yield curve to become negative. He develops this hypothesis by first assuming that a positive yield curve would suggest that $Y_t = Y_{t+7} - \delta$, where δ is the additional yield demanded by the market for the additional time until maturity. Investors will price these two bills so that they have equivalent after-tax yields. If T is the tax rate and k is the amount it will decrease by ($0 < k < 1$) then prices will adjust so that $Y_t(1-T) = (Y_{t+7} - \delta)(1-kT)$, which suggests the following:

$$(1-T)/(1-kT) + \delta/Y_t = Y_{t+7}/Y_t. \quad \text{Guenther (1994b), eq. 2.}$$

The yield spread will become negative only if:

$$(1-T)/(1-kT) < (Y_{t+7} - \delta)/Y_t. \quad \text{Guenther (1994b), eq. 3.}$$

So a decrease in tax rates will cause the market to price bill's returns such that even an otherwise positive yield curve will become negative.

Guenther's (1994b) original results are show in Table 3 along with the results of the replication of his study, in the columns denoted G and R , respectively. As in Guenther

(1994b), Table 3, the yield spreads are calculated by subtracting the yield of the bill with the shorter maturity from the yield of the bill with the longer maturity. Yields are based on the mean of weekly bid and ask Treasury bill prices calculated from bid and ask yields each Friday in the *Wall Street Journal* from the first week in June to the last week in December for the years 1979 through 1992. For each of these weeks the three pairs of Treasury bills with the shortest maturities are excluded. Years affected by ERTA and TRA rate reductions are in bold type (*t*-statistics in smaller font).

Yield-curve pairs are categorized several ways in Table 3. “Within-month” pairs refer to those adjacent yields that are not split by the end of a calendar month. “Turn-of-the-month” pairs are those that straddle the end of a month. This is done in order to provide a comparison of overall yield means to those that are affected by the changing tax rates and to control for the end-of-the-month effect documented by Park and Reinganum (1986) and Ogden (1987), in which Treasury bill yield curves are found to behave differently as aggregate payments come due at the end of calendar months.

The qualitative results of the replication are the same as in Guenther (1994b), although the magnitude of the mean yield spreads differs (as do the size of the *t*-statistics). In each of the tax-affected yearends, 1981/82, 1986/87 and 1987/88, the ordinary tax rate for individuals decreased (by 20%, 11% and 11% respectively, as shown in Table 1). In each of these affected yearends the mean yield spread for the December/January turn-of-the-month pairs is reliably negative in both the replication and in Guenther (1994b), while the mean of the within-month-pairs is reliably positive. This indicates that while, overall, the yield curve was upward sloping it became negative

sloping across the yearends where tax rates decreased. This is consistent with the market pricing the Treasury bills on an after-tax basis. Since the Treasury bills maturing in January do so under a lower tax rate than those in December their prices increase and their yields drop in comparison to those in December. This causes the average yield spread between these adjacent Treasury bill yields to be negative, causing a downward sloping yield curve.

Differences between the replication and Guenther's (1994b) study can be explained by differences in the data collection and analysis that do not affect the overall conclusions. While Guenther (1994b) only included Treasury bills that matured one week apart the replication includes bills that may mature less than one week from each other. In addition, the replication includes those bills measured between June 1 and August 31, 1981. Guenther (1994b) deletes these measurement dates because they include days where the yield curve was negative due to the Federal Reserve Banks tight money policy.

Yield spreads between successive Treasury bills provide a convenient way of testing for effects of statutory changes occurring at yearends, but they will not do the same for the May, 1997 surprise decrease in capital gains rates. The problem lies in the weekly maturities of the Treasury bills. The yearend tax changes in Guenther (1994b) always "split" pairs of successively maturing Treasury bills. As the measurement day gets closer to the end of the year there will be some Treasury bills maturing in the following year while the next shorter maturity will come due in the current year. This guarantees that some yield differences will "straddle" the yearend and provides the yield structure test used by Guenther. For example, on November 28, 1986 (the measurement

date) Treasury bills with maturities of four and five weeks were due, respectively, on December 26, 1986 and January 2, 1987. Taking the difference between the yields of these two successively maturing Treasury bills forms one point of the yield curve for November 28, 1986.

This is not the case for the decrease in capital gains rate in 1997 because the cut was announced on a Friday (May 2, 1997) and made effective as of the following Wednesday (May 7, 1997). This makes it impossible to directly apply Guenther's methodology to this tax change since at no time does a yield pair straddle a future statutory tax change. Instead the surprise announcement is made and the market impounds all of the information going forward.

4.2 Univariate statistics

Table 4 provides an initial univariate test of whether Treasury bill yields react to changes in tax rates that is similar to the analysis in Guenther (1994b). $\Delta Yield$, the first difference of $Yield$, is calculated for Treasury bills of individual maturities on successive measurement days in the sample. For example, in Table 2, Panel B, on April 2 $\Delta Yield$ for the Treasury bill maturing April 10 would be equal to $0.049 - .049613$. $\Delta Yield$ is calculated for four groups of measurement day pairs: event-pairs, those predicted to be affected by tax rate changes; all-other, any other non-event-pair; within-month, any non-event-pair that does not straddle a month end; and turn-of-the-month, any non-event pair that does straddle a month end. These provide comparison groups for the means of the event-pairs and allow the end-of-month affect documented by Park and Reinganum (1986) and Ogden (1987) to be controlled for as in Guenther (1994b).

H_1 predicts that a decrease in the capital gains income tax will result in an increase in Treasury bill yields. If yields react in a way consistent with this prediction then the May 6/7 event-pairs should be significantly positive. In Table 4, Panel A, the mean of the May 6/7 event-pairs equals 3.4 and is significantly positive at the 1% level, consistent with H_1 . The mean of all-pairs equals -2.37 and is significant at the 5% level. The mean of the turn-of-the-month pairs equals -6.01 and is significantly negative at the 1% level. A negative mean for the turn-of-the-month pairs is consistent with the end-of-month effect. The mean of the within-month pairs is insignificant. This suggests that the end-of-month effects drive the significant negative mean for the all-pairs group.

The mean changes of the May 6/7 pairs are compared to the mean changes of the all-other, within-month and turn-of-the-month pairs using both independent groups t -tests and non-parametric tests. In both sets of tests the May 6/7 pairs are significantly more positive at the 1% level for all comparisons. This is consistent with the Treasury bill market impounding new information that caused yields to increase suddenly from May 6th to the 7th, supporting the prediction in H_1 .

Since this univariate analysis of $\Delta Yield$ is not the same as Guenther's (1994b) test of the Treasury bill yield curve, it would be interesting to see how well it detects the tax affects documented in his study. Guenther's (1994b) hypothesis predicts that a decrease in the ordinary income tax rate for individuals will cause Treasury bill yields to decrease. This suggests that the Dec./Jan. yield differences measured across the 1981/82, 1986/87 and 1987/88 year-ends (when lower ordinary rates went into effect) should be significantly negative. In Table 4, Panel B, the mean of the Dec./Jan. pairs equals -6.49

and is significantly negative at the 1% level. The mean of the all-pairs group equals -0.09 and is marginally significant at the 10% level, while the mean of the within-month pairs is insignificant. The mean of the Nov./Dec. pairs equals -8.76 and is significantly negative at the 1% level.

In both the independent groups *t*-test and the non-parametric tests the mean of the Dec./Jan. pairs is significantly more negative (at the 1% level) than both the within-month and turn-of-the-month pairs, which is suggestive of Guenther's (1994b) result. However, the mean of the Dec./Jan. group is statistically indistinguishable from the mean of the Nov./Dec. group. This makes it difficult to conclude that the decrease in ordinary tax rates had a significant impact on yield changes across the affected year-ends.

5. EMPIRICAL SPECIFICATION

Two regression models, one expressed in levels and the other in changes, provide tests of the effect of a change in the capital gains tax rate on Treasury bill yields. The levels model is designed to capture the reaction of Treasury bill yields during the week in which the rate change was both announced and made effective. The changes model is intended to capture the one day change in Treasury bill yields on the date the rate change became effective (sign predictions in parentheses):

$$\begin{aligned}
 \text{Yield} = & a_0 + a_1 \text{AnnWk} + a_2 \text{LagYield} + a_3 \text{DaysMat} + a_4 \text{EndMonth} \\
 & \quad (+) \quad \quad (+) \quad \quad (+) \quad \quad (-) \\
 & + a_5 \text{Pdebt} + a_6 \text{TSspread} + a_7 \text{AaaBaa} + a_8 \text{CRSP} \\
 & \quad (+) \quad \quad (-) \quad \quad (+) \quad \quad (-) \\
 \\
 \Delta \text{Yield} = & a_0 + a_1 \text{May7} + a_3 \text{DaysMat} + a_4 \text{EndMonth} \\
 & \quad (+) \quad \quad (+) \quad \quad (-) \\
 & + a_5 \Delta \text{Pdebt} + a_6 \Delta \text{TSspread} + a_7 \Delta \text{AaaBaa} + a_8 \Delta \text{CRSP} \\
 & \quad (+) \quad \quad (-) \quad \quad (+) \quad \quad (-)
 \end{aligned}$$

where:

- Yield* = the annualized yield of an individual Treasury bill on a specific measurement date, in basis points; ΔY_{ield} is the first difference of *Yield*
- AnnWk* = 1 if the yield was measured on or between May 2 and May 7, 1997 and zero otherwise
- May7* = 1 if the yield was measured on May 7, 1997 and zero otherwise
- LagYield* = the first lag of *Yield*
- DaysMat* = the difference in days between the maturity and measurement dates
- EndMonth* = 1 if the Treasury bill matures at the end of the month and zero otherwise
- Pdebt* = the natural log of the daily level of The United States Federal Government's public debt; ΔP_{debt} is the first difference of *Pdebt*
- TSspread* = the daily difference between the Treasury's 30 year and 3 month rates; ΔT_{spread} is the first difference of *TSspread*
- AaaBaa* = the daily difference between Moody's Aaa and Baa corporate bond indices; ΔA_{aaBaa} is the first difference of *AaaBaa*
- CRSP* = the CRSP daily value weighted stock return index; ΔC_{RSP} is the first difference of *CRSP*.

5.1 Dependent variable

As described previously the dependant variable in the levels model, *Yield*, equals the annualized yield to maturity of an individual Treasury bill as measured on a specific date and is calculated using bid/ask quotes collected from the *Wall Street Journal*. The dependant variable in the changes model, ΔY_{ield} , is the first difference of *Yield*.

5.2 Tax effect variable

Two dummy variables are used to capture the effects of tax rate changes. The first, *AnnWk*, equals one if a specific yield is measured on or between May 2 and May 7, 1997. Although the cut was made effective as of May 7 it was announced on May 2. Since the market knew a cut was forthcoming it's possible that its effects on Treasury bill yields began to be felt as soon as May 2. *AnnWk* is used in the levels model in order to

test for a market reaction over this time period to the news of the tax cut and is hypothesized to be positive.

The second tax effect variable, *May7*, equals one if a specific yield is measured on May 7, 1997. Since the market became aware of the cut's effective date on May 7 the one-day increase should be significant even when controlling for other determinants of yields. *May7* is included in the changes model to test for this one-day market reaction and is hypothesized to be positive.

5.3 Other control variables

The following variables are included in the model as controls for the determinants of Treasury bill yields identified by previous research:

LagYield is included to control for the strong autocorrelation present in Treasury bill data. In an analysis of the effects changes in Treasury bill yields have on equity markets, Soydemir (2002) finds the Treasury bill yield itself to be most affected by its own lagged values. Based on Soydemir's (2002) results *LagYield* is predicted to be positive.

DaysMat is included to control for the normally upward sloping nature of the yield curve and is predicted to be positive. This is supported by Cohen, Kramer and Waugh (1966), who conclude the best regression models of Treasury bill yields are those that include days to maturity. In addition, Simon (1991) shows that holders of Treasury bills do not view bills of adjacent maturities to be substitutes. He compares a sample of unexpected cash management bills to regularly auctioned Treasury bills to investigate whether segmentation is confined to the end of the month or not, and finds that the cash

management bills are regularly sold at higher yields compared to Treasury bills of adjacent maturities. This indicates that buyers are unwilling to adjust their portfolios to take advantage of the available higher yields, and therefore must have a preference for the specific maturities currently held in their portfolios.

EndMonth is included to control for the “kink” in the yield curve when it crosses month ends, as documented by Park and Reinganum (1986), and is predicted to be negative. This kink, or unexpected decline, in the yield curve is explained by Ogden (1987) as the result of aggregate operational payments (e.g. salaries, rent) occurring at the end of each month. These payments create extra demand for Treasury bills maturing at those times, suppressing their yields as prices are bid up. This yield discount disappears along with the excess demand at the start of the next month, causing the yields to increase after the end of the month.

Pdebt is included to control for the relationship between debt yields and the supply of debt and is predicted to be positive. Fair and Malkiel (1971) compare U.S. Government debt instruments to high quality industrial and utility bonds of the same maturities to investigate the causes of yield differentials between debt of the same maturity. They find the differentials are positively influenced by the current level of outstanding debt issued by all three entities as well as the expected future supply of utility bonds within the next six months. Based on this work Cook and Hendershott (1978) include a relative supply variable in their investigation of rate differentials and find that it is positively related to the spread between yields on utility bonds and newly issued U.S. debt.

TSpread is included to control for the market's expectation of long-term inflation and is predicted to be negative. Long-term inflation expectations make shorter-term investments more popular, decreasing their yields. As the expectation of inflation increases *TSpread* will get larger as the yields on long-term investments increase to attract investment.

CRSP is included to control for the effect stock market returns may have on the performance of Treasury bills and is predicted to be negative. This tradeoff between stocks and Treasury bills is supported by Soydemir (2002) who finds a negative reaction in the US stock market to positive shocks to the Treasury bill yield. In addition, Cox, et. al. (1985) include unspecified "investment alternatives" in their theoretical model of term structure.

AaaBaa equals the yield differential between Moody's highest- and medium-grade corporate bond indices and is included to proxy for investors' risk preferences. A decrease in this spread indicates investors are moving towards safer debt investments, including Treasury bill yields, which will cause their yields to decrease. *AaaBaa* is predicted to be positive.

6. EMPIRICAL RESULTS

6.1 Descriptive statistics

Table 5 provides descriptive statistics for the sample period, April through June, 1997. Of the 2,184 daily Treasury bill yield observations available, 26 are lost in matching to *CRSP* or *AaaBaa* because of holiday closures and 43 more in taking the first difference of *Yield* in the calculation of *LagYield* for a final sample size of 2,115. The

means of the primary tax event variables, *AnnWk* (0.049) and *May7* (0.012) are consistent with the number of Treasury bills tested during the event periods. The means of *Yield* (515.06) and *LagYield* (515.40) are both consistent with prevailing interest rates during the period, and the negative value of ΔY_{ield} (-0.3408) reflects the overall downward trend during the sample.

6.2 Correlation coefficients

Table 6 provides correlation coefficients for the variables that will be used in the regression models. H_1 predicts that Treasury bill yields will increase when capital gains taxes are decreased. The coefficient between *Yield* and *AnnWk* (0.0097) is positive but insignificant while the coefficient between ΔY_{ield} and *May7* (0.044) is significantly positive, providing mixed support for H_1 .

Yield is positively correlated with *LagYield* (0.93), a result that is consistent with the known autocorrelation of Treasury bill yields. The correlation between *Yield* and *DaysMat* (0.66) is positive, consistent with the normally upward sloping Treasury bill yield curve. Surprisingly, the coefficient between *EndMonth* and *Yield* is insignificant, despite the well-documented end-of-month effect.

The relationship between *Pdebt* and *Yield* (0.29) is significantly positive, consistent with the outstanding supply of debt increasing yields. The coefficient between *Yield* and *TSpread* (-0.055) is negative. *AaaBaa* is significant and positively related to *Yield* (0.048), and *CRSP* is significant and negatively related to *Yield* (-0.082).

6.3 Diagnostic tests

In tests for multicollinearity the condition indices for the levels and changes models are 2.74 and 1.43, respectively. While criteria for the condition index are somewhat arbitrary these values are certainly well below the index of 30 that is often mentioned as an indicator of serious multicollinearity problems.¹¹ Graphs of the error terms (not reported) from the models indicate even dispersion around the axis, indicating that no heteroscedasticity is present.

The Durbin-Watson statistics for the levels and changes models are 1.53 and 1.63, respectively. Since these values are between the upper and lower limits for the Durbin-Watson tests they are inconclusive. To correct for the possibility of serial correlation the regression models reported in the tables are all estimated using a first-order autoregressive error term. As reported with the regression results the new Durbin-Watson statistics are all in excess of the upper limit (at the 1% confidence level), indicating there is no serial correlation.

6.4 Regression results

The results of the levels and changes regressions are shown in Table 7. The tax event variables *AnnWk* and *May7* are significantly positive at the 1% and 5% levels in the levels and changes regressions, respectively. This supports the hypothesis that a decrease in the capital gains tax rate has a positive effect on Treasury bill yields. In the levels model the coefficient on *AnnWk* (expressed in basis points) indicates that Treasury bill

¹¹ Freund and Little (1992) cite 30 as a threshold for multicollinearity problems. They also cite Myers (1990), who describes 1,000 as the ceiling for the square of the condition index, beyond which severe multicollinearity exists.

yields increased by .028%, when controlling for other yield determinants, during the period of the capital gains tax rate decrease. In the changes model the coefficient on *May7* indicates yields increased only fractionally on the day the cut became effective, by $4.92 \times 10^{-6}\%$, once other determinants of yields are controlled for.

As expected, *LagYield* is significantly positive in the levels model. To make certain its inclusion does not cause misleading results, the levels model was also run without *LagYield*. Its exclusion does not change the qualitative results (not reported here). *EndMonth* is insignificant in both models. *DaysMat* is significantly positive in the levels model but becomes insignificant in the changes model. This is not surprising since the changes model is based on one-day differences in *Yield*, limiting the explanatory power of *DaysMat*.

Pdebt is significantly positive in the levels model but $\Delta Pdebt$ is insignificant in the changes model. *TSpread* is significantly negative, while *AaaBaa* is reliably positive, in both models. *CRSP* is significantly negative in the levels model but is insignificant in the changes model.

7. SENSITIVITY ANALYSIS

7.1 Regression results using yearends from Guenther (1994b)

The equilibrium model of after-tax returns shown in Equation (1) is also consistent with the results of prior research. For example, taking the derivative of Equation (2) with respect to t_d results in the following:

$$\frac{\partial r}{\partial(t_d)} = \frac{(R - d)(1 - t_g)}{(1 - t_d)^2} > 0. \quad (4)$$

Which predicts that Treasury bill yields will move in the same direction as changes in the ordinary tax rate. This is consistent with Guenther's (1994b) finding that decreasing ordinary tax rates (at the end of 1981, 1986 and 1987) caused the prices of bills maturing in January to be higher than those maturing in December (resulting in a declining yield curve across the affected yearends).¹²

In this section I will replicate Guenther's (1994b) univariate findings using the same multivariate models of Treasury bill yield determinants used to test H_1 . Testing Equation (4) permits a check of the equilibrium model because both Equations (3) and (4) derive from the same initial condition. In addition, replicating Guenther's (1994b) results with the same regression models used to investigate the capital gains effect during 1997 allows the effectiveness of these models to be validated. Since H_1 and Equation (4) deal with different tax effects and yearends this should make finding significant results more difficult.

The sample used to test Equation (4) includes Treasury bill bid/ask data collected from the *Wall Street Journal* for the months of November, December and January in 1981/82 (60 days), 1986/87 (60 days) and 1987/88 (62 days). This results in a total of 182 measurement days for a total sample of 4,729 yields, which is reduced to 4,612 and 4,458 observations once *LagYield* and $\Delta Yield$ are calculated, respectively.¹³ A new tax event variable, *YearEnd*, is included in tests using this sample. In the levels model *YearEnd*

¹² Some other partial derivatives of Equation (2) also support prior research. For example, the partial derivative of R with respect to t_d is negative, supporting both Erickson & Maydew (1998) and Ayers, Cloyd & Robinson (2000). Support for Lang & Shackelford (2000) is found in the positive partial derivatives of R with respect to t_g and t_d . When t_d and t_g are interpreted as marginal tax rates their (negative and positive, respectively) partial derivatives with respect to d support Dhaliwal, Erickson and Trezevant (1999). Intuitively, the partial derivatives of R with respect to r , and r with respect to R , are positive.

equals one if the Treasury bill's yield was measured during December, 1981, 1986 or 1987 and its maturity date was in January, 1982, 1987 or 1988, respectively; zero otherwise. In the changes model *YearEnd* equals one for those values of $\Delta Yield$ calculated using the first Yield in January and the last from December, zero otherwise. Since Guenther (1994b) shows that these yearends were associated with declining yield curves *YearEnd* is hypothesized to be negative in both the levels and changes models.

Figures 2, 3 and 4 show graphs of the average Treasury bill yield over the yearends in question. It does not appear that there is anything in common with the average yields over these three different yearends. In 1981/82 (Figure 1) yields appear to be increasing at the end of the sample, with a sharp uptake across the yearend. In 1986/87 (Figure 2) the average yields appear to exhibit increased volatility through December and January, but this is nothing compared to the variation in the 1987/88 graph (Figure 3). This indicates there is no systematic variation in yields across the yearends that might influence the regression results.

Table 8 has descriptive statistics for this sample. Since this sample covers three different yearends the descriptive statistics are more difficult to interpret than if they covered one contiguous sample period. The mean of *YearEnd* is consistent with the number of Treasury bills being tested, while the mean of *Yield* appears reasonable when compared to Figures 2 through 4. Table 9 shows the correlation coefficients for this sample. *YearEnd* is negatively correlated with *Yield*, consistent with Guenther's (1994b) finding. *Yield* is positively correlated with both *LagYield*, which is consistent with the

¹³ Quotes for three Treasury bills in the 1980s are not available.

positive autocorrelation of the data, and *DaysMat*, which is consistent with an upward sloping yield curve. *Yield* is negatively correlated with *CRSP*, which supports the idea of Treasury bills and stocks competing against each other for investor attention. The correlation between *Yield* and *Pdebt*, *TSspread* and *AaaBaa* are all significant but in the direction opposite from what is predicted. As in the 1997 sample the correlation between *Yield* and *EndMonth* is not significant.

Table 10 contains the results of these regressions. The tax event variable *YearEnd* is significantly negative in both the levels and changes models. With the exception of *EndMonth* in both models and *DaysMat* in the changes model, all of the control variables are significant to some degree and are of the predicted sign. This supports Guenther's (1994b) findings that the decrease in the ordinary income tax rate for individuals would decrease Treasury bill yields. This confirmation of Guenther's (1994b) results using regressions on both the levels and changes of Treasury bill yields supports the use of the same regression models on the 1997 sample to demonstrate a capital gains effect.

7.2 Influence of Treasury bill auction announcement and auction dates

Since 1972 three- and six-month Treasury bills have been sold at weekly auctions that are announced on Tuesdays and are conducted the following Monday. Each of these announcement and auction days are a potential source of new information that might influence the Treasury bill market, so additional tests are performed to see whether or not this is the case. Two dummy variables equal to one if the bill was measured on a Monday or Tuesday, respectively, and zero otherwise, were included in the same levels and changes regressions used to test for the tax effects of the decrease in capital gains rates.

Model 1 of Tables 11 and 12 show the results of the levels and changes regressions, respectively, including these new dummy variables. Since there is no sign prediction for either *Monday* or *Tuesday* two-tailed *t*-tests for these variables are conducted. While *Monday* is significant at the 10% level in the levels model it is insignificant in the changes model, and *Tuesday* is not significant in either model. The tax effect variables, *AnnWk* and *May7*, are still significant even when *Monday* and *Tuesday* are included. *Monday* and *Tuesday* were also included in the regressions on Guenther's (1994b) yearends. These results (not reported) show neither *Monday* nor *Tuesday* are significant while the qualitative conclusions concerning *YearEnd* are unchanged.

Since each announcement also includes the volume of bills for sale at the upcoming auction it is possible the market's knowledge of this pending amount may influence yields. In order to investigate this possibility a new variable called *Visible* was calculated. For each day after an auction announcement *Visible* equals the dollar volume of Treasury bills that will be for sale at the next auction date. Fair & Malkiel (1971) show that the pending supply of debt for sale has a positive influence on yields, so *Visible* is predicted to be positive. Model 2 in Tables 11 and 12 show the results of the regressions including this new variable for the levels and changes models, respectively. *Visible* is significant at the 10% level in the levels model but insignificant in the changes model. Both *AnnWk* and *May7* remain significant even when *Visible* is included. When *Visible* is included in the regressions on Guenther's (1994b) data (results not reported) the significance and direction of *YearEnd* are unchanged.

7.3 Impact of the May 13, 1997 increase in yields on regression results

Figure 1 shows that Treasury bill yields increased sharply on May 13, 1997 as well as on the May 7 event day. On May 14, 1997 *The New York Times* reported that Treasury prices fell the previous day on new data that described “surprisingly strong business for manufacturers,” a possible indicator of inflation. A new dummy variable, *May13*, that equals one for yields measured on May 13, zero otherwise, was included in the regressions to investigate whether the May 13 increase might influence the results. Model 3 in Table 11 shows the results of the levels regression. *May13* is significant at the 5% level while the tax effect variable, *May7*, continues to be significant. When *May13* is included in the changes model the results in Model 3 of Table 12 show it to be insignificant while leaving the tax effect variable qualitatively unchanged. This suggests that the May 13 increase in yields is explainable with the existing control variables while the May 7 increase is the result of the market receiving new information.

As a final check the levels and changes models are run including *Monday*, *Tuesday*, *Visible* and *May13* at the same time, along with the previously used market controls. Model 4 in Tables 11 and 12 show the results of these levels and changes models, respectively. In the levels model all controls except *Tuesday* and *EndMonth* are significant to some degree. In the changes model only $\Delta TSpread$ and $\Delta AaaBaa$ are significant. Both *AnnWk* and *May7* remain significant in both models even with all of the controls included. *Monday*, *Tuesday* and *Visible* were also included in the regressions run on Guenther’s (1994b) yearends. The results of these tests (not reported here) show that *Monday*, *Tuesday* and *Visible* are all significant in the levels model while only *Monday* is

significant in the changes model. *YearEnd* remains significantly negative at the 5% level in both models.

7.4 Comparison of results using shorter sample period

The sample used to examine whether the May 7, 1997 change in capital gains tax rates affects Treasury bill yields runs from April – June, 1997. In these tests the event variables, *AnnWk* in the levels model and *May7* in the changes model, are defined to equal one if the Treasury bill's yield is measured between May 2 and May 7, or on May 7 only, respectively. This implies that any of the effects of the tax change are limited to either the announcement week or the day the change became effective, when in fact any influence the new tax rate has on yields will continue indefinitely into the future. While it may be more theoretically correct to look for any tax effect on an ongoing basis, Treasury bills are influenced by so many different inputs that any tax effect would likely be drowned out in the noise. Therefore the inclusion of extra measurement days after May 7 may only include extra noise in the analysis to the extent the tax effect does exist but the variable is not defined to detect it.

To examine whether this is the case additional tests are run using a shorter sample that runs from April through May 7, 1997, in effect truncating the sample to include only the last week when the announcement was made and became effective. Table 13 shows the results of these tests, which include all of the original explanatory variables as well as those variables introduced in the sensitivity tests in Tables 11 and 12.

Results from running the levels model on the shorter sample are slightly weaker than they were using the full sample. While the level of significance of the controls

LagYield, *DaysMat*, *Pdebt* and *CRSP* is unchanged, that of *TSspread* drops from the 1% to the 5% level, while *Monday*, and *Visible* become insignificant. *Tuesday*, which was insignificant in the full sample, becomes significant at the 1% level in the short sample, while *AaaBaa* drops from the 1% level to become insignificant. *EndMonth* is unchanged and insignificant. The tax variable of interest, *AnnWk*, remains significant but drops from the 1% to the 5% level.

When the changes model is run on the shorter sample the results appear stronger. The control variables *Monday*, *Tuesday*, *DaysMat*, and $\Delta Pdebt$, which were all insignificant in the full sample, become significant at the 1% level in the shorter sample. *Visible*, *EndMonth* and *CRSP* remain insignificant in the shorter sample, while the significance of *AaaBaa* increases from 10% to 5% and *TSspread* decreases from 1% to 5%. *May7*, the event variable, increases in significance from 5% to 1%. The model's R^2 also jumps from 0.021 to 0.062, indicating there is three times more explanatory power when the model is run on the shorter sample.

Overall these results indicate that using the shorter sample may remove some unneeded noise from the regression tests. For some of the explanatory variables, for example, *Monday* and *Tuesday*, using the shorter sample also has the undesirable effect of removing some of the variables' variation from the sample. When the sample is truncated, only five Mondays and six Tuesdays remain, down from the original count of 14, each. Since the other variables represent daily levels this should not be a problem.

8. CONCLUSIONS

This study provides a new test of the equilibrium of after-tax rates of return presented in Miller (1977) by investigating whether a change in tax rates affects the return of an investment asset that is not directly taxed by the rate being changed. Starting with a model of after-tax investment returns I predict the yield of an ordinary-income asset will have an inverse reaction to changes in the capital gains tax rate. This prediction is tested using levels and changes regressions in a sample of daily Treasury bill yields. The yield on the Treasury bills, which are only subject to the ordinary income tax rate, appears to increase in response to the surprise reduction in capital gains tax rates on May 7, 1997. While small, this increase is statistically significant and is robust to other possible macroeconomic and institutional determinants.

This same model of after-tax returns is also consistent with the prediction that decreasing ordinary tax rates will cause Treasury bill prices to increase and their yields to decrease. This is consistent with Guenther's (1994b) hypothesis, which he supports with univariate tests of yield curve pairs straddling the affected yearends. I test this prediction using my multivariate regression models and a sample of daily Treasury bill yields covering the same yearends tested by Guenther (1994b). Consistent with Guenther (1994b), I find that Treasury bill yields decreased significantly across these yearends and that this decrease is robust to the inclusion of the same institutional and macroeconomic controls used to examine the 1997 data. This result supports both Guenther's (1994b) univariate findings and the use of these models to examine the 1997 tax change.

These findings contribute to the accounting literature on taxes and investment pricing in several ways. Existing research into asset pricing uses settings in which the investment's return is directly subject to the changing tax rate. The setting in this paper examines the effects of a tax rate change on an asset's yield that is not directly taxed at that rate, providing a potentially cleaner setting. In addition, because both the 1981 and 1986 tax acts changed both the ordinary and capital gains tax rates, studies using those settings may misstate the effect of specific tax changes on investment prices. Finally, these results suggest shareholder-level taxes are impounded into prices in ways not previously considered. This should be of interest to researchers investigating the effect shareholder-level taxes have on firms' cost of capital and the valuation of investments. Since Treasury bill rates form the basis for many contractual interest rates, such as for credit cards, policy makers should also be interested to learn that changes to the capital gains tax rate may affect these markets in ways not previously anticipated.

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FIGURE 1
Average Treasury Bill Yield from April 25 to May 15, 1997

FIGURE 2
Average Treasury Bill Yield from November, 1981 to January, 1982

FIGURE 3
Average Treasury Bill Yield from November, 1986 to January, 1987

FIGURE 4
Average Treasury Bill Yield from November, 1987 to January, 1988

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TABLE 1
Changes in Tax Rates for Individuals

<i><u>Tax Act</u></i>	<i><u>Effective Yearend</u></i>	<i><u>Ordinary</u></i>	<i><u>Capital</u></i>
ERTA 1981	1981/82	.70 to .50	.28 to .20
TRA 1986	1986/87	.50 to .39	.20 to .28
TRA 1986	1987/88	.39 to .28	0.28
RRA 1990	1990/91	.28 to .31	0.28
RRA 1993	1992/93	.31 to .396	0.28
TRA 1997	May 7, 1997	.396	.28 to .20

Source: Scholes, et. al. (2002, p. 75) and IRS website.

TABLE 2
Example of Treasury Bill Data

Panel A: Bid/Ask prices for five individual Treasury bills on four different measurement dates

Measurement Date		Bid	Ask	Bid	Ask	Bid	Ask	Bid	Ask	Bid	Ask
4/1/97	Yield	490	486	485	481	494	492	494	490	511	510
	Maturity	4/3/97	4/3/97	4/10/97	4/10/97	4/17/97	4/17/97	4/24/97	4/24/97	5/1/97	5/1/97
4/2/97	Yield	487	483	536	533	542	541	487	483	514	513
	Maturity	4/10/97	4/10/97	4/17/97	4/17/97	4/22/97	4/22/97	4/24/97	4/24/97	5/1/97	5/1/97
4/3/97	Yield	474	470	538	534	486	482	506	502	511	507
	Maturity	4/10/97	4/10/97	4/17/97	4/17/97	4/24/97	4/24/97	5/1/97	5/1/97	5/8/97	5/8/97
4/4/97	Yield	484	480	545	541	495	491	513	509	514	510
	Maturity	4/10/97	4/10/97	4/17/97	4/17/97	4/24/97	4/24/97	5/1/97	5/1/97	5/8/97	5/8/97

Panel B: Yields for ten individual Treasury bills for four different measurement dates

Measurement Date											
4/1/97	Yield	0.050299	0.049613	0.050043	0.049864	0.052179	0.052765	0.052486	0.052615	0.052744	0.052463
	Maturity	4/3/97	4/10/97	4/17/97	4/24/97	5/1/97	5/8/97	5/15/97	5/22/97	5/29/97	6/5/97
4/2/97	Yield	0.049484	0.049000	0.050040	0.049962	0.051869	0.052201	0.052482	0.052611	0.052638	0.052664
	Maturity	4/3/97	4/10/97	4/17/97	4/24/97	5/1/97	5/8/97	5/15/97	5/22/97	5/29/97	6/5/97
4/3/97	Yield	0.049200	0.054253	0.049247	0.052171	0.051688	0.051458	0.051892	0.052123	0.052251	0.052329
	Maturity	4/10/97	4/17/97	4/24/97	5/1/97	5/8/97	5/15/97	5/22/97	5/29/97	6/5/97	6/12/97
4/4/97	Yield	0.047878	0.054401	0.049142	0.051200	0.051735	0.051761	0.051991	0.052221	0.052247	0.052171
	Maturity	4/10/97	4/17/97	4/24/97	5/1/97	5/8/97	5/15/97	5/22/97	5/29/97	6/5/97	6/12/97

TABLE 3
Mean Yield Spreads Between Pairs of Treasury Bills^a
(Replication of Guenther's 1994b Results)

Classification of adjacent T-bills ^b	Years													
	1979-80		1980-81		1981-82		1982-83		1983-84		1984-85		1985-86	
	G	R	G	R	G	R	G	R	G	R	G	R	G	R
<i>Within-month pairs</i>	2.09	1.79	5.10	5.15	7.38	6.22	6.17	5.50	3.14	2.61	3.90	2.85	2.30	2.38
	7.84	6.85	6.40	4.76	7.10	5.32	15.02	9.63	15.37	8.61	8.18	4.13	5.23	5.25
<i>Turn-of-the-month pairs</i>														
October/November	4.18	4.92	9.85	10.68	24.69	23.54	19.75	20.72	9.32	10.31	17.64	17.51	7.96	1.87
	2.94	3.29	2.67	2.94	2.97	3.35	5.46	5.85	7.05	6.47	6.91	7.26	1.57	2.44
November/December	0.25	1.61	5.10	5.63	15.14	19.62	13.69	13.13	3.65	4.02	0.00	-2.55	0.72	0.31
	0.23	1.24	2.97	2.94	3.85	3.47	5.15	5.06	4.75	4.89	0.03	-0.86	1.60	0.52
December/January	11.29	15.39	37.20	42.79	-20.52	-31.02	8.12	8.10	-0.06	-2.20	10.81	7.17	1.92	0.57
	2.96	2.47	4.25	4.77	-3.14	-2.35	3.24	3.34	-0.05	-1.12	5.95	1.93	1.33	0.25
January/February	11.22	13.27	5.29	5.21	14.33	11.45	8.39	8.39	6.75	6.80	6.02	5.97	4.23	4.28
	2.02	2.10	2.69	2.28	4.91	5.52	4.77	4.77	7.52	7.61	4.39	4.38	3.62	3.65
February/March	5.40	0.84	-7.25	-7.39	9.18	9.01	6.98	7.01	1.88	1.70	3.06	3.00	1.37	1.37
	2.83	0.39	-2.59	-2.66	5.09	5.77	4.97	5.01	1.61	1.45	2.95	2.93	2.98	2.98

Classification of adjacent T-bills ^b	Years													
	1986-87		1987-88		1988-89		1989-90		1990-91		1991-92		1992-93	
	G	R	G	R	G	R	G	R	G	R	G	R	G	R
<i>Within-month pairs</i>	1.87	1.89	5.46	3.98	4.58	4.58	1.55	3.27	1.81	1.80	1.78	2.40	1.40	1.30
	6.72	5.43	6.18	3.85	5.57	4.10	2.52	1.90	6.07	3.67	12.27	2.68	8.97	7.59
<i>Turn-of-the-month pairs</i>														
October/November	1.52	0.32	-3.21	-1.07	-1.35	-1.14	-0.29	-0.93	0.94	0.40	3.99	3.66	2.20	1.98
	3.58	0.30	-2.20	-0.63	-0.78	-0.69	-0.13	-0.44	0.88	0.35	3.45	3.09	4.52	4.07
November/December	-0.93	-1.97	-0.07	-2.13	-4.94	-8.70	-2.37	-2.02	2.54	2.98	0.28	-0.70	2.26	2.25
	-1.95	-1.71	-0.03	-0.58	-4.86	-2.24	-1.09	-0.73	1.97	2.28	0.49	-0.70	1.87	2.03
December/January	-3.17	-5.05	-8.81	-13.54	9.45	9.39	5.10	7.22	-2.78	2.94	1.89	1.97	7.46	7.93
	-1.86	-2.34	-3.31	-2.30	2.91	3.14	1.43	1.75	-1.97	0.41	3.45	2.90	4.77	5.06
January/February	3.96	5.49	15.79	11.74	14.82	14.95	4.18	4.23	2.71	2.81	2.44	2.37	2.86	2.65
	5.84	3.94	3.67	4.26	2.15	2.17	1.60	1.62	2.09	2.19	5.00	4.77	7.20	7.56
February/March	3.13	3.69	3.41	13.97	5.33	5.17	-4.39	-4.76	0.38	0.31	1.77	1.83	2.08	2.14
	4.67	5.02	0.49	4.70	5.91	5.72	-2.65	-2.66	0.90	0.73	3.00	3.11	4.43	4.32

^aAs in Guenther's (1994b) Table 3, yield spreads are calculated by subtracting the yield of the bill with the shorter maturity from the yield of the bill with the longer maturity. Yields are based on the mean of weekly bid and ask Treasury bill prices calculated from bid and ask yields each Friday in the *Wall Street Journal* from the first week in June to the last week in December for the years 1979 through 1992. For each of these weeks the three pairs of Treasury bills with the shortest maturities are excluded. Years affected by ERTA and TRA rate reductions are in bold type (t-statistics in smaller font). ^bIf two bills mature within the same calendar month, then they are classified as within-month pairs. If two adjacent bills mature in different calendar months, then they are classified as turn-of-the-month pairs.

TABLE 4
Univariate Statistics for $\Delta Yield^a$

Panel A: March-June, 1997

<i>Comparison groups^b</i>	<i>Mean</i>	<i>DF</i>	<i>T stat</i>	<i>Probability</i>	<i>Comparison to means of May 6/7 pairs</i>				
					<i>Independent Groups T Tests</i>			<i>Wilcoxon</i>	
					<i>Difference</i>	<i>T stat</i>	<i>Probability</i>	<i>Rank Sum Test</i>	
								<i>One-sided</i>	
								<i>Z stat</i>	<i>Probability</i>
<i>all other pairs</i>	-0.4850	2114	-2.37	0.0178	3.8815	4.09	0.0004	3.72	<.0001
<i>all other within-month pairs</i>	-0.2820	2039	-1.35	0.1761	3.6785	3.88	0.0006	3.60	0.0002
<i>turn-of-the-month pairs</i>	-6.0120	74	-6.87	<.0001	9.4085	7.39	<.0001	6.07	<.0001
<i>May 6/7, 1997 pairs</i>	3.3965	24	3.67	0.0012	n/a	n/a	n/a	n/a	n/a

Panel B: Nov.-Jan., 1981/82, 1986/87 and 1987/88

<i>Comparison groups^b</i>	<i>Mean</i>	<i>DF</i>	<i>T stat</i>	<i>Probability</i>	<i>Comparison to means of Dec./Jan. pairs</i>				
					<i>Independent Groups T Tests</i>			<i>Wilcoxon</i>	
					<i>Difference</i>	<i>T stat</i>	<i>Probability</i>	<i>Rank Sum Test</i>	
								<i>One-sided</i>	
								<i>Z stat</i>	<i>Probability</i>
<i>all other pairs</i>	-0.9020	4534	-1.77	0.0773	-5.5890	-2.31	0.0234	-4.84	<.0001
<i>within-month pairs</i>	-0.7640	4456	-1.48	0.1396	-5.7270	-2.36	0.0204	-4.91	<.0001
<i>Nov./Dec. pairs</i>	-8.7570	77	-3.55	0.0007	2.2660	0.66	0.5082	-0.87	0.1927
<i>Dec./Jan. pairs</i>	-6.4910	76	-2.74	0.0076	n/a	n/a	n/a	n/a	n/a

^a $\Delta Yield$ equals the first difference of *Yield*, expressed in basis points.

^b*All other pairs* refers to all values of $\Delta Yield$ except the May 6/7 pairs in Panel A and the Dec./Jan. pairs in Panel B. *Within-month pairs* refers to those values of $\Delta Yield$ that do not straddle month ends (excluding May 6/7 pairs in Panel A), while *turn-of-the-month pairs* are those that do (excluding Dec./Jan. pairs in Panel B). *May 6/7, 1997 pairs* and *Dec./Jan. pairs* are those values of $\Delta Yield$ that are calculated across, respectively, May 6/7, 1997 and the yearends 81/82, 86/87 and 87/88.

TABLE 5
Descriptive Statistics for April - June, 1997

Variable: ^a	N ^b	Mean	Std. Dev.	Median	Min.	Max.
<i>AnnWk</i>	2,115	0.04870	0.21529	0.00000	0.00000	1.00000
<i>May7</i>	2,115	0.01182	0.10810	0.00000	0.00000	1.00000
<i>Yield</i>	2,115	515.060	24.3991	519.641	284.509	561.929
<i>ΔYield</i>	2,115	-0.34080	9.34130	-0.04125	-222.409	232.556
<i>LagYield</i>	2,115	515.401	24.1272	519.773	284.509	561.929
<i>EndMonth</i>	2,115	0.24350	0.42930	0.00000	0.00000	1.00000
<i>DaysMat</i>	2,115	88.9210	49.8853	91.0000	2.00000	182.000
<i>Pdebt</i>	2,115	29.3089	0.00302	29.3085	29.3043	29.3148
<i>TSspread</i>	2,115	1.86482	0.10165	1.85000	1.65000	2.11000
<i>AaaBaa</i>	2,115	-0.61502	0.01059	-0.62000	-0.64000	-0.59000
<i>CRSP</i>	2,115	0.00160	0.08585	0.00183	-0.02413	0.02368

^a*AnnWk* equals 1 for Treasury bill yields measured on or between May 2 and May 7, 1997 and 0 otherwise. *May7* equals 1 for Treasury bill yields measured on May 7, 1997 and 0 otherwise. *Yield* is the annually adjusted yield, in basis points, of a specific Treasury bill as of a specific measurement date. *ΔYield* and *LagYield* are the first difference and first lag, respectively, of *Yield*. *EndMonth* equals 1 if the maturity dates of the bill and the next longer maturity bill adjacent to it are split by the end of a calendar month. *DaysMat* equals the number of days until the bill matures. *Pdebt* equals the natural log of the level of all government debt. *TSspread* equals the spread between the Treasury's 30 year and three month instruments. *AaaBaa* equals the difference between Moody's Baa and Aaa bond yield indices. *CRSP* equals the CRSP value weighted stock index. ^bOf the 2,184 daily T Bill yield observations available, 26 are lost in matching to *CRSP* or *AaaBaa* and 43 more in the calculation of *LagYield* for a final sample size of 2,115.

TABLE 6
Correlation coefficients of variables used in regression models^a
April - June, 1997

	<i>AnnWk</i>	<i>May7</i>	<i>ΔYield</i>	<i>Yield</i>	<i>LagYield</i>	<i>EndMonth</i>	<i>DaysMat</i>	<i>Pdebt</i>	<i>TSspread</i>	<i>AaaBaa</i>	<i>CRSP</i>
<i>AnnWk</i>	1.0000	0.4834 <.0001	-0.0160 0.4611	0.0097 0.6543	0.0161 0.4604	-0.0107 0.6246	0.0046 0.8330	-0.2763 <.0001	-0.0604 0.0054	-0.0919 <.0001	0.1317 <.0001
<i>May7</i>		1.0000	0.0438 0.0442	0.0100 0.6474	-0.0069 0.7517	-0.0009 0.9673	0.0068 0.7563	-0.1215 <.0001	0.0163 0.4527	-0.0454 0.0367	-0.1637 0.0001
<i>ΔYield</i>			1.0000	0.2204 <.0001	-0.1643 <.0001	0.0106 0.6247	0.0022 0.9182	0.0394 0.0701	-0.1040 <.0001	0.0011 0.9589	-0.0822 0.0002
<i>Yield</i>				1.0000	0.9260 <.0001	0.0217 0.3193	0.6639 <.0001	0.2919 <.0001	-0.0550 0.0114	0.0477 0.0282	-0.0646 0.0029
<i>LagYield</i>					1.0000	0.0178 0.4135	0.6705 <.0001	0.2800 <.0001	-0.0154 0.4797	0.0478 0.0278	-0.0335 0.1232
<i>EndMonth</i>						1.0000	0.0978 <.0001	-0.0037 0.8661	-0.0160 0.4635	-0.0057 0.7942	0.0024 0.9122
<i>DaysMat</i>							1.0000	-0.0128 0.5579	-0.0212 0.3307	-0.0135 0.5363	-0.0106 0.6256
<i>Pdebt</i>								1.0000	0.2293 <.0001	-0.0646 0.0030	-0.1623 <.0001
<i>TSspread</i>									1.0000	0.1986 <.0001	-0.0836 <.0001
<i>AaaBaa</i>										1.0000	-0.1481 <.0001
<i>CRSP</i>											1.0000

^aThis table is based on the same variables and sample for which descriptions are provided in Table 5.

TABLE 7
Regression Results for Hypothesis 1^a

Regressions on Yield Levels			Regressions on Yield Differences		
<u>Variable^b</u>	<u>Prediction</u>		<u>Variable^b</u>	<u>Prediction</u>	
<i>Intercept</i>	n/a	-22,148 *** 2778	<i>Intercept</i>	n/a	-4.9E-05 4.8E-05
<i>AnnWk</i>	+	2.818 *** 1.190	<i>May7</i>	+	4.9E-04 ** 2.2E-04
<i>LagYield</i>	+	0.793 *** 0.014			
<i>EndMonth</i>	-	-0.333 0.409	<i>EndMonth</i>	-	1.8E-05 4.4E-05
<i>DaysMat</i>	+	0.070 *** 0.006	<i>DaysMat</i>	+	4.5E-08 4.6E-07
<i>Pdebt</i>	+	761.580 *** 95.010	<i>ΔPdebt</i>	+	2.3E-02 2.0E-02
<i>TSspread</i>	-	-16.355 *** 2.524	<i>ΔTSspread</i>	-	-2.5E-03 *** 4.0E-04
<i>AaaBaa</i>	+	68.041 *** 24.056	<i>ΔAaaBaa</i>	+	4.5E-03 * 2.9E-03
<i>CRSP</i>	-	-70.781 *** 28.695	<i>ΔCRSP</i>	-	-2.1E-03 2.1E-03
Adjusted R²		0.828	Adjusted R²		0.020
N^c		2,115	N^c		2,115
DW Stat.		2.021 ***	DW Stat.		2.045 ***

***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively, using a one-sided t test.

Standard errors are in lower case. ^aAll models are estimated with a first-order autoregressive error term.

^bVariables in the levels models are as defined in Table 5, while variables in the changes model are their first differences. ^cSamples are based on the same 2,115 observations described in Table 5.

TABLE 8
Descriptive Statistics for
November - January, 1981/82, 1986/87 and 1987/88

Variable: ^a	N ^b	Mean	Std. Dev.	Median	Min.	Max.
<i>YearEnd</i>	4612	0.06201	0.24120	0.00000	0.00000	1.00000
<i>Yield</i>	4612	748.928	296.256	586.983	112.556	1405.71
<i>ΔYield</i>	4458	-0.99496	34.1845	-0.05651	-574.445	516.588
<i>LagYield</i>	4612	749.923	296.710	587.161	112.556	1405.71
<i>EndMonth</i>	4612	0.18278	0.38653	0.00000	0.00000	1.00000
<i>DaysMat</i>	4612	91.2062	52.0441	92.0000	1.00000	183.000
<i>Pdebt</i>	4612	-0.69797	0.36374	-0.53259	-1.25818	-0.33009
<i>TSpread</i>	4612	10.7448	3.76110	8.75000	7.50000	17.5000
<i>AaaBaa</i>	4612	-1.57946	0.42941	-1.40000	-2.52000	-1.10000
<i>CRSP</i>	4612	0.00062	0.01178	0.00132	-0.05555	0.03344

^a*Yearend* equals 1 if the yield was measured during December and its maturity date is in January, zero otherwise. *Yield* is the annually adjusted yield, in basis points, of the Treasury bill as of a specific measurement date. *ΔYield* and *LagYield* are the first difference and first lag, respectively, of *Yield*. *EndMonth* equals 1 if the maturity dates of the Treasury bill and the next longer maturity bill adjacent to it are split by the end of a calendar month. *DaysMat* equals the number of days until the bill matures. *Pdebt* equals the natural log of the level of all government debt. *Prime* equals the prime rate. *AaaBaa* equals the difference between Moody's Baa and Aaa bond yield indices. *CRSP* equals the CRSP value weighted stock index.

^bOf the 4,729 daily Treasury bill yield observations available, 117 and 271 are lost in the calculation of *LagYield* and *ΔYield*, respectively, for a final sample size of 4,612 in the levels model and 4,458 in the changes model.

TABLE 9
Correlation coefficients of variables used in regression models^a
November - January, 1981/82, 1986/87 and 1987/88

	<i>YearEnd</i>	<i>ΔYield</i>	<i>Yield</i>	<i>LagYield</i>	<i>EndMonth</i>	<i>DaysMat</i>	<i>Pdebt</i>	<i>TSpread</i>	<i>AaaBaa</i>	<i>CRSP</i>
<i>YearEnd</i>	1.0000	-0.0450 0.0023	-0.1118 <.0001	-0.1065 <.0001	0.0027 0.8543	-0.2868 <.0001	-0.0190 0.1964	-0.0220 0.1353	-0.0383 0.0092	-0.0105 0.4751
<i>ΔYield</i>		1.0000	0.0444 0.0026	-0.0709 <.0001	-0.0022 0.8791	-0.0021 0.8876	0.0229 0.1202	-0.0283 0.0550	0.0233 0.1134	0.0018 0.9039
<i>Yield</i>			1.0000	0.9934 <.0001	0.0020 0.8939	0.1641 <.0001	-0.9207 <.0001	0.9489 <.0001	-0.8445 <.0001	-0.0652 <.0001
<i>LagYield</i>				1.0000	0.0022 0.8802	0.1641 <.0001	-0.9219 <.0001	0.9507 <.0001	-0.8459 <.0001	-0.0653 <.0001
<i>EndMonth</i>					1.0000	-0.0311 0.0349	-0.0039 0.7902	0.0039 0.7903	-0.0043 0.7702	-0.0012 0.9377
<i>DaysMat</i>						1.0000	-0.0006 0.9703	-0.0011 0.9412	-0.0010 0.9465	0.0046 0.7556
<i>Pdebt</i>							1.0000	-0.9571 <.0001	0.9599 <.0001	0.0771 <.0001
<i>TSpread</i>								1.0000	-0.8849 <.0001	-0.0765 <.0001
<i>AaaBaa</i>									1.0000	0.0569 0.0001
<i>CRSP</i>										1.0000

^aAll variables are as defined in Table 8.

TABLE 10

Regression Results for Guenther's (1994b) Yearends^a

Regressions on Yield Levels			Regressions on Yield Differences		
<u>Variable</u> ^b	<u>Prediction</u>		<u>Variable</u> ^b	<u>Prediction</u>	
<i>Intercept</i>	n/a	3,346 *** 326.582	<i>Intercept</i>	n/a	-3.2E-05 1.3E-04
<i>YearEnd</i>	-	-15.036 *** 2.653	<i>YearEnd</i>	-	-5.2E-04 ** 2.5E-04
<i>LagYield</i>	+	0.890 *** 0.007			
<i>EndMonth</i>	-	-0.446 0.895	<i>EndMonth</i>	-	-2.6E-05 9.4E-05
<i>DaysMat</i>	+	0.074 *** 0.014	<i>DaysMat</i>	+	-1.1E-06 1.2E-06
<i>Pdebt</i>	+	-114 *** 11.094			
<i>TSpread</i>	-	-2.564 ** 1.306	<i>ΔTSpread</i>	-	-7.1E-03 *** 5.5E-04
<i>AaaBaa</i>	+	30.299 *** 6.799	<i>ΔAaaBaa</i>	+	7.2E-03 *** 1.2E-03
<i>CRSP</i>	-	-82.264 * 61.708	<i>ΔCRSP</i>	-	-1.6E-02 *** 4.0E-03
Adjusted R²		0.971	Adjusted R²		0.053
N		4,612	N		4,458
DW Stat.		1.987 ***	DW Stat.		2.004 ***

***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively, using a one-sided *t*-test.

Standard errors are in lower case. ^aAll models are estimated with a first-order autoregressive error term. ^bIn the levels model *YearEnd* equals one if a bill's yield is measured in December but it matures in January, zero otherwise. In the changes model *YearEnd* equals one for those values of *ΔYield* calculated using the first yield in January and the last from December, zero otherwise. Other variables are as defined in Table 8. Public debt data is available only on a yearly basis during the 1980's, making it impossible to difference *Pdebt*.

TABLE 11
Sensitivity Analysis Using Yield Levels^a

Variable ^b	Prediction	Model Number			
		1	2	3	4
<i>Intercept</i>	n/a	-21,892 *** 2786	-22,474 *** 2781	-22,942 *** 2801	-23,005 *** 2820
<i>AnnWk</i>	+	2.748 ** 1.189	2.961 *** 1.190	2.966 *** 1.191	3.026 *** 1.191
<i>Monday</i>	+/-	1.121 † 0.645			1.113 † 0.643
<i>Tuesday</i>	+/-	0.708 0.622			0.480 0.639
<i>Visible</i>	+		-1.5E-08 * 9.3E-09		-1.4E-08 * 9.3E-09
<i>May13</i>	+			4.649 ** 2.208	4.178 ** 2.275
<i>LagYield</i>	+	0.792 *** 0.014	0.793 *** 0.014	0.792 *** 0.014	0.792 *** 0.014
<i>EndMonth</i>	-	-0.339 0.409	-0.337 0.409	-0.338 0.409	-0.346 0.409
<i>DaysMat</i>	+	0.070 *** 0.006	0.070 *** 0.006	0.070 *** 0.006	0.070 *** 0.006
<i>Pdebt</i>	+	753 *** 95.301	773 *** 95.101	789 *** 95.789	791 *** 96.440
<i>TSpread</i>	-	-15.787 *** 2.552	-15.968 *** 2.529	-16.309 *** 2.521	-15.524 *** 2.558
<i>AaaBaa</i>	+	69.061 *** 24.074	65.634 *** 24.040	71.676 *** 24.092	70.515 *** 24.143
<i>CRSP</i>	-	-80.209 *** 29.194	-69.897 *** 28.632	-64.549 ** 28.816	-72.207 *** 29.387
Adjusted R²		0.829	0.829	0.829	0.830
N		2,115	2,115	2,115	2,115
DW Stat.		2.020 ***	2.020 ***	2.021 ***	2.019 ***

***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively, using a one-sided *t*-test. † indicates significance at the 10% level using a two-sided *t*-test. Standard errors are in lower case. ^aAll models are estimated with a first-order autoregressive error term. ^b*Monday* and *Tuesday* equal one if *Yield* was measured on a Monday or Tuesday, respectively, zero otherwise. *Visible* equals the supply of bills available at the next auction date. *May13* equals one if *Yield* was measured on May 13, 1997, zero otherwise. Other variables are defined in Table 5.

TABLE 12
Sensitivity Analysis Using Yield Differences^a

Variable ^b	Prediction	Model Number			
		1	2	3	4
<i>Intercept</i>	n/a	-6.3E-05 5.2E-05	-2.1E-05 1.0E-04	-5.2E-05 4.8E-05	-4.2E-05 1.0E-04
<i>May7</i>	+	5.0E-04 ** 2.2E-04	4.9E-04 ** 2.2E-04	5.0E-04 ** 2.2E-04	5.1E-04 ** 2.2E-04
<i>Monday</i>	+/-	5.3E-05 6.4E-05			5.3E-05 6.4E-05
<i>Tuesday</i>	+/-	1.7E-05 6.2E-05			6.2E-06 6.4E-05
<i>Visible</i>	+		-3.0E-13 9.5E-13		-2.4E-13 9.5E-13
<i>May13</i>	+			2.3E-04 2.2E-04	2.3E-04 2.3E-04
<i>EndMonth</i>	-	1.8E-05 4.4E-05	1.8E-05 4.4E-05	1.8E-05 4.4E-05	1.8E-05 4.4E-05
<i>DaysMat</i>	+	5.4E-08 4.6E-07	4.7E-08 4.6E-07	4.8E-08 4.6E-07	5.6E-08 4.6E-07
<i>ΔPdebt</i>	+	2.2E-02 2.0E-02	2.4E-02 2.0E-02	2.3E-02 2.0E-02	2.2E-02 2.0E-02
<i>ΔTSpread</i>	-	-2.5E-03 *** 4.1E-04	-2.5E-03 *** 4.1E-04	-2.5E-03 *** 4.0E-04	-2.4E-03 *** 4.2E-04
<i>ΔAaaBaa</i>	+	4.5E-03 * 2.9E-03	4.4E-03 * 2.9E-03	4.2E-03 * 2.9E-03	4.1E-03 * 3.0E-03
<i>ΔCRSP</i>	-	-2.2E-03 2.1E-03	-2.1E-03 2.1E-03	-1.7E-03 2.1E-03	-1.8E-03 2.1E-03
Adjusted R²		0.021	0.021	0.021	0.021
N		2,115	2,115	2,115	2,115
DW Stat.		2.045 ***	2.045 ***	2.045 ***	2.044 ***

***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively, using a one-sided *t*-test. † indicates significance at the 10% level using a two-sided *t*-test. Standard errors are in lower case. ^aAll models are estimated with a first-order autoregressive error term. ^b*Monday* and *Tuesday* equal one if *ΔYield* was measured on a Monday or Tuesday, respectively, zero otherwise. *Visible* equals the supply of bills available at the next auction date. *May13* equals one if *ΔYield* was measured on May 13, 1997, zero otherwise. Other variables are as defined in Table 5.

TABLE 13

Comparison of Results with Shorter Sample Period^a

Regressions on Yield Levels				Regressions on Yield Differences			
Variable ^c	Prediction	Table 11	Shorter Samp.	Variable ^c	Prediction	Table 12	Shorter Samp.
<i>Intercept</i>	n/a	-23,005 *** 2820	-9,411 *** 2270	<i>Intercept</i>	n/a	-4.2E-05 1.0E-04	-4.9E-05 7.9E-05
<i>AnnWk</i>	+	3.026 *** 1.191	1.352 ** 0.771	<i>May7</i>	+	5.1E-04 ** 2.2E-04	3.0E-04 *** 1.3E-04
<i>Monday</i>	+/-	1.113 † 0.643	-0.509 0.481	<i>Monday</i>	+/-	5.3E-05 6.4E-05	-1.5E-04 ††† 5.1E-05
<i>Tuesday</i>	+/-	0.480 0.639	-2.986 ††† 0.460	<i>Tuesday</i>	+/-	6.2E-06 6.4E-05	-3.5E-04 ††† 4.9E-05
<i>Visible</i>	+	-1.4E-08 * 9.3E-09	-3.0E-09 7.4E-09	<i>Visible</i>	+	-2.4E-13 9.5E-13	6.5E-13 7.3E-13
<i>May13</i>	+	4.178 ** 2.275	n/a	<i>May13</i>	+	2.3E-04 2.3E-04	n/a
<i>LagYield</i>	+	0.792 *** 0.014	0.976 *** 0.011				
<i>EndMonth</i>	-	-0.346 0.409	0.159 0.225	<i>EndMonth</i>	-	1.8E-05 4.4E-05	2.3E-05 2.2E-05
<i>DaysMat</i>	+	0.070 *** 0.006	0.014 *** 0.004	<i>DaysMat</i>	+	5.6E-08 4.6E-07	7.5E-07 *** 3.1E-07
<i>Pdebt</i>	+	791 *** 96.440	322 *** 77.620	<i>ΔPdebt</i>	+	2.2E-02 2.0E-02	3.8E-02 *** 1.5E-02
<i>TSpread</i>	-	-15.524 *** 2.558	-6.232 ** 2.941	<i>ΔTSpread</i>	-	-2.4E-03 *** 4.2E-04	-9.1E-04 ** 4.5E-04
<i>AaaBaa</i>	+	70.515 *** 24.143	18.607 22.197	<i>ΔAaaBaa</i>	+	4.1E-03 * 3.0E-03	5.3E-03 ** 2.4E-03
<i>CRSP</i>	-	-72.207 *** 29.387	-84.447 *** 20.174	<i>ΔCRSP</i>	-	-1.8E-03 2.1E-03	6.3E-04 1.6E-03
Adjusted R²		0.830	0.941	Adjusted R²		0.021	0.062
N^c		2,115	1,186	N^c		2,115	1,186
DW Stat.		2.019 ***	2.096 ***	DW Stat.		2.044 ***	2.132 ***

***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively, using a one-sided *t*-test. †††, ††, and † indicate significance at the 1%, 5% and 10% levels, respectively, using a two-sided *t*-test. Standard errors are in lower case. ^aAll models are estimated with a first-order autoregressive error term. ^bVariables in the levels models are as defined in Table 5, while variables in the changes model are their first differences.

^cSamples are based on the same 2,115 observations described in Table 5.

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