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Capital Gains Taxes and Asset Prices: Capitalization or Lock-in?

ZHONGLAN DAI, EDWARD MAYDEW, DOUGLAS A. SHACKELFORD, and HAROLD H. ZHANG*

ABSTRACT

This paper demonstrates that the equilibrium impact of capital gains taxes reflects both the capitalization effect (i.e., capital gains taxes decrease demand) and the lock-in effect (i.e., capital gains taxes decrease supply). Depending on time periods and stock characteristics, either effect may dominate. Using the Taxpayer Relief Act of 1997 as our event, we find evidence supporting a dominant capitalization effect in the week following news that sharply increased the probability of a reduction in the capital gains tax rate and a dominant lock-in effect in the week after the rate reduction became effective.

THIS PAPER JOINTLY TESTS two effects of capital gains taxation on equity trading: a demand-side capitalization effect and a supply-side lock-in effect. While previous studies have tested these effects separately, to the best of our knowledge this is the first study to evaluate them jointly and empirically document the relative dominance of each effect surrounding a change in a tax rate. Employing an equilibrium approach, we show that these effects' net tax impact on asset prices is ambiguous. Evaluating returns and trading volume around the 1997 reduction in the capital gains tax rate, we find evidence that the capitalization and the lock-in effects jointly affect trading. In particular, the capitalization effect dominates the lock-in effect in the week following an increase in the probability of a reduction in the capital gains tax rate, as buyers respond to information that future capital gains tax rates will be lower. The lock-in effect, however, dominates the capitalization effect after the rate reduction actually becomes effective.

Taxation is one of the most prevalent market frictions in financial markets, affecting investors' decisions and distorting the valuation of assets. Capital gains taxes in particular play an important role in determining an investor's trading strategies and can ultimately affect asset prices. Because investors

*Zhonglan Dai is at the School of Management, University of Texas at Dallas, Edward Maydew is at the Kenan-Flagler Business School, University of North Carolina, Douglas A. Shackelford is at the Kenan-Flagler Business School, University of North Carolina and NBER, and Harold H. Zhang is at the School of Management, University of Texas at Dallas. We thank Ashiq Ali, Robert Kieschnick, Suresh Radhakrishnan, Scott Weisbenner, Yexiao Xu, Rob Stambaugh (the editor), an anonymous referee, and seminar participants at the 2006 NBER Behavioral Response to Taxation/Public Economics Program Meeting, the 2006 UNC Tax Symposium, and the University of Texas at Dallas for helpful comments. All errors are our own.

endogenously respond to the imposition of capital gains taxes, the tax effect on asset prices can be complicated and difficult to measure. In his review of taxes in the finance literature, Graham (2003 p. 1120) concludes that "Though intriguing in theory, the profession has made only modest progress in documenting whether investor taxes affect asset prices ... we need more market evidence about the importance of personal taxes affecting asset prices." To date, research on the effects of investor-level capital gains taxes on asset prices has produced conflicting results. Several studies report that the presence of the capital gains tax reduces stock prices and current stock returns (see Guenther and Willenborg (1999), Lang and Shackelford (2000), and Ayers, Lefanowicz, and Robinson (2003), among others), while other studies document that imposing a capital gains tax increases stock prices and current stock returns (see Feldstein, Slemrod, and Yitzhaki (1980) Landsman and Shackelford (1995), Reese (1998), Poterba and Weisbenner (2001), Klein (2001), Blouin, Raedy, and Shackelford (2003), Jin (2006), Ellis, Li, and Robinson (2006), and George and Hwang (2007), among others). The former is referred to as the *capitalization effect* and is often justified by the argument that investors demand a lower price to buy assets on which they have to pay capital gains taxes in the future. The latter is referred to as the *lock-in effect* and is attributed to investors requiring higher prices to sell assets if they have to pay taxes on selling them. Recognizing that the two effects work in opposite directions, the purpose of this paper is to understand the interaction of the two effects and the circumstances under which one effect can be expected to dominate the other surrounding a tax rate change.

Theoretical studies on taxes and asset pricing are scarce. They often focus on trading strategies for investors to avoid paying capital gains taxes and their impact on asset prices when investors face embedded capital gains on their asset holdings. For example, Constantinides (1983, 1984) shows that investors can rebalance their portfolios without triggering capital gains taxes if they are allowed to short-sell assets in which they have embedded gains. This allows investors to separate their optimal liquidation of assets from their optimal consumption-investment policies. Klein (1999) introduces a general equilibrium model of asset pricing with capital gains taxes where investors face short-sale constraints so that they cannot rebalance their portfolio without triggering capital gains taxes liability. He makes predictions about the effects of capital gains taxes on asset prices without explicitly solving for the equilibrium price.

Viard (2000) analyzes the dynamic asset-pricing effects and incidence of realization-based capital gains taxes. Under the assumption of small realization taxes, he derives the first-order conditions for equilibrium asset prices. To obtain the first-order effects, he linearizes the first-order conditions around the no-tax equilibrium. He finds that asset prices increase with the current realization tax, in part to offset the sale disincentive associated with the tax, consistent with the lock-in effect. Shackelford and Verrecchia (2002) develop a trading model where the long-term and short-term capital gains tax rates differential creates a trade-off between optimal risk-sharing and optimal tax-related trading. They show that sellers are reluctant to sell appreciated assets

sooner because they are subject to higher capital gains taxes. To entice sellers, buyers must provide compensation in the form of higher sales prices.

In this paper, we analyze the effects of capital gains taxation on prices while jointly considering the capitalization effect and the lock-in effect. Intuitively, the capitalization argument considers the tax effect from buyers' perspective (demand side), while the lock-in effect considers the tax impact from sellers' perspective (supply side). A more complete analysis of capital gains tax effects must simultaneously allow for demand and supply to interact. In equilibrium, the net effect of the capital gains tax on stock markets will be the combination of both effects. Our study provides such a unified framework and offers predictions for the capital gains tax effect on security markets.

Our analysis suggests that a change in capital gains taxes influences asset prices by shifting both the demand for assets and the supply of assets. Specifically, when the capital gains tax is increased, the demand curve for assets is shifted down, reflecting the decline in prices that is necessary to attract buyers, and the supply curve is shifted up, reflecting the boost in prices required to entice current owners to sell. The equilibrium net tax effect on asset prices is therefore ambiguous, as it depends on which effect dominates. However, an increase in capital gains taxes unambiguously reduces the float of assets (number of shares actively traded). In the event of a capital gains tax cut, the demand curve for the assets shifts up and the supply curve shifts down. That is, the equilibrium net tax effect on asset price is still ambiguous, but the float of assets is unambiguously increased.

To detail the predictions of our analysis, suppose the capital gains tax rate is reduced. If the capitalization effect dominates the lock-in effect, stock prices will increase, leading to higher current stock returns. Conversely, if the lock-in effect dominates the capitalization effect, we predict that stock prices will decrease and thereby lower current stock returns. These effects are likely to apply to all stocks traded on the stock market and constitute the marketwide capital gains tax effect on stock prices.

Furthermore, the capital gains tax effect will vary depending on the characteristics of stocks because of their differences in tax costs. For instance, growth stocks (i.e., stock whose valuation depends largely on future dividend growth) are more likely to face capital gains taxes than income stocks (i.e., those stocks currently distributing dividends). Accordingly, in the event of a capital gains tax cut, growth stocks should experience even higher returns than income stocks when the capitalization effect dominates the lock-in effect. For stocks with large price appreciation and a high percentage of tax-sensitive investor ownership (such as individual investors and mutual funds), a capital gains tax cut will reduce investors' tax cost of selling these stocks for portfolio rebalancing when the lock-in effect dominates, leading to even lower current returns on these stocks. These effects constitute the cross-sectional effects of a capital gains tax change on asset prices.

Although the capitalization effect and the lock-in effect coexist, the relative importance of the two effects should vary around the timing of a capital gains tax rate change. Specifically, in the event of a capital gains tax cut, the

capitalization effect (price increase caused by a demand shift upward) will be stronger than the lock-in effect *before* the tax cut becomes effective and the lock-in effect (price decrease caused by a supply shift downward) will dominate the capitalization effect *after* the tax cut effective date. The reason for the timing difference is that investors react to changes in the probability of a capital gains tax rate cut before the rates actually fall. In other words, buyers increase their demand for stocks in response to news of a future tax cut. Conversely, because capital gains are taxed on realization, tax-sensitive stockholders likely will refrain from selling shares with embedded gains until the capital gains tax rate cut becomes effective. Consequently, we select different event windows for a dominant capitalization effect and a dominant lock-in effect in our empirical investigation. Different event windows are critical for identifying the relative dominance of capitalization and lock-in.

We perform the empirical tests of these predictions by examining return and volume responses to the 1997 capital gains tax cut on stocks included in the CRSP data set for the period between January 1, 1995, and December 31, 1997. Our empirical analysis confirms that while both the capitalization and the lock-in effects jointly influence asset prices, the magnitude of each effect differs across the timing of the tax cut and across stocks with different characteristics.

The 1997 capital gains tax rate reduction provides a rare opportunity to jointly investigate the effects of capitalization and lock-in on asset prices. In late April 1997, information leaked that the Democratic White House and the Republican Congressional leadership had reached an accord to reduce the capital gains tax rate. This news preceded the actual effective tax rate by about 1 week. During that interim week, we find that the capitalization effect dominated the lock-in effect. This is consistent with investors buying more shares (through both personal accounts and mutual funds) as the probability of lower capital gains tax rates on future sale of the shares increased. Conversely, we find that the lock-in effect dominated the capitalization effect during the week following the date the tax cut became effective. This is consistent with the tax-sensitive individual investors selling stocks (through both personal accounts and mutual funds) with large embedded gains after the tax cut became effective.

Although consistent with our prediction, broad market movements surrounding the effective date may reflect other factors that moved the markets during those 2 weeks. However, our cross-sectional analyses provide compelling evidence about the effects of capitalization and lock-in. Specifically, we find that

- Nondividend-paying stocks experienced a stronger capitalization effect than dividend-paying stocks during the week the capitalization effect dominated.
- Stocks with large price appreciation in the past and with high individual percentage ownership experienced a stronger lock-in effect and earned lower immediate returns during the week the lock-in effect dominated.
- Trading volume was greater during the week immediately before and after the tax cut became effective.

We infer from these results that capitalization and lock-in effects jointly affect market returns in the predicted manner.

The paper is organized as follows. Section I discusses the effect of capital gains taxes on stock prices and its empirical implications using a simple demand and supply framework. Section II lays out the empirical methodology and Section III provides empirical analysis and discussions. Finally, Section IV concludes.

I. Capital Gains Taxes and Asset Prices in an Equilibrium Framework

Consider an economy in which tax-sensitive investors are required to pay taxes on appreciation in stock value on the sale of the stock. The overall tax effect on stock prices is affected by both stock buyers and sellers. In the presence of the capital gains tax, stock buyers will require a lower price to acquire the stock to compensate them for their future tax liability (the capitalization effect). This will shift the demand for the stock at all price levels.

Turning to stock sellers, we assume that the capital gains tax that investors face if they sell exceeds the capital gains tax that they anticipated facing when they originally purchased the stock. Investors face higher capital gains taxes than anticipated when their expected holding period exceeds their realized holding period. When this occurs, the sale accelerates the tax payment, and the seller loses the time value of money. The seller therefore requires a higher price to sell the stock to recover the cost differential in the realized and anticipated capital gains taxes. This will move the supply of the stock at all price levels.

Both theoretical explanations and empirical evidence support the assumption behind the lock-in effect. For example, Dammon, Spatt, and Zhang (2001) document that in general investors may find it optimal to sell stocks with embedded capital gains to rebalance their portfolio if they are overweighted in equity. Specifically, they investigate how an investor's liquidation policy and realization decisions depend on the investor's age, the investor's existing stock holding, and the tax basis on the stock holding. They find that two offsetting forces jointly affect an investor's realization decisions. On the one hand, an investor would like to hold a balanced portfolio to capture the corresponding diversification benefit. On the other hand, because the tax on capital gains is forgiven at death (the tax basis is reset to the prevailing market price for the beneficiary), he would like to defer realization of capital gains because of positive mortality rates throughout an investor's lifetime.

Dammon et al. (2001) find that for large embedded capital gains, investors retain their initial equity holding because the tax cost of rebalancing is too high. For somewhat smaller gains, young and middle-aged investors scale back their holdings of stock. In general, the amount of rebalancing depends on the size of the embedded capital gain, the investor's age, and the extent to which the investor's existing portfolio deviates from the unconstrained optimum, which is the optimal equity holding when the investor can rebalance without triggering capital gains taxes. The unconstrained optimal holding of equity is age-dependent and reaches its maximum at a rather late age.

Their finding has implications for the relation between the expected and realized holding periods. To understand this relation, suppose that an investor starts from an optimal stock holding given his age, current stock holding, and tax basis. His expected holding period will be similarly determined according to the average stock returns going forward. However, if the stock experiences a larger price run-up than the investor anticipated, the investor's equity proportion will exceed the investor's optimal stock proportion according to the expected stock return going forward. The investor is now overweighted in stock for his situation. In this case, it is optimal for the investor to rebalance his portfolio by selling some stocks with embedded capital gains to move closer to the unconstrained optimum for his situation. Because the economy is populated with heterogeneous investors with different ages, stock holdings, and tax bases, at any given time, there are always investors rebalancing to move closer to their unconstrained optimum if their stocks enjoyed a large unexpected price run-up resulting in overweighted equity positions. In such cases, the investor's realized holding period is shorter than his expected holding period for stock.

In their comparative static analysis, Dammon et al. (2001) also find that a cut in the capital gains tax rate will result in the realization of higher capital gains because the cost of rebalancing is reduced. This is particularly true for young investors who benefit the most from rebalancing. The implication of this finding is that in the case of a relatively surprising capital gains tax cut, such as the Taxpayer Relief Act of 1997 (TRA 97), investors will be more willing to sell stocks with embedded capital gains to rebalance their portfolio ahead of their originally anticipated rebalancing. This also results in a shorter realized holding period than the expected holding period.

Other research also describes factors that can cause the realized holding period to differ from the expected holding period. Poterba (2001) documents that elderly investors with substantial appreciation in their portfolios tend to postpone the distribution of a larger proportion of their assets until after death compared with their counterparts of similar wealth who possess smaller embedded capital gains. This is consistent with the explanation that an investor wishes to hold stock with embedded capital gains until death to avoid capital gains taxes.

Shackelford and Verrecchia (2002) analyze a related situation where buyers rationally compensate sellers to entice them to trade before they qualify for long-term capital gains treatment. Under current law, gains on sales of stock held for 1 year or less are taxed at 35%; gains held for more than 1 year are taxed at 15%. If a seller's expected holding period exceeds 1 year, then his expected capital gains tax rate is 15%. To sell and face 35% short-term capital gains tax rates, the seller will demand a higher price. Shackelford and Verrecchia (2002) show that when news is released, prices move and some shareholders may find themselves in a position in which they would benefit from rebalancing. If they had expected to sell after qualifying for long-term treatment, they now must trade off the risk of being overweighted in an appreciated stock with the tax considerations of paying higher short-term capital gains rates. The result will be some trading, though less than would be optimal

in the absence of capital gains taxes, with trading decreasing in the appreciation the shareholder enjoys and the spread between the long-term and short-term capital gains tax rates. Blouin et al. (2003) provide evidence consistent with the theory in Shackelford and Verrecchia (2002). They examine price changes around earnings announcements and additions to the S&P 500 during the 1980s and 1990s and find prices rising on news for investors nearing qualification for long-term treatment, as predicted.

Poterba and Weisbenner (2001) link the January effect to these differences in short- and long-term capital loss tax rates. Reese (1998) shows that prices increase just before investors who receive shares in an IPO qualify for long-term capital gains treatment. Both are consistent with the assumption that an investor's expected holding period may exceed their realized holding period.

To demonstrate the effect of a capital gains tax on stock prices, we use an equilibrium approach based on the demand and supply framework. We assume that the demand curve for the stock is downward-sloping, so that investors are willing to buy more shares of the stock at lower prices and fewer shares at higher prices, and that the supply curve is upward-sloping, so that investors are willing to sell more shares at higher prices and fewer shares at lower prices, both before and after capital gains taxes.

Figure 1 illustrates the effect of a change in the capital gains tax rate on stock prices and the interaction between the two opposing forces, capitalization and lock-in. To facilitate the discussion in our empirical analysis, we examine the stock price effect of a capital gains tax cut. At first, suppose that the initial capital gains tax rate is τ_C^0. The demand and the supply for any particular stock are depicted as D and S in the graph and the two intersect each other at point A, which determines the equilibrium price P_0 and float of shares Q_0. Now, consider a capital gains tax cut from τ_C^0 to τ_C^1, $\tau_C^1 < \tau_C^0$. The demand curve shifts to the right from D to D' due to the increase in demand associated with the capitalization effect. At the same time, the supply curve also shifts to the right from S to S' due to the increase in supply associated with the lock-in effect. In equilibrium, the new demand and supply curves intersect each other at point B, which provides us with a new equilibrium price, P_1, and a new float of shares, Q_1. It is obvious that whether the new price is higher or lower depends on which effect dominates. However, the float of shares is clearly higher. In the event of a capital gains tax increase, the shift in demand and supply is reversed. Consequently, the float of shares is unambiguously decreased, whereas the change in equilibrium price remains ambiguous depending on which effect (capitalization or lock-in) dominates. In the Appendix, we formalize the demand and supply analysis and analytically demonstrate that the effect of capital gains taxes on stock prices is ambiguous, depending on the relative magnitude of the capitalization effect and the lock-in effect.

Our analysis above has the following empirical implications. First, when the capitalization effect dominates the lock-in effect, a reduction in the capital gains tax will cause an increase in stock prices (higher current stock returns). This will arise when buyers are more responsive to an imminent capital gains tax cut than are current sellers. Conversely, when the lock-in effect dominates the

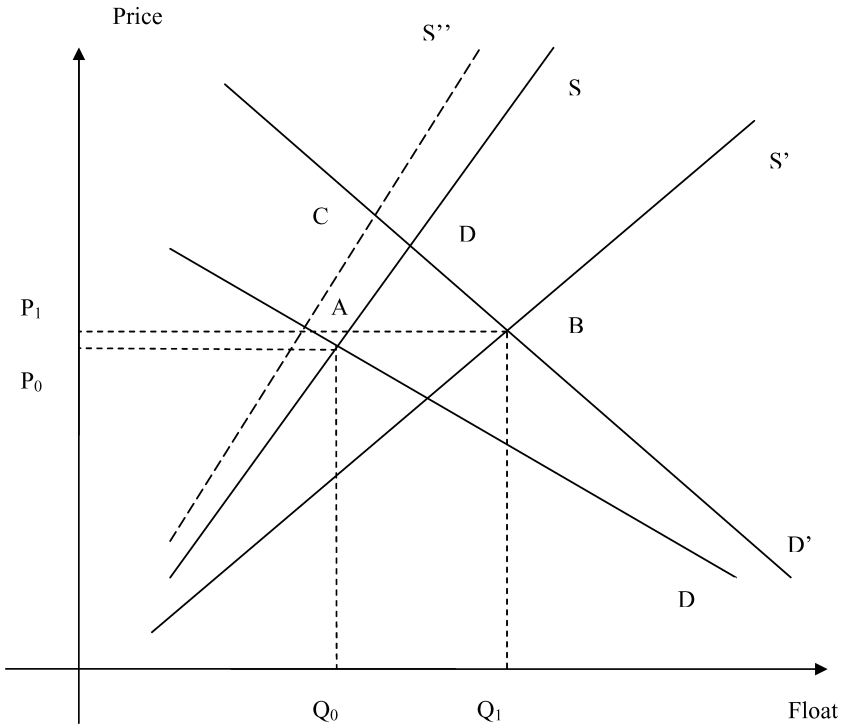

Figure 1. Effects of capital gains taxes on asset price and share float. This figure illustrates how tax capitalization and lock-in from capital gains taxes affect a stock's demand and supply and thus affect its equilibrium price and float. (P_0, Q_0) is the equilibrium price and quantity for the capital gains tax rate τ_C^0 and (P_1, Q_1) is the equilibrium price and quantity for the capital gains tax rate τ_C^1.

capitalization effect, a reduction in the capital gain tax rate will cause a decrease in stock prices (lower current stock returns). This will happen if current sellers are more responsive to the capital gains tax cut than are buyers. Second, the float of shares is inversely related to the capital gains tax rates. When the capital gains tax is reduced, both the capitalization and the lock-in effects reinforce each other to increase the number of shares actively traded. The above implications apply to all stocks with embedded capital gains and thus represent marketwide reactions to a change in the capital gains tax rate.

Because of the different effects of capital gains taxes on stock buyers and sellers, stocks with different characteristics will also be affected differently in the event of a capital gains tax change. Growth stocks are expected to offer larger future price appreciation than income stocks. A capital gains tax cut will reduce the buyer's future tax liability and attract more demand. These stocks will experience a greater price increase and higher returns than income stocks in the event of a capital gains tax cut. In general, dividend-paying stocks are more likely to be income stocks, while nondividend-paying stocks are more likely to be growth stocks. This means that for the capitalization effect, stock

returns are likely higher for nondividend-paying firms than dividend-paying firms. From a stock seller's perspective, tax-sensitive investors holding stocks with large long-term price appreciation will have lower current tax costs on selling when the capital gains tax is reduced. Thus, tax-sensitive investors will be more inclined to sell stocks with large embedded capital gains to rebalance their portfolio. This implies that in the event of a capital gains tax cut, stocks with large embedded capital gains will experience a larger price decline than will other stocks. These implications pertain to individual stock characteristics. We therefore call them cross-sectional effects of a change in the capital gains tax rate.

In addition, investors anticipating the capital gains tax cut may withhold selling shares with embedded gains before the tax cut becomes effective (seller's strike). In this case, the supply curve may remain unchanged or even move up from S to S''. The demand and supply curve may intersect at point C or D. This will lead to a temporary increase in both the stock price and float of shares. This may provide an alternative explanation to a dominating capitalization effect before the capital gains tax cut becomes effective. In the next section, we empirically test both the marketwide and cross-sectional effects of a capital gains tax change by jointly considering the capitalization and lock-in effects, including a possible alternative explanation for the capitalization effect (seller's strike).

II. Empirical Methodology

To empirically test the above implications, we use the TRA 97 capital gains tax reduction as our event. TRA 97 lowered the top tax rate on capital gains from 28% to 20% for assets held more than 18 months. TRA 97 is particularly attractive as a sample event because the tax cut was both large and relatively unexpected. Often, tax legislation follows a protracted process with gradual changes in the probability of a particular bill becoming law. In the case of TRA 97, however, Congress has provided researchers with an attractive research setting by coming to rapid agreement on a large, unexpected reduction in capital gains tax rates.

Having a well-defined event is particularly important in this study because we need to define separate event windows for two opposing effects. The key to jointly identifying the capitalization effect and the lock-in effect is to understand that stock buyers and sellers perceive the expected capital gains tax cut differently as discussed earlier. They differ not only in terms of required rate of return or valuation but also in terms of when they react to the news/event. A buyer will react to the capital gains tax cut information *before* the tax cut becomes effective in order to capture the expected tax cut benefit. In contrast, a seller subject to capital gains taxes will more likely sell shares with embedded capital gains to rebalance his portfolio *after* the tax cut becomes effective. As a result, the capitalization effect is more likely to dominate before the tax cut announcement and the lock-in effect is more likely to dominate after the tax cut becomes effective.

For TRA 97, little information was released until Wednesday April 30, 1997, when the Congressional Budget Office (CBO) surprisingly announced that the estimate of the 1997 deficit had been reduced by $45 billion. Two days later on May 2, the President and Congressional leaders announced an agreement to balance the budget by 2002 and, among other things, reduce the capital gains tax rate. These announcements greatly increased the probability of a capital gains tax cut.[1] On Wednesday May 7, 1997, Senate Finance Chairman William Roth and House Ways and Means Chairman William Archer jointly announced that the effective date of any reduction in the capital gains tax rate would be May 7, 1997.

With the above background in mind, we posited that during the week of Wednesday, April 30 to Tuesday, May 6, 1997, the capitalization effect (WK_C) dominates as demand increases in reaction to the increased likelihood of a capital gains tax cut. The same event window is used in Blouin, Hail, and Yetman (2006); Lang and Shackelford (2000) use a similar event window (April 29 to May 5, 1997). We also posit that during the week of Wednesday May 7 to Tuesday May 13, 1997, the lock-in effect (WK_L) dominates as current shareholders sell their appreciated stocks to rebalance their portfolios.

Note that the capital gains tax rate reduction only applied to income that is reported on personal tax returns, that is, capital gains from sales of shares held directly by individuals or indirectly by individuals in flow-through entities such as mutual funds, partnerships, trusts, S corporations, or limited liability corporations that pass dividend income to investors' personal tax returns. Capital gains taxes are not levied on tax-deferred accounts (e.g., qualified retirement plans, including pensions and IRAs), tax-exempt organizations, and foreigners. Corporations pay capital gains taxes; however, the rate reduction in TRA 97 did not apply to corporations. Thus, the ensuing tests predict variation in returns based on the amount of holdings by individual investors and mutual funds.[2]

To capture the group of investors who are most sensitive to the capital gains taxes, we construct proxies for the percentage of tax-sensitive investor ownership of a stock (individual investors and/or mutual funds) using data on shares outstanding and shares owned by institutional investors. Data on institutional investors' ownership are obtained from their quarterly filings with the U.S. Securities and Exchange Commission (known as Form 13F).

Let R_{it} be firm i's stock return at time t. To test the effect of a capital gains tax rate cut on stock prices, we formulate the basic empirical regression equations as follows.

[1] There were some conflicting signals on the capital gains tax cut before April 1997 as detailed in Sinai and Gyourko (2004). Based on articles in the *New York Times* and *Wall Street Journal*, they find that President Clinton had already said that "he might be willing to cut capital gains taxes to reach a budget compromise" in the first week of February, though at that point "the Administration's preference is for a capital gains tax increase." However, on February 13 and February 23, there were additional news reports suggesting that the White House would accept a tax cut. That said, we view the surprising announcement by the CBO as the strongest indication for an imminent capital gains tax announcement.

[2] Along these lines, several studies examine investor-level trading behavior in response to tax incentives, including Graham and Kumar (2006) and Ivkovic, Poterba, and Weisbenner (2005).

For firms with positive embedded gains:

$$\begin{aligned} R_{it} = \alpha &+ \beta_1 WK_C + \beta_2 WK_L + \beta_3 WK_C * Div_{i(t-1)} \\ &+ \beta_4 WK_L * Gains_{i(t-1)} * TSO_{i(t-1)} \\ &+ \beta_5 WK_C * Gains_{i(t-1)} * TSO_{i(t-1)} \\ &+ \beta_6 Beta\_market_i + \beta_7 Beta\_momentum_i \\ &+ \gamma Controls + \varepsilon_{it}. \end{aligned} \tag{1}$$

For all firms:

$$\begin{aligned} R_{it} = \alpha &+ \beta_1 WK_C + \beta_2 WK_L \\ &+ \beta_3 WK_C * Div_{i(t-1)} \\ &+ \beta_4 WK_L * Gains_{i(t-1)} * TSO_{i(t-1)} \\ &+ \beta_5 WK_C * Gains_{i(t-1)} * TSO_{i(t-1)} \\ &+ \beta_6 Beta\_market_i + \beta_7 Beta\_momentum_i \\ &+ \beta_8 WK_C * Loss_{i(t-1)} * TSO_{i(t-1)} \\ &+ \beta_9 WK_L * Loss_{i(t-1)} * TSO_{i(t-1)} \\ &+ \gamma Controls + \varepsilon_{it}, \end{aligned} \tag{2}$$

where WK_C represents the dummy variable for the week during which we expect the capitalization effect to dominate (hereafter, we refer to WK_C as the capitalization week), WK_L represents the dummy variable for the week during which we expect the lock-in effect to dominate (hereafter, we refer to WK_L as the lock-in week), $Div_{i(t-1)}$ is a dummy variable that takes the value of one if there was *no* dividend distribution in the prior year and zero otherwise, $Gains_{i(t-1)}(Loss_{i(t-1)})$ is the embedded capital gains (losses) prior to time t and in our baseline case is measured as the past 2-year stock price appreciation (depreciation), $TSO_{i(t-1)}$ is the percentage of shares of stock i owned by tax-sensitive investors at time (t – 1) and is measured as either the sum of individual investor and mutual fund ownership in the most recent past quarter or individual investor ownership alone, $Beta\_market_i$ is stock i's market return beta, $Beta\_momentum_i$ is stock i's beta on the momentum factor, and *Controls* refer to all other variables that may affect stock returns.

Our specifications above consider both the broad stock market reactions to the capital gains tax cut and the cross-sectional differences in the tax effect for different stocks with diverse characteristics. Intuitively, a capital gains tax cut will increase the demand for a stock. Thus, in the event of a capital gains tax cut, the coefficient on the capitalization week dummy (WK_C) will be positive ($\beta_1 > 0$). Similarly, for existing tax-sensitive shareholders who are contemplating the sale of shares with embedded capital gains, a tax cut will induce them to sell the stock to rebalance. When the lock-in effect dominates the capitalization effect,

a tax rate cut will lead to lower returns on stocks with embedded capital gains resulting in a negative sign for the lock-in week dummy variable ($\beta_2 < 0$). These constitute the broad market effect of a capital gains tax cut on stock prices.

Firms differ in their dividend policy, growth potential (and consequently their future capital gains tax liability), size of embedded capital gains, and current tax costs on selling. Thus, the magnitude of the reaction to the capital gains tax cut will likely vary with the characteristics of these firms. Our analysis in the previous section suggests that in the event of a capital gains tax cut, the impact from the demand side on stock returns will be larger for growth stocks than for income stocks. This is captured by a positive coefficient on the interaction term $WK_C * Div_{i(t-1)}$ indicating a larger price increase for growth stocks than income stocks during the capitalization week ($\beta_3 > 0$).

On the other hand, for a current shareholder who faces a capital gains tax liability, a capital gains tax reduction offers an incentive for him to sell shares with large embedded capital gains to rebalance, leading to large downward price pressure associated with the lock-in effect on stock returns. Therefore, during the week the lock-in effect dominates the capitalization effect, stocks with larger embedded capital gains and a higher percentage of tax-sensitive investor ownership will experience lower stock returns. In our specifications above, this is captured by a negative coefficient on the interaction term $WK_L * Gains_{i(t-1)} * TSO_{i(t-1)}$ in both equations (1) and (2) ($\beta_4 < 0$).

As discussed in Section I, an alternative explanation for a dominating capitalization effect in the week before the capital gains tax cut is that tax-sensitive investors may withhold selling stocks with large embedded gains, leading to a price run-up. This is referred to as the "seller's strike." To empirically test if a price run-up in the week before the capital gains tax cut announcement is caused by a dominating capitalization effect or a seller's strike, we include in our specifications the interaction $WK_C * Gains_{i(t-1)} * TSO_{i(t-1)}$. If the seller's strike causes the price run-up, we would expect a positive coefficient on the interaction. Otherwise, the price increase is likely to be the result of a dominating capitalization effect.

In addition, our regression includes measures of the systematic risk of individual stock returns to both market returns and the momentum factor. This is motivated by the standard capital asset-pricing theory and existing empirical evidence suggesting that systematic risks are important determinants of individual stock returns. Given that a tax cut is a marketwide event, the returns to the market portfolio and momentum will likely be affected by the event themselves. Consequently, in our baseline specifications, we include betas of individual stock returns to the market return and the momentum factor as control variables. We discuss the results of using the beta-adjusted stock returns as dependent variables in our robustness check later.

Our specification for all firms includes 2 additional interaction terms, $WK_C * Loss_{i(t-1)} * TSO_{i(t-1)}$ and $WK_L * Loss_{i(t-1)} * TSO_{i(t-1)}$. These interaction terms focus on the responses of loss firms to the capital gains tax cut in the capitalization week and the lock-in week. They allow us to further identify if tax-sensitive investors will engage in tax-efficient trading in the event of a capital gains tax

change. Intuitively, tax-sensitive investors should more aggressively sell stocks with large embedded capital losses before the capital gains tax is reduced to benefit from the higher tax deduction. This would create some downward pressure on these stocks during the capitalization week. Consequently, the coefficient on $WK_C * Loss_{i(t-1)} * TSO_{i(t-1)}$ should be positive, indicating that the prices of stocks with embedded losses are likely to decrease in the size of losses during the capitalization week because $Loss_{i(t-1)} < 0$. Conversely, since there is no lock-in on stocks with embedded losses and the capitalization effect remains during the lock-in week, the coefficient on $WK_L * Loss_{i(t-1)} * TSO_{i(t-1)}$ will likely be negative, indicating increased demand associated with the capitalization effect.

To test the prediction with respect to the effect of the capital gains tax cut on the float of shares, we need first to provide a measure for the float of stock. Unlike the shares outstanding, the float of shares measures the number of shares actively traded and is usually less than shares outstanding. For example, shares owned by insiders sometimes are subject to certain restrictions and cannot be quickly sold in the market. Such shares are not included in the float. Some long-term buy-and-hold investors are also less inclined to churn their portfolio due to short-term price fluctuation. Their holdings are not normally part of the float.

However, for a major event, such as a capital gains tax cut, an investor may find it optimal to buy additional stocks and/or to sell some stocks with large price appreciation to rebalance his portfolio. Trading from these investors is likely to temporarily increase trading volume. In particular, the increase in trading volume caused by the capital gains tax cut is likely to be concentrated in the few weeks when the tax cut is announced. We use trading volume as a proxy for the float of shares of stocks.[3]

Let v_{it} be stock i's logarithmic weekly trading volume. Following Michaely and Vila (1996) and Dhaliwal and Li (2006), we first compute the excess trading volume as the difference between the weekly trading volume at time t and the average weekly trading volume in the most recent past month relative to the 1-month weekly average trading volume, that is,

$$\Delta v_{it} = \frac{v_{it} - \frac{1}{4}\sum_{j=t-4}^{t-1} v_{ij}}{\frac{1}{4}\sum_{j=t-4}^{t-1} v_{ij}}. \tag{3}$$

We then formulate our regression equations for the tax effect on trading volume as follows:

For firms with positive embedded gains:

$$\begin{aligned}\Delta v_{it} = {} & \alpha + \beta_1 WK_C + \beta_2 WK_L + \beta_3 WK_C * Div_{i(t-1)} \\ & + \beta_4 WK_L * Gains_{i(t-1)} * TSO_{i(t-1)} \\ & + \beta_5 WK_C * Gains_{i(t-1)} * TSO_{i(t-1)} + \gamma Controls + \varepsilon_{it}.\end{aligned} \tag{4}$$

[3] Because our theoretical predictions pertain to the float, our empirical analysis on trading volume is used as informal evidence on the relation between capital gains taxes and the float.

For all firms:

$$\begin{aligned}\Delta v_{it} = {} & \alpha + \beta_1 WK_C + \beta_2 WK_L + \beta_3 WK_C * Div_{i(t-1)} \\ & + \beta_4 WK_L * Gains_{i(t-1)} * TSO_{i(t-1)} + \beta_5 WK_C * Gains_{i(t-1)} * TSO_{i(t-1)} \\ & + \beta_6 WK_C * Loss_{i(t-1)} * TSO_{i(t-1)} + \beta_7 WK_L * Loss_{i(t-1)} * TSO_{i(t-1)} \\ & + \gamma Controls + \varepsilon_{it}, \end{aligned} \tag{5}$$

where the variables are defined as above and the controls are discussed in the next section.

Our prediction for stock float suggests that the coefficients on WK_C and WK_L will be positive, reflecting the marketwide response in trading volume to a capital gains tax cut. The interaction term $WK_C * Div_{i(t-1)}$ also will likely be positive because more tax-sensitive investors should buy shares of stocks with growth potential during the week the capitalization effect dominates. Furthermore, the interaction term, $WK_L * Gains_{i(t-1)} * TSO_{i(t-1)}$, will be positive because more tax-sensitive investors sell their holdings with large embedded capital gains to rebalance their portfolios during the week the lock-in effect dominates. For brevity, in our discussions of the empirical analysis, we use the term *trading volume* to refer to excess trading volume.

III. Empirical Analysis

A. Sample and Summary Statistics

We use stocks included in the CRSP data set between January 1, 1990, and December 31, 1997. Following Lang and Shackelford (2000), we focus on weekly returns. Explanatory variables include a dividend dummy, embedded capital gains and losses, the percentage of individual and/or mutual fund ownership of a stock, week dummies defined to identify the event period, a measure of an individual stock's exposure to the market return ($Beta\_market_i$), a measure of an individual stock's exposure to the momentum factor ($Beta\_momentum_i$), and various interaction terms to identify the tax effect.

We calculate the weekly return as

$$R_{it} = \sum \log\left(r_{it}^d + 1\right), \tag{5}$$

where r_{it}^d is the daily return and t runs from Wednesday to the following Tuesday to be consistent with the event windows. The logarithmic weekly volume is similarly calculated as

$$v_{it} = \sum \log\left(Vol_{it}^d\right), \tag{6}$$

where Vol_{it}^d is the daily trading volume of stock i on day t and the summation runs from Wednesday to the following Tuesday. We use volumes in both shares traded and dollar amounts for our empirical analysis.

We obtain daily stock returns and trading volume from the daily CRSP data set. Dividend, stock price, and shares outstanding are extracted from the monthly CRSP data set. To obtain the percentage of shares of each stock owned by individual investors, we extract institutional investors' ownership from Form 13F submitted to the SEC by investment management companies.[4] We then compute two measures of tax-sensitive ownership of stock i at time t (TSO_{it}) as follows:

The percentage of individual investor ownership (IND_{it}):

$IND_{it} = 1 -$ Percentage of shares owned by institutional investors at time t.

The percentage of individual investor and mutual fund ownership ($IND\&MF_{it}$):

$IND\&MF_{it} = IND_{it} +$ Percentage of shares owned by mutual funds at time t.

We exclude noncommon shares such as preferred stocks from our analysis. For our baseline case, we define the embedded capital gain (loss) as the price appreciation (depreciation) in the last 2 years. Specifically, the 2-year embedded capital gain (loss) is calculated as the price appreciation (depreciation) in the past 2 years up to the most recent month prior to time t and takes the value of zero if the stock price change is negative (positive) for each stock. For instance, the 2-year embedded gain for March 31, 1997, is calculated as a stock's price appreciation from February 1995 to February 1997 and takes the value of zero if the stock price change for the period is negative. As a robustness check, we also use embedded capital gains and losses measured at 18 months, 3 years, and 5 years and find that inferences largely hold.

To obtain measures of exposure of individual stock returns to the market return and the momentum factor, for each stock we estimate a multiple regression of the firm's weekly excess return on the weekly market excess return and weekly momentum factor using data on these variables between August 1, 1992, and April 16, 1997.[5] The regression slope for the market return and the momentum factor is used for $Beta\_market_i$ and $Beta\_momentum_i$, respectively.

For the empirical tests, we use weekly returns in the last 3 years of the data (1995, 1996, and 1997). Our control variables for the weekly return regressions include the dividend distribution dummy, the percentage of tax-sensitive investor ownership, the embedded capital gains, the interaction terms $WK_L{*}Gains_{i(t-1)}$, $WK_L{*}TSO_{i(t-1)}$, $WK_C{*}Gains_{i(t-1)}$, $WK_C{*}TSO_{i(t-1)}$, $Gains_{i(t-1)}{*}TSO_{i(t-1)}$, and $TSO_{i(t-1)}{*}Div_{i(t-1)}$, the size of the firm as measured by the logarithm of the firm's market capitalization at $t - 1$, and the calendar effect represented by month and annual dummies. For the return

[4] We thank Rabih Moussawi for providing the institutional stock ownership data. Ayers et al. (2003), Dhaliwal and Li (2006), and Dhaliwal et al. (2005), among many others, also use this measure to capture the extent to which individuals hold shares in the firm.

[5] To construct the weekly momentum factor, we use the daily data on the momentum factor (Up minus Down or UMD) available from Kenneth R. French's Website. Six value-weighted portfolios formed on size and prior (2–12) returns are used to construct UMD. The monthly portfolios are the intersections of two portfolios formed on size and three portfolios formed on prior (2–12) returns. UMD is the average return on the two high prior return portfolios minus the average return on the two low prior return portfolios.

Table I
Definitions of Variables

Wret	The weekly stock return, which is calculated as $R_{it}^{w} = \sum \log(r_{it}^{d} + 1)$, where r_{it}^{d} is the daily return and t runs from Wednesday to the following Tuesday.
Vol	The sum of daily logarithmic volume running from Wednesday to the following Tuesday.
Size	The logarithm of the market value in the prior month.
$Vol	The sum of daily logarithmic dollar volume running from Wednesday to the following Tuesday.
Div	A dummy variable that takes the value of one if the company did not pay any dividend in the prior year, zero otherwise.
$\Delta P/P$	The 2-year stock price change up to the prior month.
IND	The percentage of individual ownership calculated as one minus the percentage of shares held by institutional investors the prior quarter.
IND&MF	The percentage of shares owned by individual investors and mutual funds in the prior quarter.
Turnover	The monthly trading volume divided by the outstanding shares.
Beta_market	The beta estimates of regressing weekly individual stock returns on the market return.
Beta_momentum	The beta estimates of regressing weekly individual stock returns on the momentum factor.
Adj ret	The adjusted weekly return after removing the systematic components associated with the market return and the momentum factor.
Adj Vol	The difference between the current weekly volume and the average weekly volume in shares in the past 3 months relative to the 3-month weekly average volume (equation (3)).
Adj $Vol	The difference between the current weekly volume and the average weekly volume in dollars in the past 3 months relative to the 3-month weekly average volume (equation (3)).
WK_C	A dummy variable that takes on a value of one during the week from April 30, 1997, to May 6, 1997; zero otherwise.
WK_L	A dummy variable that takes on a value of one during the week from May 7, 1997, to May 13, 1997; zero otherwise.
Gains	The 2-year holding period gains up to the prior month.
Loss	The 2-year holding period losses up to the prior month.
TSO	The tax-sensitive investor ownership measured either by the percentage of shares owned by individual investors and mutual funds (*IND&MF*) or by individual investors alone (*IND*) in the prior quarter.

regression for all firms, we also include the embedded losses and the interactions $WK_L{*}Loss_{i(t-1)}$, $WK_C{*}Loss_{i(t-1)}$, and $Loss_{i(t-1)}{*}TSO_{i(t-1)}$. For the volume regressions, we use the dividend distribution dummy, the percentage of shares owned by individual investors and mutual funds, firm size, the interaction terms $Gains_{i(t-1)}{*}TSO_{i(t-1)}$ and $Gains_{i(t-1)}{*}Div_{i(t-1)}$, and the calendar effect as control variables. For the volume tests using the all firm sample, we include the interactions $Loss_{i(t-1)}{*}TSO_{i(t-1)}$ and $Loss_{i(t-1)}{*}Div_{i(t-1)}$.

Table I presents the variable definitions and Table II presents the basic summary statistics for variables used in our regression analysis for both the subsample of firms with positive embedded capital gains and the full sample, including firms with embedded capital losses. The subsample consists of

Table II
Summary Statistics

This table reports summary statistics for the sample of stocks included in CRSP between January 1, 1990, and December 31, 1997. See Table I for variable definitions.

Variables	Mean	Median	*SD*	Min	Max
Panel A: Firms with positive embedded gains					
Wret_raw (%)	0.3322	0.0000	5.9414	−188.87	135.73
Size	12.5161	12.2795	2.0974	7.2788	19.3035
Div	0.4634	0.0000	0.4986	0.0000	1.0000
ΔP/P(2-year)	0.7677	0.4500	1.5103	0.0000	131.37
IND	0.6672	0.6980	0.2353	0.0000	0.9999
IND&MF	0.7662	0.7915	0.1689	0.0904	1.0000
Beta_market	0.6019	0.5566	0.5362	−1.4986	2.6963
Beta_momentum	0.0171	0.0257	0.4009	−3.1574	1.5292
Adjret (%)	0.1000	0.0088	5.7738	−189.01	134.72
Turnover	0.0846	0.0454	0.1373	0.0000	5.0819
AdjVol	−0.0001	−0.0019	0.0625	−0.5693	0.6586
Adj$Vol	0.0004	−0.0012	0.0526	−0.4636	0.6574
Panel B: All firms					
Wret_raw (%)	0.2909	0.0000	6.8390	−188.87	179.17
Size	12.0903	11.8530	2.1175	5.2587	19.3035
Div	0.4946	0.0000	0.5000	0.0000	1.0000
ΔP/P(2-year)	0.4040	0.1932	1.3301	−0.9947	131.37
IND	0.6893	0.7271	0.2294	0.0000	0.9999
IND&MF	0.7808	0.8117	0.1658	0.0904	1.0000
Beta_market	0.6042	0.5593	0.5416	−1.4986	2.6963
Beta_momentum	0.0153	0.0239	0.4049	−3.1574	1.5292
Adjret (%)	0.0489	−0.0400	6.7166	−189.01	179.43
Turnover	0.0792	0.0444	0.1253	0.0000	5.0819
AdjVol	0.0007	−0.0015	0.0652	−0.5739	0.6759
Adj$Vol	0.0009	−0.0011	0.0560	−0.5520	0.6574

information on 2,682 firms with positive embedded gains for the past 2 years and a total of 273,004 observations. The average weekly return for firms with positive embedded capital gains is 0.33% with a standard deviation of 5.9%. The full sample, including firms with embedded capital losses, consists of 415,129 firm-week observations and has a lower average weekly return of 0.29% and a slightly higher standard deviation of 6.84%. On average, about 46% of the firms in the gains subsample and 49% of all firms in the full sample did not pay dividends (recall that *Div* takes a value of one if the firm does not pay dividends). The average 2-year price appreciation for the gains subsample is 77% with a standard deviation of 151%. When gain and loss firms are combined, the average 2-year stock price change is 40% with a standard deviation of 133%. The 2-year stock price change is highly skewed with half of the firms gaining less than 45% for the gains subsample and about 19% for the full sample as indicated

by the median. The average percentage of shares owned by individual investors is 67% with a standard deviation of 24% for the gains subsample. Individual and mutual funds together own 77% of stocks on average, with a standard deviation of slightly less than 17% for the gains subsample. The mean and standard deviation for the individual and/or mutual fund ownership are of similar magnitude to those of the full sample. The average individual stock beta on the market return is 0.6 with a standard deviation of 0.54. The average beta on the momentum factor is much smaller at 0.02 with a relatively large standard deviation of 0.40 for the positive gains subsample. Similar mean and standard deviation obtain for the full sample with all firms. The adjusted weekly return removes the systematic components associated with the market return and the momentum factor. The mean adjusted weekly returns for individual stocks are 0.05–0.1% in the gains sample and all-firm sample, respectively, with a standard deviation of 5.8–6.7%, respectively. The adjusted weekly return is much lower on average than the unadjusted return.

The excess trading volume has an average close to zero with a standard deviation of 0.06 for positive gains firms when measured in logarithmic shares and an average of 0.0004 with a standard deviation of 0.05 when measured in logarithmic dollar volume. For the full sample with all firms, the excess trading volume has an average of 0.0007 with a standard deviation of 0.065 for logarithmic shares and an average of 0.0009 with a standard deviation of 0.056 for logarithmic dollar volume. For both the gains subsample and the full sample with all firms, individual stocks have an average monthly turnover of 0.08 with a standard deviation of 0.13.

We use generalized least squares to estimate our regression model in order to account for correlated residuals in regressions. Specifically, we use clustered standard error estimates, which are shown to be unbiased in regression analysis using panel data sets by Peterson (2005).[6]

B. Return Tests for Joint Tax Capitalization and Lock-in Effects

Our first set of regression results is based on equation (1) and reported in Table III. The first two columns of estimates and p values correspond to the percentage of tax-sensitive ownership (*TSO*) for individual investors and mutual funds combined, while the last two columns measure tax-sensitive ownership using individual investors only. The coefficients on key variables are qualitatively very similar. Specifically, consistent with our predictions, the coefficient estimate associated with WK_C is positive and statistically significant at the 1% level. This indicates that the market reacted positively to the possibility of a capital gains tax cut. The weekly return for the capitalization week is 7.68% higher than the average weekly return when tax-sensitive ownership is measured by individual investors and mutual funds combined (*IND&MF*), and

[6] We use SAS's PROC MIXED procedure to estimate our models, treating the firm as our subject so that each firm is one cluster. The goodness of fit for this procedure is given by the −2 residual log likelihood.

Table III

Return Tests for Tax Capitalization and Lock-In: Positive Gains Firms

This table reports the results of the regression based on equation (1), which tests the joint effects of tax capitalization and lock-in on stock returns. See Table I for variable definitions. The dependent variable is the weekly stock return, *Wret*. All the estimates are in percentage terms. Year dummies and month dummies are included in all specifications to control for possible calendar effects. Model (1) uses the percentage of shares owned by both individual investors and mutual funds as the measure of tax-sensitive ownership and model (2) uses individual investors only as the measure of tax-sensitive ownership.

		Individuals and Mutual Funds		Individuals only	
Variables	Predicted signs	Estimate	p value	Estimate	p value
WK_C	+	7.683	(0.0001)	5.785	(0.0001)
WK_L	−	−2.931	(0.0004)	−1.821	(0.0001)
$WK_C * Div$	+	1.196	(0.0002)	1.198	(0.0001)
$WK_L * Gains * TSO$	−	−2.068	(0.0308)	−1.538	(0.0114)
$WK_C * Gains * TSO$	+	−0.968	(0.500)	−0.382	(0.6711)
Beta_market		0.084	(0.0080)	0.092	(0.0041)
Beta_momentum		0.066	(0.0629)	0.070	(0.0491)
Div		0.052	(0.6500)	−0.096	(0.1911)
TSO		0.202	(0.0513)	0.181	(0.0148)
Gains		−0.112	(0.3053)	−0.114	(0.0526)
$WK_L * Gains$		1.885	(0.0177)	1.313	(0.0045)
$WK_L * TSO$		3.355	(0.0019)	2.215	(0.0015)
$Gains * TSO$		0.079	(0.5140)	0.086	(0.2211)
$WK_C * TSO$		−7.373	(0.0001)	−5.674	(0.0001)
$WK_C * Gains$		1.622	(0.1955)	1.077	(0.1225)
$TSO * Div$		−0.449	(0.0017)	−0.295	(0.0031)
Size		−0.017	(0.0289)	−0.013	(0.0728)
Sample size		273,004		273,004	
−2 residual log likelihood		–770,282		–770,290	

is 5.79% higher when tax-sensitive ownership is measured by individual investors only (*IND*). The estimates suggest that during the capitalization week, the elasticity of stock prices to the capital gains tax change is −26.88% (7.68%/[(20% − 28%)/28%]) when the tax-sensitive ownership is measured by individual investors and mutual funds combined and is −20.27% (5.79%/[(20% − 28%)/28%]) when tax-sensitive ownership is measured by individual investors only. The estimated elasticity of stock prices to the capital gains tax change indicates that a 1% change in capital gains tax rate leads to a 0.20–0.27% change in stock prices in the capitalization week. The estimates are generally consistent with Goolsbee (1998), who documents that a 10% tax credit increases capital goods prices by 3.5–7%.[7]

[7] Three caveats apply to our estimates of the elasticity of stock prices to the capital gains tax. First, the estimates are only for the capitalization week and the state of the economy at that time. Second, they are obtained under TRA 97 tax regime change from 28% to 20%. The magnitude may vary if the initial and the reduced tax rates are very different from those for TRA 97. Third,

The estimate for WK_L is negative and also statistically significant at the 1% level. The estimated coefficient suggests that the average weekly return in the lock-in week is 2.93% (1.82%) lower than the average weekly return using *IND&MF* (*IND*). This provides empirical support for a marketwide dominating lock-in effect during the week immediately after the capital gains tax cut became effective. Furthermore, these estimates suggest that during the lock-in week, the elasticity of stock prices to the capital gains tax change ranges from 6.37% (−1.82%/[(20% – 28%)/28%]) when *TSO* is measured by *IND* to 10.26% (−2.93%/[(20% – 28%)/28%]) when *TSO* is measured by *IND&MF*. The estimates suggest that a 1% change in the capital gains tax rate leads to a 0.06–0.10% change in stock prices in the lock-in week. The elasticity estimates for the lock-in week are smaller than the elasticity estimates for the capitalization week in magnitude. This is consistent with our intuition that investors with large embedded capital gains can take their time in selling their shares after the lower capital gains tax rate became effective.

Consistent with our predictions on the cross-sectional behavior of stock returns, the interaction term $WK_C * Div$ is positive and highly statistically significant with a p value of less than 1%. The estimated coefficient shows that nondividend-paying stocks yield 1.2% higher returns on average during the capitalization week than do dividend-paying stocks for the same period for both measures of tax-sensitive ownership. Lang and Shackelford (2000) report that nondividend-paying firms experience 4.25% higher weekly return on average. The coefficient estimate associated with the interaction term $WK_L * Gains * TSO$ is negative at −2.07% based on *IND&MF* and negative at −1.54% based on *IND*. Both are statistically significant at the 3% level. This suggests that stocks with large embedded capital gains and high tax-sensitive ownership have lower returns during the lock-in week. The coefficient implies that for firms with the average percentage of individual and mutual fund ownership, a 1 standard deviation increase in 2-year embedded capital gains will yield 2.4% (−2.07% × 151% × 76.6%) lower weekly returns during the lock-in week. For firms with the average 2-year embedded capital gains, a 1 standard deviation increase in the percentage of individual and mutual fund ownership leads to 27 basis points (−2.07% × 76.8% × 16.9%) lower weekly returns during the lock-in week. When tax-sensitive ownership is measured by individual investors only, the corresponding reduction in the average weekly returns during the lock-in week is lower, at 1.6% (−1.54% × 151% × 66.7%) and 28 basis points (−1.54% × 76.8% × 23.5%), respectively.

The above findings are consistent with investors buying stocks as the probability of a capital gains tax cut increases before the announcement and tax-sensitive investors selling their shares after the effective date of capital gains

they assume that the full price adjustment arising from the rate reduction occurred during the investigation period. In other words, before the announcement the market expected the future capital gains tax rate to be 28% forever, and immediately after the announcement they expected the rate to be 20% forever. The same caveats also apply to the elasticity estimates for the lock-in week.

tax cut. Investors respond by increasing their demand for stocks and driving up prices during the capitalization week. This is particularly evident for nondividend-paying growth stocks, whose returns are more likely to face capital gains taxation. After the lower tax rate became effective, individual investors sensitive to capital gains tax liabilities were more inclined to sell positions with large embedded capital gains to rebalance their portfolios. This leads to a lower price for stocks with large embedded capital gains and a higher percentage of individual stock ownership during the lock-in week.

Our findings suggest that a dominant lock-in effect is stronger in a subset of stocks that have both large embedded capital gains and high tax-sensitive ownership in the week after the tax cut became effective. Given that TRA 97 directly affects individual investors and mutual funds with large embedded capital gains, this finding is consistent with our prediction on the relation between stock prices and capital gains taxes.

The coefficient on the interaction term $WK_C * Gains * TSO$ is negative but statistically insignificant for both measures of tax-sensitive ownership. The p value for the coefficient estimate is above 50% for both *IND&MF* and *IND*. This suggests that there is no empirical support for the seller's strike, an alternative explanation of the price run-up during the capitalization week. The reason is that if investors were withdrawing from the market after the announcement of a rate cut but before the effective date, we would expect share prices to increase during the capitalization week for the appreciated shares that were going to be sold after the effective date. Since the coefficient on the interaction term $WK_C * Gains * TSO$ is insignificant, we infer that increased demand largely accounted for the increase in prices during the capitalization week, rather than a seller's strike.

Our regression analysis also provides the following findings. Consistent with capital asset-pricing theory, a firm's exposure to systematic market risk has a positive effect on the firm's return. The estimated coefficient on *Beta_market* ranges from 0.08% to 0.09% and is statistically significant at less than the 1% level across the 2 regressions. Firms' exposure to the momentum factor also has a positive effect on returns. The coefficient on *Beta_momentum* ranges from 0.066 to 0.07 with p values ranging from 4.9% to 6.3% for the two regressions. Stocks with higher tax-sensitive investor ownership experience about 0.2% higher weekly returns on average. The interaction between WK_L and the embedded capital gains is significantly positive. This may be caused by demand from institutional investors that did not face a capital gains tax cut.

Stocks with higher tax-sensitive investor ownership experience a lower average weekly return during the capitalization week and a higher average weekly return during the lock-in week. Nondividend-paying stocks with higher tax-sensitive investor ownership also yield a lower weekly return on average. Firm size has a negative and marginally significant effect on stock returns.

Although not reported in the table, we find that the annual dummy is highly statistically significant for 1995 but not for 1996. The monthly dummies, on the other hand, are all statistically significant, indicating the existence of monthly return variation.

C. Return Tests with all Firms

For firms without embedded capital gains, lock-in will not likely have a significant effect on stock returns. However, tax-sensitive investors with embedded capital losses may sell their holdings before the tax cut becomes effective so that they can benefit from the higher tax rebate under the higher tax rate.[8] If so, firms with embedded capital losses and high tax-sensitive investor ownership will experience some downward price pressure during the week before the tax cut announcement. For these stocks, the price run-up caused by the capitalization effect, which increases the demand from investors who have no existing positions in the stocks and from investors who are not subject to taxation, will likely be attenuated.

Conversely, because there is no lock-in effect on stocks with embedded capital losses after the tax cut announcement, the selling pressure will likely be small while the capitalization effect remains for these stocks. To check the robustness of our findings of joint capitalization and lock-in effects and to test the hypotheses on firms with embedded capital losses, we estimate equation (2), which incorporates interaction terms with embedded losses $WK_C * Loss * TSO$ and $WK_L * Loss * TSO$, using observations on all firms.

Table IV reports the regression results with the additional interaction terms. Both the signs and magnitude of the effects of key variables are similar to those for firms with positive embedded capital gains only. Specifically, the coefficient for the capitalization week is 8.23% (6.23%) with a p value of less than 1% when tax-sensitive ownership is measured by percentage of shares owned by individual investors and mutual funds (individual investors only). The coefficient for the lock-in week is -2.96% and -1.85% for the two measures of tax-sensitive ownership, respectively, both statistically significant at the 1% level. Regarding the cross-sectional effect of the tax cut, we find that firms that do not distribute dividends earn 1.1% higher average weekly returns during the week the capitalization effect dominates for both measures of tax-sensitive ownership. This is slightly lower than the estimates using firms with positive embedded capital gains only. The coefficient estimate for the interaction $WK_L * Gains * TSO$ is negative at -2.06% and -1.51% for the two measures of tax-sensitive ownership and remains statistically significant at the 3% level. The magnitude of the effect is again slightly lower than in the case with gains-only firms.

The coefficient on the interaction $WK_C * Gains * TSO$ remains negative and statistically insignificant with a high p value (60% and above) for both measures of tax-sensitive ownership. This shows that there is no strong evidence for seller's strike during the capitalization week. In other words, the run-up in prices during the capitalization week appears to be driven more by increased

[8] Complex netting provisions, which are beyond the scope of this paper, govern the taxation of capital gains and losses (see Shackelford (2000)). That said, our predictions about the incentives to sell stocks with embedded capital losses before the rate fell assume that investors can utilize the capital losses. More specifically, we assume a net capital gain position, that is, total capital gains exceed total capital losses.

Table IV

Return Tests for Tax Capitalization and Lock-In: All Firms

This table reports the results of the regression based on equation (2), which tests the joint effects of tax capitalization and lock-in on stock returns for all firms (i.e., both those with embedded capital gains and embedded capital losses). See Table I for variable definitions. The dependent variable is the weekly stock return, *Wret*. All the estimates are in percentage terms. Year dummies and month dummies are included in all specifications to control for possible calendar effects. Model (1) uses the percentage of shares owned by both individual investors and mutual funds as the measure of tax-sensitive ownership. Model (2) uses individual investors only as the measure of tax-sensitive ownership.

		Individuals and Mutual Funds		Individuals only	
Variables	Predicted signs	Estimate	p value	Estimate	p value
WK_C	+	8.230	(0.0001)	6.231	(0.0001)
WK_L	−	−2.964	(0.0001)	−1.849	(0.0001)
$WK_C * Div$	+	1.050	(0.0002)	1.083	(0.0001)
$WK_L * Gains * TSO$	−	−2.062	(0.0266)	−1.506	(0.0124)
$WK_C * Gains * TSO$	+	−0.732	(0.5998)	−0.133	(0.8805)
Beta_market		0.093	(0.0005)	0.097	(0.0004)
Beta_momentum		0.072	(0.0210)	0.073	(0.0195)
Div		−0.004	(0.9681)	−0.156	(0.0141)
TSO		0.063	(0.4924)	0.033	(0.6218)
Gains		−0.077	(0.4155)	−0.087	(0.1015)
$WK_L * Gains$		1.883	(0.0143)	1.288	(0.0047)
$WK_L * TSO$		3.331	(0.0009)	2.192	(0.0009)
$Gains * TSO$		0.049	(0.6485)	0.064	(0.3275)
$WK_C * TSO$		−8.001	(0.0001)	−6.260	(0.0001)
$TSO * Div$		−0.382	(0.0019)	−0.217	(0.0129)
$WK_C * Gains$		1.453	(0.2291)	0.912	(0.1804)
Loss		0.143	(0.7492)	0.423	(0.1740)
$WK_C * Loss$		1.540	(0.8549)	1.379	(0.8130)
$WK_L{}^*Loss$		−16.06	(0.0041)	−10.97	(0.0032)
$Loss * TSO$		0.247	(0.6551)	−0.076	(0.8568)
$WK_C * Loss * TSO$		−2.766	(0.7862)	−2.939	(0.7004)
$WK_L * Loss * TSO$		15.54	(0.0204)	10.40	(0.0291)
Size		−0.034	(0.0001)	−0.032	(0.0001)
Sample size		415,129		415,129	
−2 residual log likelihood		−1,056,315		−1,056,313	

demand for shares than by a withdrawal from the market by sellers. The coefficient estimate on *Beta_market* remains positive and statistically significant. The coefficient estimate for *Beta_momentum* is now significant at the 2% level. The magnitudes are similar to the case with positive gains firms.

The coefficient on $WK_C * Loss * TSO$ is insignificant for both measures of tax-sensitive ownership. Contrary to expectations, the coefficient on $WK_L * Loss * TSO$ is positive. Together, the coefficients provide no support for investors unloading depreciated shares before the effective date for the rate reduction.

D. Robustness Tests

In this section, we perform robustness checks on our findings documented earlier. We focus on alternative measures of embedded capital gains and losses, controlling for the turnover in stock trading and an alternative measure of stock returns that adjusts for market return risk and the momentum factor as in a conventional event study. Specifically, we reestimate equation (2) measuring embedded capital gains (losses) as the price appreciation (depreciation) in the past 18 months, 3 years, and 5 years. We also reestimate equations (1) and (2) including turnover as an explanatory variable. Finally, we reestimate equations (1) and (2) using adjusted individual stock returns that remove the systematic components attributed to the market return and the momentum factor. In all of our robustness tests, tax-sensitive ownership is measured as the percentage of shares owned by individual investors.[9]

Table V reports the results for 18-month, 3-year, and 5-year embedded capital gains and losses for all firms, respectively. The signs of the coefficient estimates for the key variables remain the same as for the baseline case with 2-year embedded capital gains and losses. The coefficient estimates are also all statistically significant for the key variables except for the interaction $WK_L * Gains * TSO$ for the 3-year and 5-year measures of embedded gains and losses. The interaction $WK_C * Gains * TSO$ remains statistically insignificant using the 18-month embedded gains and losses measures. The estimated coefficient is negative and significant for the 3-year and 5-year embedded gains and losses measures. This again indicates no evidence of a seller's strike at these holding periods as it would take a positive coefficient to suggest a seller's strike.

Stocks with high turnover have shorter holding periods and thus larger tax costs. In Table VI, we report results for our baseline case controlling for the turnover in stock trading. The coefficient estimates for all key variables have the same sign and statistical significance as the baseline case reported in Tables III and IV. The magnitude of the estimated coefficients is in general slightly smaller when we control for stock turnover. For both samples, turnover itself has a significantly negative effect on the stock returns, indicating that higher turnover is associated with a lower return.

In Table VII, we report the regression results for both positive gains firms and all firms when the dependent variable is measured as the adjusted individual stock returns. To construct the adjusted individual stock returns, we subtract the systematic components. *Beta_market* $*$ *Market return* and *Beta_momentum* $*$ *Momentum factor* from the raw individual stock returns. Again, the signs of the estimated coefficients for all key variables remain the same as for the baseline cases reported in Tables III and IV. The estimated coefficients for all key variables are also statistically significant except for the interaction $WK_C * Div$. The other significant change is the magnitude of the coefficient estimate for WK_C. It is reduced from around 8% to about 2.6%. Both changes in the estimated coefficients for WK_C and

[9] The results are qualitatively similar when tax-sensitive ownership is measured by the percentage of shares owned by individual investors and mutual funds combined.

Table V

Robustness Check: All Firms, with Different Holding Periods

This table reports the results of the robustness checks across different holding periods of the regression based on equation (2), which tests the joint effects of tax capitalization and lock-in on stock returns. See Table I for variable definitions. The dependent variable is the weekly stock return, *Wret*. All the estimates are in percentage terms. Year dummies and month dummies are included in all specifications to control for possible calendar effects. Model (1) uses the embedded capital gains calculated based on the past 18-month price change for the prior month, model (2) uses the embedded capital gains calculated based on the past 3-year price change for the prior month, and model (3) uses 5-year stock price change.

		Holding period = 18 ms.		Holding period = 3 yrs.		Holding period = 5 yrs.	
Variables	Predicted signs	Estimate	*p* value	Estimate	*p* value	Estimate	*p* value
WK_C	+	6.387	(0.0001)	5.714	(0.0001)	5.622	(0.0001)
WK_L	−	−1.978	(0.0001)	−1.296	(0.0019)	−1.039	(0.0074)
$WK_C * Div$	+	1.054	(0.0002)	1.276	(0.0001)	1.408	(0.0001)
$WK_L * Gains * TSO$	−	−2.659	(0.0233)	−0.479	(0.1073)	−0.125	(0.4476)
$WK_C * Gains * TSO$	+	0.034	(0.9774)	−1.357	(0.0112)	−0.794	(0.0047)
Beta_market		0.103	(0.0001)	0.092	(0.0007)	0.096	(0.0006)
Beta_momentum		0.075	(0.0126)	0.069	(0.0280)	0.080	(0.0123)
Div		−0.164	(0.0072)	−0.176	(0.0040)	−0.144	(0.0217)
TSO		0.014	(0.8374)	0.066	(0.2586)	0.071	(0.2195)
Gains		−0.124	(0.0452)	−0.011	(0.5950)	−0.022	(0.0151)
$WK_L * Gains$		2.698	(0.0010)	0.451	(0.1029)	0.136	(0.3338)
$WK_L * TSO$		1.785	(0.0119)	1.524	(0.0129)	1.082	(0.0661)
$Gains * TSO$		0.100	(0.2014)	−0.011	(0.6744)	0.010	(0.3463)
$WK_C * TSO$		−6.211	(0.0001)	−5.254	(0.0001)	−5.004	(0.0001)
$TSO * Div$		−0.190	(0.0228)	−0.196	(0.0200)	−0.237	(0.0064)
$WK_C * Gains$		0.488	(0.6382)	1.490	(0.0025)	0.790	(0.0018)
Loss		0.438	(0.1748)	0.307	(0.2632)	0.106	(0.6802)
$WK_C * Loss$		−1.682	(0.7385)	5.339	(0.2259)	3.963	(0.2851)
$WK_L * Loss$		−9.341	(0.0037)	−6.329	(0.0615)	−5.571	(0.0508)
$Loss * TSO$		−1.682	(0.7385)	−0.021	(0.9535)	0.203	(0.5627)
$WK_C * Loss * TSO$		0.100	(0.9880)	−5.426	(0.3497)	−3.382	(0.4837)
$WK_L * Loss * TSO$		6.251	(0.1276)	5.444	(0.2007)	3.978	(0.2790)
Size		−0.039	(0.0001)	−0.032	(0.0001)	−0.029	(0.0001)
Sample size		404,544		415,153		412,730	
−2 residual log likelihood		−1,028,842		−1,056,227		−1,051,751	

Table VI
Robustness Check: Controlling for Turnover

This table reports the results of the robustness checks of the regressions based on equations (1) and (2), which test the joint effects of tax capitalization and lock-in on stock returns, controlling for turnover. See Table I for variable definitions. The dependent variable is the weekly stock return, *Wret*. All the estimates are in percentage terms. Year dummies and month dummies are included in all specifications to control for possible calendar effects.

		Positive gains firms		All firms	
Variables	Predicted signs	Estimate	p value	Estimate	p value
WK_C	+	5.774	(0.0001)	6.215	(0.0001)
WK_L	−	−1.801	(0.0001)	−1.817	(0.0001)
$WK_C * Div$	+	1.169	(0.0002)	1.056	(0.0002)
$WK_L * Gains * TSO$	−	−1.542	(0.0113)	−1.500	(0.0130)
$WK_C * Gains * TSO$	+	−0.421	(0.6431)	−0.178	(0.8432)
Beta_market		0.189	(0.0001)	0.186	(0.0001)
Beta_momentum		0.117	(0.0018)	0.118	(0.0002)
Div		0.000	(0.9972)	−0.056	(0.3808)
TSO		0.177	(0.0149)	0.023	(0.7191)
Gains		−0.064	(0.2361)	−0.030	(0.5453)
$WK_L * Gains$		1.313	(0.0042)	1.279	(0.0047)
$WK_L * TSO$		2.175	(0.0018)	2.136	(0.0013)
$Gains * TSO$		0.052	(0.4056)	0.026	(0.6572)
$WK_C * TSO$		−5.665	(0.0001)	−6.247	(0.0001)
$TSO * Div$		−0.365	(0.0002)	−0.288	(0.0009)
$WK_C * Gains$		1.115	(0.1166)	0.955	(0.1699)
Loss				0.423	(0.1679)
$WK_C * Loss$				1.317	(0.8214)
$WK_L * Loss$				−10.94	(0.0033)
$Loss * TSO$				−0.091	(0.8253)
$WK_C * Loss * TSO$				−2.892	(0.7049)
$WK_L * Loss * TSO$				10.35	(0.0302)
Turnover		−1.095	(0.0001)	−1.210	(0.0001)
Size		−0.018	(0.0194)	−0.032	(0.0001)
Sample size		273,004		415,164	
−2 residual log likelihood		−770,429		−1,056,495	

$WK_C * Div$ can be attributed to the fact that the market return and the momentum factor are themselves affected by the tax cut event. Indeed, our regression results discussed earlier consistently show that stock returns across the broad market are higher during the capitalization week. This implies that the market return itself is higher during the capitalization week. Therefore, given that individual firms have positive exposure to the market returns on average, when we remove the systematic component associated with the market returns we effectively reduce the price run-up in the adjusted returns. One could argue that because the market returns and the momentum factors are also affected by the capital gains tax cut event, to examine the overall effect on individual stock returns, it is important not to remove the systematic components associated

Table VII

Robustness Check: With Market- and Momentum-Adjusted Returns

This table reports the results of the robustness checks of the regressions based on equations (1) and (2), which test the joint effects of tax capitalization and lock-in on stock returns, controlling for market- and momentum-adjusted returns. See Table I for variable definitions. The dependent variable is *Adjret*, the weekly stock return after removing the systematic components associated with the market return and the momentum factor. All the estimates are in percentage terms. Year dummies and month dummies are included in all specifications to control for possible calendar effects.

		Positive gains firms		All firms	
Variables	Predicted signs	Estimate	p value	Estimate	p value
WK_C	+	2.598	(0.0019)	3.049	(0.0003)
WK_L	−	−3.058	(0.0002)	−3.157	(0.0001)
$WK_C * Div$	+	0.176	(0.5835)	0.100	(0.7217)
$WK_L * Gains * TSO$	−	−2.056	(0.0317)	−2.067	(0.0262)
$WK_C * Gains * TSO$		0.114	(0.9304)	0.357	(0.7800)
Div		0.099	(0.4223)	0.023	(0.8242)
TSO		0.419	(0.0001)	0.276	(0.0001)
$Gains$		−0.094	(0.4019)	−0.058	(0.5551)
$WK_L * Gains$		1.821	(0.0228)	1.830	(0.0180)
$WK_L * TSO$		3.587	(0.0008)	3.626	(0.0003)
$Gains * TSO$		0.054	(0.6656)	0.023	(0.8387)
$WK_C * Gains$		0.272	(0.8100)	0.078	(0.9431)
$WK_C * TSO$		−2.989	(0.0059)	−3.559	(0.0011)
$TSO * Div$		−0.620	(0.0001)	−0.534	(0.0001)
$Loss$				0.649	(0.1500)
$WK_C * Loss$				9.107	(0.2804)
$WK_L * Loss$				−15.42	(0.0058)
$Loss * TSO$				−0.159	(0.7754)
$WK_C * Loss * TSO$				−9.536	(0.3541)
$WK_L * Loss * TSO$				15.12	(0.0236)
$Size$		−0.032	(0.0001)	−0.054	(0.0001)
Sample size		273,004		415,129	
−2 residual log likelihood		−785,193		−1,070,665	

with these factors. From that perspective, Tables III and IV show the complete effects of a capital gains tax cut on stock returns.

E. Trading Volume Tests for Joint Tax Capitalization and Lock-in Effects

Next, we test the impact of the tax cut on trading volume. Table VIII shows the results of the regression analysis for firms with positive embedded gains only and for all firms using trading volume in shares and in dollar amount. Consistent with our predictions, the capitalization week and the lock-in week exhibit higher trading volume in terms of both logarithmic shares and logarithmic dollar amount. The effect is highly statistically significant with a p value of less than 1%. The estimated coefficient for the capitalization week is consistently above 2%. Specifically, when the trading volume is measured by

Table VIII
Volume Tests for Tax Capitalization and Lock-In

This table tests the joint effects of tax capitalization and lock-in on trading volume. See Table I for variable definitions. The dependent variable is percentage excess trading volume either measured in logarithmic shares (1) or logarithmic dollar volume (2). All the estimates are in percentage terms. Year dummies and month dummies are included in all specifications to control for possible calendar effects.

Variables	Predicted signs	Positive gains firms		All firms	
		Volume (1)	$volume (2)	Volume (1)	$volume (2)
WK_C	+	2.360	2.089	2.524	2.215
		(0.0001)	(0.0001)	(0.0001)	(0.0001)
WK_L	+	0.672	0.617	0.543	0.488
		(0.0004)	(0.0001)	(0.0013)	(0.0008)
$WK_C * Div$	+	−0.353	−0.347	−0.566	−0.484
		(0.2479)	(0.1696)	(0.0451)	(0.0404)
$WK_L * Gains * TSO$	+	0.092	0.120	0.131	0.169
		(0.6313)	(0.4902)	(0.4761)	(0.3213)
$WK_C * Gains * TSO$		0.205	0.191	0.186	0.172
		(0.3137)	(0.3023)	(0.3391)	(0.3323)
$Gains * TSO$				−0.056	−0.048
				(0.0129)	(0.0139)
$WK_C * Loss * TSO$				0.314	0.047
				(0.7508)	(0.9587)
$WK_L * Loss * TSO$				−2.072	−1.909
				(0.0151)	(0.0207)
$Loss * TSO$				−0.344	−0.168
				(0.0001)	(0.0030)
$Size$		−0.030	−0.027	−0.050	−0.045
		(0.0001)	(0.0001)	(0.0001)	(0.0001)
Sample size					
−2 residual log likelihood		−642,706	−725,441	−943,272	−1,053,043

logarithmic shares, the excess volume is about 2.4–2.5% higher for both the positive gains subsample and the full sample than average trading volume for the capitalization week. The excess trading volume is about 2.1–2.2% higher than average trading volume for the capitalization week when measured by logarithmic dollar amount. The estimated coefficient on WK_L suggests that trading volume is about 0.5–0.7% higher for the lock-in week than the average trading volume when measured by logarithmic shares. The increase in trading volume is slightly smaller at about 0.5–0.6% based on the logarithmic dollar amount. The finding holds for both the positive gains subsample and the full sample.

The coefficient estimate for the interaction term $WK_C * Div$ is statistically insignificant at the 5% p value level for the positive gains subsample and negative and marginally significant for the full sample. The estimated coefficient on the interaction term $WK_L * Gains * TSO$ is positive for both measures of trading volume, consistent with our predictions, but is statistically insignificant.

The interaction term, $WK_C * Gains * TSO$, has an insignificant effect on trading volume for both the positive gains subsample and the all-firm full sample. This is consistent with our finding on the return tests of the seller's strike. As in the return tests, we incorporate two additional interaction terms, $WK_C * Loss * TSO$ and $WK_L * Loss * TSO$, in the regression with all firms. As we discussed in the return tests with loss firms, investors may sell shares with embedded capital losses before the tax cut to benefit from the higher tax rebate under the higher tax rate. Therefore, the coefficient on $WK_C * Loss * TSO$ will likely be negative because $Loss < 0$. After the tax cut becomes effective, because there is no lock-in effect on firms with embedded capital losses, the capitalization effect is likely to increase the demand and the coefficient on $WK_L * Loss * TSO$ will also likely be negative. The estimated coefficient on $WK_L * Loss * TSO$ has the predicted sign and is statistically significant at the 2% level for both measures of trading volume. The estimated coefficient on $WK_C * Loss * TSO$ is statistically insignificant at conventional test levels. Annual and monthly dummies are all statistically significant as in the return tests.

Our findings on the effect of a capital gains tax cut on trading volume are generally consistent with those in a recent paper by Ayers, Li, and Robinson (2006). Ayers et al. (2006) examine buy and sell order flow around the Taxpayer Relief Act of 1997 and find evidence of both a capitalization and lock-in effect, with the capitalization effect being stronger than the lock-in effect. Our findings are also consistent with the results reported in Blouin et al. (2003). Using announcements of quarterly earnings and additions to the Standard and Poors 500 index as their events, they document that trading volume falls with the incremental taxes saved by deferring the sale of appreciated assets. Here, as the capital gains tax is reduced, the incremental taxes saved will decrease. This will lead to an increase in trading volume. In other words, in their case a holding period incentive causes current shareholders to postpone the sale of shares, which shifts supply to the left, whereas in our setting current shareholders sell some stocks with embedded gains to rebalance their portfolios, leading to the supply curve shifting to the right.

IV. Conclusions

We analyze the effect of capital gains taxes on returns and trading volume using an equilibrium approach that incorporates both the capitalization effect and the lock-in effect. Extant studies separately test the capitalization effect and the lock-in effect. To the best of our knowledge, this is the first study to jointly model and test both effects. Our analysis predicts that in the presence of capital gains taxes, the net effect on asset prices is ambiguous. If the capitalization effect dominates (is dominated by) the lock-in effect, stock prices will decrease (increase). The relative strength of the capitalization effect and the lock-in effect depends on the time period surrounding a tax rate change and firm characteristics such as dividend policy, growth potential, and the percentage of tax-sensitive individual ownership. The number of shares actively traded increases (decreases) as the capital gains tax rate decreases (increases).

We empirically test our predictions using weekly returns and trading volume from January 1, 1995, to December 31, 1997, focusing on the 1997 capital gains tax rate cut. Consistent with our predictions, we find evidence of both the capitalization and the lock-in effects. In particular, the capitalization effect dominates the lock-in effect the week between news of the rate reduction and its effective date (April 30, 1997, to May 6, 1997), reflecting anticipation of the proposed tax cut making it into law. Weekly stock returns during the capitalization week are 5–8% higher than average weekly returns. Moreover, nondividend-paying stocks have higher stock returns during the capitalization week (about 1.2%) than dividend-paying stocks.

In contrast, the lock-in effect dominates the capitalization effect during the first week after the rate reduction becomes effective (May 7, 1997, to May 13, 1997). The weekly stock returns are 1–3% lower during the lock-in week on average. Stocks with large embedded capital gains and a high percentage of individual investor and mutual fund ownership experience lower returns on average during the lock-in week. A 1 standard deviation increase in the 2-year embedded capital gains leads to 2.4% lower weekly returns during the lock-in week for firms with average percentage of individual investor and mutual fund ownership.

Stocks experience higher trading volume during the week immediately before and after the tax cut becomes effective. The results are robust for measures of volume in terms of both shares and dollar amounts.

This paper joins an emerging literature in financial economics (see Reese (1998), Guenther and Willenborg (1999), Poterba and Weisbenner (2001), and Klein (2001), among others) in providing evidence that personal capital gains taxes affect equity trading. Together, these papers challenge a common assumption in financial economics that shareholder taxes are irrelevant in pricing stocks. Although the inferences that can be drawn from these papers are limited to the settings that they examine, their findings call for additional research to examine whether equity prices vary as shareholder taxes change and with the mix of taxable and nontaxable shareholders.

Appendix: A Simple Model of the Effect on Stock Price of Capital Gains Tax

Investors in the economy trade multiple stocks indexed by i. To facilitate our exposition, we introduce the following notations. Let P_{it} be the time t *market price* of stock i, D_{it} be the dividend distributed in period t on stock i, B_{it} be the time t tax basis of the *investor* who currently owns stock i, τ_g be the capital gains tax rate, and τ_d be the dividend tax rate. We denote P_{it}^D as the *price buyers are willing to pay* for a share of stock i at time t and P_{it}^S as the *price sellers are willing to accept* for a share of stock i at time t. Thus, P_{it}^D and P_{it}^S represent the demand and supply curves at time t, respectively.

As in Section I, we assume that the demand curve for the stock is downward-sloping, while the supply curve for the stock is upward-sloping. Furthermore,

we assume that investors' demand for the stock is determined by the expected payoff of investing in the stock, and the supply is determined by investors' reservation value of the stock and the immediate tax cost on selling.

The demand curve for the stock can then be represented as follows:

$$P_{it}^{D} = E_t\left[\frac{P_{it+1} + D_{it+1}(1-\tau_d) - G_{it+1}\tau_g}{1+r_i}\right], \tag{A1}$$

where r_i is the discount rate applied to the cash flow of stock i and G_{it+1} represents investors' anticipated capital gain realization. We assume that the anticipated capital gain realization takes the form

$$G_{it+1} = \alpha_i(P_{it+1} - P_{it}), \tag{A2}$$

where $\alpha_i \in (0, 1]$. This specification takes into account the fact that investors who purchase the shares have to pay the market price, which serves as the basis for computing buyers' capital gains tax liabilities when they sell in the following period.[10] Moreover, parameter α_i is used to allow investors to use tax-efficient trading strategies to reduce their realized capital gains.[11]

To characterize the supply curve, we assume that sellers' reservation value of the stock (excluding the tax cost) is a fraction of the stock's current market price to simplify the derivation. Specifically, a typical tax-sensitive shareholder with embedded capital gains who contemplates selling will require a price high enough to compensate him for his reservation value and tax liability. This implies

$$P_{it}^{S} = \rho_i P_{it} + (P_{it} - B_{it})\tau_g, \tag{A3}$$

where $\rho_i P_{it}$ represents the seller's net-of-tax reservation value for a share of stock i and $(P_{it} - B_{it})\tau_g$ is the seller's capital gains tax. We assume that the seller's net-of-tax reservation value is less than the market price ($0 < \rho_i \leq 1$) because the tax burden is borne by both sellers and buyers in equilibrium.[12]

In equilibrium, the demand for a company's shares equals the supply of the shares, and the price paid by the buyer equals the price received by the seller (including taxes), that is,

$$P_{it}^{D} = P_{it}^{S}. \tag{A4}$$

Substituting (A2) into (A1) and using the market-clearing condition (A4), we arrive at the following equilibrium price for stock i in the presence of taxes:

$$P_{it} = E_t\left[\frac{P_{it+1}(1-\alpha_i\tau_g) + D_{it+1}(1-\tau_d) + (1+r_i)\tau_g B_{it}}{(1+r_i)(\rho_i+\tau_g) - \alpha_i\tau_g}\right]. \tag{A5}$$

[10] This will be the case if the investor uses the last-in and first-out (LIFO) rule in calculating his tax liability.

[11] This also allows sellers to have a tax basis different from the current price.

[12] $\rho_i = 1$ only when the capital gains tax rate is zero.

Rewriting equation (A5) recursively, we obtain the price of stock i at time t as follows:

$$P_{it} = E_t \left[\sum_{j=t+1}^{\infty} \left(\frac{1-\alpha_i \tau_g}{(1+r_i)(\rho_i+\tau_g)-\alpha_i \tau_g} \right)^{j-1} \frac{D_{ij}(1-\tau_d)+(1+r_i)\tau_g B_{ij-1}}{(1+r_i)(\rho_i+\tau_g)-\alpha_i \tau_g} \right]. \tag{A6}$$

Assuming that the dividend D_{ij} grows at a constant rate d_i and the tax basis B_{ij} grows at rate b_i, we have the following simplified expression for the price of stock i at time t:

$$\begin{aligned} P_{it} = & \frac{D_{it+1}(1-\tau_d)}{[(1+r_i)\rho_i - d_i] + (1+r_i-\alpha_i+\alpha_i d_i)\tau_g} \\ & + \frac{(1+r_i)\tau_g B_{it}}{[(1+r_i)\rho_i - b_i] + (1+r_i-\alpha_i+\alpha_i b_i)\tau_g}. \end{aligned} \tag{A7}$$

Denote the first term in equation (A7) as X_i and the second term as Y_i. Taking the first derivative of X_i and Y_i with respect to τ_g yields

$$\frac{\partial X_i}{\partial \tau_g} = -\frac{(1+r_i-\alpha_i+\alpha_i d_i)}{[(1+r_i)\rho_i - d_i + (1+r_i-\alpha_i+\alpha_i d_i)\tau_g]^2} D_{it+1}(1-\tau_d), \tag{A8}$$

$$\frac{\partial Y_i}{\partial \tau_g} = \frac{(1+r_i)\rho_i - b_i}{[(1+r_i)\rho_i - b_i + (1+r_i-\alpha_i+\alpha_i b_i)\tau_g]^2} (1+r_i) B_{it}. \tag{A9}$$

Equation (A8) is unambiguously negative. We call this effect the capitalization effect of the capital gains tax because the term X includes dividend and dividend growth, which concern a potential buyer. Furthermore, the cross-derivative of $\frac{\partial X_i}{\partial \tau_g}$ with respect to dividend growth d_i, $\frac{\partial^2 X_i}{\partial \tau_g \partial d_i}$, is also negative. Hence, the magnitude of the capitalization effect becomes larger as the dividend growth rate of a company (d_i) increases and the dividend tax rate (τ_d) decreases. This implies that in the event of a tax cut, growth stocks will experience a larger price increase than income stocks.

The sign of equation (A9) depends on the size of the investors' embedded capital gains over time. We have a positive lock-in effect if the following condition holds:

$$\frac{(1+r_i)\rho_i}{b_i} > 1. \tag{A10}$$

The above inequality suggests that the lock-in effect depends positively on stock i's discount (or capitalization) rate and the investor's net-of-tax reservation price but is inversely related to the rate at which the investor's tax basis grows. If we interpret the capitalization rate as the average appreciation rate

of the stock price, then the left-hand side measures the size of embedded capital gains. If the appreciation rate is high and the investor demands a high reservation price relative to the tax basis growth rate, the embedded capital gains are large and inequality (A10) will be satisfied. In this case, there is a positive lock-in effect. However, if the appreciation rate is low and the investors demand a very low reservation price relative to the tax basis growth rate, the investors will have little embedded capital gains or even a capital loss and there will be no lock-in effect. To empirically identify a dominant lock-in effect, we need to focus on stocks with large embedded capital gains for tax-sensitive investors.

The combined effect of capital gains taxes on stock prices is given by

$$\frac{\partial P_{it}}{\partial \tau_g} = \frac{\partial X_i}{\partial \tau_g} + \frac{\partial Y_i}{\partial \tau_g}. \tag{A11}$$

Overall, because the capitalization effect ($\partial X_i/\partial \tau_g < 0$) and the lock-in effect ($\partial Y_i/\partial \tau_g > 0$) work in opposite directions, the net effect of capital gains taxes on stock prices is ambiguous. If the capitalization effect dominates, the net effect of capital gains taxes on stock prices is negative; if the lock-in effect dominates, the net effect of capital gains taxes positive.

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