Tax-Motivated Trading by Individual Investors[†]

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Abstract

We study the stock trades of a large number of individual investors to investigate how tax incentives affect the realization of capital gains and losses. We compare investors' realization behavior in their taxable and tax-deferred accounts, and thereby identify the effect of taxes on trading decisions. We reach four conclusions. First, we find clear evidence of a lock-in effect for capital gains in taxable accounts relative to tax-deferred accounts. We find evidence of the "disposition effect," the tendency for investors to hold losses and sell gains, in both types of accounts and especially at short holding periods. The lock-in effect is stronger for large stock transactions than for small ones. Second, we find tax-loss selling throughout the calendar year, though it is most pronounced in December. Tax loss trading is more pronounced among investors who have realized capital gains elsewhere in the portfolio during the year. Third, we observe substantial heterogeneity in individual investors' propensity to trade. Controlling for this heterogeneity, however, does not alter the relation between a stock's past performance and the realization decision. Finally, we find that relatively few investors repurchase stocks that they have sold at a loss, even after the 30-day "wash sale" holding period has expired.

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The realization-based capital gains tax in the United States presents investors with important opportunities for tax management. Constantinides (1984) demonstrates that the optimal strategy for taxable investors is to realize losses while deferring the realization of capital gains. Many other studies, such as Ritter (1988), Poterba and Weisbenner (2001), and Grinblatt and Moskowitz (2004), note that taxpayers with accrued capital losses have an incentive to realize these losses before the end of the tax year and thereby to reduce their income tax liability. Such year-end tax-loss selling is often cited as a contributory factor in the unusual behavior of stock returns in late December and early January.

While there is no general theory of why investors trade assets, a number of recent empirical studies, notably Odean (1998), Barber and Odean (2000, 2001, 2004) and Grinblatt and Keloharju (2001), have shown that asset and household characteristics are related to trading probabilities. These studies raise questions about whether investor behavior accords with the predictions of simple models of tax-efficient behavior in a world of serially uncorrelated asset returns. Rather than realizing losses and deferring gains, investors appear to be more likely to realize gains than to realize losses. Shefrin and Statman (1985) labeled this phenomenon the "disposition effect." They attributed it to investor unwillingness to dispose of assets that had declined in value, thereby admitting to themselves and others that their investment insight had failed, and to investor willingness to sell appreciated assets, thereby avoiding the regret associated with watching a one-time winning investment turn into a loss. This hypothesis about behavior, which derives from Kahnemann and Tversky's (1979) discussion of prospect theory, represents an important tenet of the emerging field of behavioral finance. Recent work on the disposition effect, such as Strobl (2003), has begun to explore optimal asset trading rules if asset returns exhibit serial dependence, to see whether observed patterns may be consistent with tax-efficient investor behavior.

The finding that many investors sell appreciated securities, rather than securities with losses, stands in contrast to a number of studies in public finance that suggest that capital gain realizations are inversely related to the capital gains tax rate. This literature, started by Feldstein, Slemrod, and Yitzhaki (1980) and surveyed in Poterba (2002), relies on data from individual tax returns. Tax returns track the outcome of investor trades, but they contain no information on taxpayer portfolios and consequently on the set of assets that a taxpayer could have traded. This makes it difficult to investigate how taxation or other factors affect the decision to realize gains or losses within a portfolio. The findings in this literature are not necessarily inconsistent with evidence of a disposition effect. Taxpayers facing higher marginal tax rates on realized gains may realize fewer gains than taxpayers with lower tax rates, even if both sets of taxpayers are realizing gains with

higher probability than losses. Nevertheless, the tax return findings suggest that at least some taxpayers are responsive to tax considerations. Studies that find a disposition effect are often interpreted as contradicting the importance of tax-motivated trading.

In this paper, we use a detailed data set on the investments made by a sample of individual investors at a large discount brokerage house in the United States between 1991 to 1996 to investigate several issues related to capital gains taxation and investor behavior. We evaluate tax-induced lock-in effects by comparing trading behavior in taxable and tax-deferred accounts. We provide new evidence on the determinants of end-of-year tax-loss trading. We also investigate whether "wash sale" restrictions that prevent investors from claiming tax losses if they repurchase a security within thirty days of realizing a loss have a detectable impact on portfolio decisions.

Because we observe many stock purchases by the same investor, we can allow for individual heterogeneity in asset realization rates, while also controlling for the effects of asset returns, turn-of-the-year effects, and other factors that may affect stock trading. The ability to control for investor heterogeneity in our econometric modeling allows us to test whether the relation between stock sales and past performance simply reflects differences across investors, with some investors both selling more than others and earning on average higher returns, or whether it reflects behavioral differences for most investors associated with asset returns.

A central focus of our analysis is the comparison of trading behavior in taxable and tax-deferred accounts. Since we observe many individuals with stock investments in both settings, we can control for individual heterogeneity in trading propensities and focus on how the tax differences between these accounts affects behavior. The disposition effect predicts a positive correlation between realization probabilities and past returns, while tax considerations predict a negative correlation. Under the assumption that the disposition effect has the same impact on investments held in taxable and tax-deferred accounts, comparing the trading probabilities in the two provides a means to identify the magnitude of tax-motivated trading. The disposition effect should be evident in trading behavior in both taxable and tax-deferred accounts, but the effect of taxation on trading decisions should only emerge in taxable accounts.

Our results suggest that for stock purchases worth at least $10,000, the probability of selling appreciated stock in taxable accounts falls below the probability for similar stocks in tax-deferred accounts, particularly after the stock has been held for a few months. For example, a capital gain of 25% is associated with a 22% increase in the monthly hazard rate of selling stock in a taxable account during the first six months after purchase, compared with a 28% increase in tax-deferred accounts. Conditional on having held the stock for one year, a 25% capital gain is

associated with a 6% reduction in monthly hazard rates in a taxable account, while there is no correlation between past gains and selling probabilities in tax-deferred accounts. Conditional on being held a year, the probability that a stock with an accrued capital gain is sold within five years of purchase is 16 percentage points lower if the stock is in a taxable account than if it is in a tax-deferred account. Investors are particularly reluctant to sell stocks with gains in taxable accounts relative to tax-deferred accounts during the month of December. This is consistent with trying to postpone tax liabilities into the next tax year.

We confirm the findings of Odean (1998), Barber and Odean (2004), and many others, who show that individual investors are more apt to sell losers than winners in taxable accounts in December. Unlike most previous studies, however, we consider how holding period differences as well as investor attributes affect loss realization. We reach three novel conclusions. First, December tax-loss selling is particularly strong for stocks that qualify for short-term loss treatment and hence generate larger tax savings for investors. The realization of short-term losses in December increased when the differential between short-term and long-term capital gains tax rates increased in the 1993 Omnibus Budget Reconciliation Act. Second, tax-loss selling increases when the overall market is doing well or when the investor has realized gains, and thus the demand for loss offsets is likely to be high. This suggests that investors try to realize tax losses when they have accumulated taxable gains. Third, by comparing realizations in taxable and tax-deferred accounts we find evidence of tax-loss selling in all months, though the effect is less pronounced than that in December. For example, a 25% loss is associated with an 11% higher monthly realization probability in a taxable account, relative to tax-deferred account, in months other than December, and for an 81% higher realization probability in December. Finally, we find that the probability that a stock will be repurchased within thirty days, if it is sold at a loss in December, is lower than the probability of such a repurchase following sales in other months. This pattern is consistent with wash-sale rules affecting individual investors' trading activity, particularly in December.

The paper is divided into five sections. The first describes our data set and presents summary information on trading probabilities and holding periods for common stocks. Section two presents empirical evidence on the probability of selling individual stocks as a function of holding period return and calendar month. The third section examines the role of wash sale restrictions and presents modest evidence that these restrictions affect investor behavior. Section four examines the implications of our findings for the distribution of holding periods for stock purchases, and for effective capital gains tax rates. There is a brief conclusion.

I. Data Description and Summary

We analyze a data set, obtained from a large discount brokerage house, of individual investors' monthly positions and trades over a six-year period from 1991 to 1996. It covers all the investments 78,000 households made through the brokerage house, ranging from common stocks, mutual funds, government and corporate bonds, foreign securities, to derivatives. Each household has at least one account, but some have many. The maximum is twenty-one and the median is two. Nearly 30,000 households have both taxable accounts and tax-deferred accounts, which are either IRAs or Keogh plans. The data set does not cover tax-deferred accounts provided through work such as 401(k)-type plans. For a detailed description of the data set see Barber and Odean (2000).

We focus on trades of common stocks. These investments constitute nearly two thirds of the total value of household investments in the sample. We use the Center for Research in Security Prices (CRSP) database to obtain information on stock returns. We are particularly interested in stock trades made by the households that had both taxable and tax-deferred accounts. This sample criterion ensures that any differences in trading activity between taxable and tax-deferred accounts will not be driven by differences in the type of investors in taxable and tax-deferred accounts, as–by construction they are the same in our sample. Of all such stock trades, we considered all purchases that did not have matching sales in the sample period, as well as the purchases and the sales that we could match unambiguously. Examples of trades that we could not match unambiguously include sales that do not have a preceding purchase by the same household earlier during the sample period, as well as sales that are preceded by multiple purchases. When multiple sales follow a single purchase, we include only the first sale in our data sample. For example, if an investor bought 1,000 shares of Microsoft in June 1991, and sold 500 shares in January 1993, we would treat this as a sale of the stock position. This means that our analysis may understate the actual holding period for some common stock investments. However, the circumstances described in the example are unusual: ninety-three percent of the sales in our sample liquidate the investor's full position.

A. Summary Statistics

Table 1 presents summary information on the number of stock purchases, stock sales, and the dollar values of such trades for different years in our sample. Applying the criteria outlined above resulted in 414,047 purchases during the sample period, representing 23,877 different households. We often restrict the sample to the 97,266 stock purchases of $10,000 or more. These represent 23 percent of all purchases, but nearly two-thirds of the dollar-weighted purchases. Just below three-fifths of all stock purchases, and two thirds of those valued at more than $10,000, were executed in

taxable accounts, with the balance executed in tax-deferred accounts. Fifty-two percent of all purchases, and 60 percent on a value-weighted basis, were followed by sales before the end of our sample on November 30, 1996.

We focus on the interaction between holding period, accrued gain or loss, and the sale probability for each stock position. Our approach differs from Odean's (1998) focus on the "proportion of gains realized" and the "proportion of losses realized" in various calendar months. These proportions aggregate positions held for many different holding periods and are thus not suited to address holding period dependence in the disposition effect. Our richer empirical framework allows for interactions between holding period returns, calendar months, and tax status.

One of the potential concerns about this data set is that it may be unrepresentative of the broader individual investor population because a low-cost discount broker might attract high-trading investors. The IRS periodically publishes the distribution of the holding period of sales of corporate stock reported on individual tax returns. Specifically, Auten and Wilson (1999) and Wilson (2002, 2003) report Sales of Capital Assets (SOCA) data for 1985, 1997, 1998, and 1999. IRS data on the realization of all capital gains and losses on corporate stock in taxable accounts enable us to make some comparisons with realization patterns in this data set.

Table 2 presents summary statistics based on the IRS data and our data set, and finds substantial agreement between the two. Specifically, the left section of Panel A in Table 2 reports the distribution of stock sales by holding period, focusing on stock held at most four years, for the four years the IRS has made SOCA data available. The reported holding periods of stocks sold display a high concentration of short-term trades. The IRS data show that the percentage of stocks sold that has been held one month or less has increased steadily over the period, rising from 14% in 1985 to 21% in 1997 to 35% in 1999. Similarly, the fraction of stock sold with a holding period of one to four years has fallen from 47% in 1985 to 29% in 1997 to 23% in 1999.

To compare the IRS data with our brokerage house data, we focus on stock sales during 1995, the last full year in our sample. We focus on sales in 1995 that we can link back to the original purchase. Since the data set starts in 1991, that means we can trace back sales to their original purchase as long as the holding period is at most four years. The right section of Panel A in Table 2 reports the distribution of stock sales by holding period, again focusing on stocks held at most four years, for sales in taxable accounts during 1995 in the brokerage house data. The most directly comparable published IRS data, both in terms of closeness in date as well as closeness in stock market environment, are the data for 1997. The return on S&P 500 was 38% in 1995 and 33% in 1997. The distributions of holding periods are remarkably similar. The percentage of stocks sold

with a holding period of one month or less is 21% in both data sets and the proportion of sales with a holding period of one to four years is remarkably close: 29% in the IRS data and 30% in the brokerage house data. The distribution of sales of stocks originally purchased for $10,000 or more, the sample of "large" purchases on which we will later focus attention, features more sales with shorter holding periods relative to sales with longer holding periods. This result foreshadows the stronger capital gain lock-in effect we will report for larger purchases.

Finally, Panel B of Table 2 reports the distribution of stock sales by both holding period and calendar month of the sale, disaggregated by whether the stock had a capital gain or capital loss when it was sold. The distributions for gains and losses reported on tax returns in 1997 are very similar to the respective distributions for gains and losses recorded in the brokerage house data in 1995. The percentage of sales in December is also similar in the two data sets. Indeed, 16.9% of realizations of losses occur in December in the brokerage house data, compared to 14.2% of loss realizations reported on tax returns, whereas December realizations of gains represent 6.6% and 8.4% of gain realizations, respectively. While the IRS data are useful for benchmarking how representative the trading activities of customers of the brokerage house are of the general individual investor, they cannot be used to study how the probability of realization depends on the stock's gain or loss. Any such analysis requires a data set like ours that records the timing of stock purchases as well as sales.

B. Graphical Summary of Holding Periods and Trading Probabilities

We begin our analysis of how stock appreciation or depreciation affects realization probabilities by calculating hazard functions for the probability of selling stock. Figure 1 reports the hazard rate—the probability of sale in a given month conditional on holding the stock until that point—for holding periods between one and 36 months. The figure is based on purchases during the month of January, because selecting a single month makes it easier to identify end-of-year effects (month 12) and other unusual patterns in turnover. The corresponding figure based on all purchases in all months is very similar to Figure 1. The figure shows the hazard rate for all stock purchases in taxable accounts (the dashed line), as well as the hazard for all stocks in taxable accounts that experienced a gain between their date of purchase and the beginning of the specified month (full black line), and all stocks that experienced a loss (full gray line). Turn-of-the-year trading is reflected in the hazard rate spikes in months 12, 24, and 36. The hazard rate for stock sale in the taxable account drops quickly in the first six months after the date of purchase. The hazard rate is fifteen percent during the first month, but it drops to less than five percent per month after six months and continues to decline at longer holding periods, falling to less than 2% per month after 18 months.

This pattern is observed both for stocks with gains and for stocks with losses. At most holding periods, the hazard rate for stocks with gains is higher than that for stocks with losses.

To facilitate the interpretation of this information on selling patterns, Figure 2a reports the cumulative probability that an investor who purchases stock in a taxable account will sell that stock by various holding periods. If h(t) denotes the hazard rate in month t, the probability that the stock is still held at the end of month t is $\Pi_{s=1,t}(1-h(s))$. The probability that the stock is sold in month t is $h(t)*\Pi_{s=1,t-1}(1-h(s))$. The cumulative probability of sale is calculated from the hazard function estimates for each month up to the given holding period. The two solid lines present sale probabilities calculated for all positions in the sample, while the two dashed lines correspond to the positions for which the investor's initial purchase was at least $10,000. We distinguish transactions involving a purchase of at least $10,000 on the grounds that wealthy investors may be more conscious of, and more affected by, tax considerations than more modest investors are. The tax consequences of a large trade are also larger than those associated with a small trade, just because the transaction size is larger.

Figure 2a suggests several conclusions. First, cumulative sale probabilities rise rapidly in the months just after purchase, but flatten out soon thereafter. By six months after purchase, roughly two-fifths of stocks have been sold, by one year after the date of purchase nearly one-half of all stocks have been sold, and by three years after purchase nearly two-thirds have been sold. This is indicative of the reduced likelihood of sale in a given month as the holding period increases. Feng and Seasholes (2004) discover a similar pattern in their analysis of trading hazards for a large sample of Chinese investors. Second, sale probabilities for stocks with gains are higher than the corresponding probabilities for stocks with losses, both in the entire sample and in the sample of large purchases. By one year after the date of purchase, the probability that the stock has been sold is more than 50 percent if the stock had a capital gain at the beginning of every month since the time of purchase. The probability is lower, 44 percent, if the stock had a loss at the beginning of every month since purchase. This confirms Odean's (1998) "disposition effect" findings. Finally, sale probabilities are marginally higher for the sample of large stock purchases than for the entire sample. At the twenty-four month horizon, the cumulative sale probability for a stock that never closed at a loss at the end of any month, and with an initial $10,000 purchase, is 69 percent, compared with 63 percent for the sample of all purchases.

If the realization-based capital gains tax discourages investors from selling appreciated securities and encourages them to realize losses, then we should see differences in the cumulative

sale probabilities between taxable and tax-deferred accounts for stock purchases with both subsequent gains and subsequent losses. To that end, Figure 2b reports the differences between cumulative sale probabilities for stocks held in different types of accounts. The solid black line is the differential cumulative sale probability for stocks that have had gains at the beginning of every month since the date of purchase and the dashed black line is the analogous plot for stock purchases of more than $10,000. For large stock purchases, the sale probability after two years is eight percent lower in taxable than in tax-deferred accounts, as capital gains tax "lock-in" would predict.

The solid gray line in Figure 2b, which corresponds to all purchases, and the dashed gray line, which corresponds to purchases in excess of $10,000, represent the differentials between the cumulative sale probabilities in taxable and tax-deferred accounts for stocks that had experienced losses at the beginning of each of the months since purchase. The probability of realizing losses is higher in taxable accounts than it is in tax-deferred accounts.

C. Hazard Rates as a Function of Gain and Loss

The hazard rates for holding period t shown in Figure 1 were estimated by regression analysis using the sample of all stocks purchased in January that were still being held t months after purchase. Each stock purchase is indexed by i, and the probability that position i is liquidated t months after purchase, conditional on not having been sold until that date, is the hazard rate. The hazard rates are estimated using a linear probability model of the form

$$(1) \qquad SELL_{i,t} = \alpha_t + \beta_{1,t}*I(GAIN)_{i,t-1} + \beta_{2,t}*I(LOSS)_{i,t-1} + \varepsilon_{i,t.}$$

In this equation $I(GAIN)_{i,t-1}$ and $I(LOSS)_{i,t-1}$ are indicator variables for stocks that have experienced an increase or decrease in price since the date of purchase, respectively, and $SELL_{i,t}$ is an indicator variable set to unity if stock position i is liquidated t months after it was purchased, and zero otherwise. If the gain and loss indicator variables are excluded from the regression, the coefficient α_t corresponds to the hazard rate for month t. In (1), however, α_t represents the hazard rate at holding period t for a stock that is still worth precisely the same amount as its purchase value. The hazard rate for selling a stock t months after purchase if the stock has a gain is $\alpha_t + \beta_{1,t}$, while the hazard rate for a stock with a loss is $\alpha_t + \beta_{2,t}$.

We compute the probability that a stock with a gain in all months since purchase will still be held after T months as $\Pi_{s=1,T}(1- \alpha_s - \beta_{1,s})$. This should be distinguished from the survival rate for all stocks that have gains, relative to the date of purchase, after T periods. The latter will differ from this calculation because some stocks with gains after T periods have experienced losses in some intervening months, but rebounded to a price level above the purchase price. Because we do not

observe stock returns for the initial month of purchase, we assign the unconditional probability of sale in month one to all positions when we compute the survival rate for appreciated and depreciated stocks.

Equation (1) allows separate hazard rates for appreciated and depreciated stocks, but it does not distinguish stocks based on the amount of gain or loss. Since larger gains and losses may have a more substantial impact on trading probabilities than small gains and losses, we also estimate a modified hazard model of the form:

$$(2) \qquad SELL_{i,t} = \alpha_t + \beta_{1,t} * GAIN_{i,t-1} + \beta_{2,t} * LOSS_{i,t-1} + \varepsilon_{i,t}$$

where $GAIN_{i,t-1} = \max(Return_{i,t-1}, 0)$, and $LOSS_{i,t-1} = \min(Return_{i,t-1}, 0)$. GAIN is non-negative and LOSS is non-positive, so a positive coefficient on GAIN raises the probability of stock sale, while a negative coefficient on LOSS does the same.

Table 3 reports coefficient estimates corresponding to equation (2) for the sample of large stock purchases, those worth at least $10,000. Each regression is estimated using the sample of stock positions that were not liquidated until at least the holding period indicated in the first column of the table. While Figure 1 presented estimates of equation (1), Figure 3a presents the information in Table 3 in a graphical format. We focus on a hypothetical stock that exhibits a gain of 25 percent at the end of every month since the date of purchase, and another hypothetical stock that exhibits a loss of 25 percent in an analogous manner. For assets held in taxable accounts, the disposition effect is particularly clear in the first few months after the date of purchase. In the second month of ownership, for example, the probability of sale for a stock with a 25 percent gain is five percentage points higher than the analogous probability for a stock that has experienced no change in value, which is shown by the leftmost black bar in Figure 3a. The sale probability for a stock with a 25 percent loss is 2.4 percent lower than that for a stock with no price change; this is shown by the leftmost white bar. By six months after the date of purchase, the differential sale probabilities that result from gains and losses are fairly small.

Figure 3b contrasts the sale probability for stocks with 25 percent gains, and 25 percent losses, in taxable and tax-deferred accounts. The likelihood of selling a position with an unrealized gain of 25 percent is greater in the tax-deferred than it is in the taxable account, particularly for short holding periods. Moreover, the probability of selling a position with a loss is higher in the taxable than it is in the tax-deferred account. Thus, while there is a positive correlation between returns and stock sales over holding periods less than a year, it is less positive in taxable than in tax-deferred accounts. This finding is consistent with the hypothesis that the capital gains tax liability triggered

by gain realization in taxable accounts reduces realizations in these accounts, but does not affect holdings in tax-deferred accounts.

II. Holding Periods, End-of-Year Selling, and Stock Sales

Previous research suggests that stock trading is not just a function of cumulative returns, but that it may also vary as a function of calendar month. In particular, Barber and Odean (2004) report that the proportion of gains realized and the proportion of losses realized in taxable and tax-deferred accounts are very similar in all months except December, when the ratio for taxable accounts drops dramatically while the ratio for tax-deferred accounts remains stable. Their findings suggest that tax-loss selling takes place in December, but their "proportion of gains realized" method is unable to disentangle the effects of asset price changes, holding period, and calendar month, which prevents estimation of the lock-in effect.

To disentangle the effects of calendar month, holding period, and embedded capital gains and losses on investor trading decisions, we estimate a variety of parametric and nonparametric hazard models for stock sales. Since the mean number of stock purchases for investors in our data set is seventeen, and since the median investor purchases nine stocks over the six-year sample, we are able to control for household heterogeneity in the propensity to sell stock. We can therefore investigate the robustness of our findings on lock-in and disposition effects with respect to various approaches to modeling household heterogeneity.

A. Cox Proportional Hazards Models with Nonparametric Baseline Hazards

We estimate a Cox proportional hazards model with GAIN, LOSS, and a range of indicator variables for the characteristics of the holding period as variables that shift the realization probability. The baseline hazard rate is estimated non-parametrically, following the methods of Han and Hausman (1990) and Meyer (1990). The proportional hazards specification assumes that the hazard function for the sale of stock purchase i, t months after the purchase, takes the form

$$h_i(t) = \gamma(t) * e^{X\beta_{i,t}} \tag{3}$$

where $\gamma(t)$ denotes the baseline hazard. We begin with a simple specification that focuses on the link between gains, losses, the end of the calendar year, and trading decisions:

$$\begin{aligned} X_{i,t}\beta = {} & \beta_1 * GAIN_{i,t-1} + \beta_2 * GAIN_{i,t-1} * December_{i,t} + \beta_3 * LOSS_{i,t-1} + \\ & \beta_4 * LOSS_{i,t-1} * December_{i,t} + \beta_5 * December_{i,t} + \varepsilon_{i,t}, \end{aligned} \tag{4}$$

We report hazard function estimates for the full sample of stock purchases, but we focus most of our analysis on the sample of purchases with an initial value of more than $10,000. The disposition effect predicts households will sell stocks with accrued gains and hold stocks with accrued losses. In specification (4), this implies that $\beta_1 > 0$ and $\beta_3 > 0$. Tax-motivated trading predicts exactly the opposite—households will hold stocks with accrued gains and sell stocks with accrued losses. In (4), this implies that $\beta_1 < 0$ and $\beta_3 < 0$. Further, a desire to postpone the realization of gains into the next tax year implies $\beta_2 < 0$, i.e., investors are less apt to realize gains in December, while a desire to capture tax losses in the current calendar year implies $\beta_4 < 0$, with investors are more apt to realize losses in December. Thus, positive coefficients on GAIN and LOSS are consistent with the disposition effect dominating trading decisions, while negative coefficients are consistent with tax motivations dominating.

We estimate hazard models for taxable accounts as well as models for all accounts with an indicator variable and interaction terms to test for statistical differences between behavior in taxable and tax-deferred accounts. In this case, the specification becomes:

$$
\begin{aligned}
(5) \qquad X_{i,t}\,\beta = {} & \beta_1 * GAIN_{i,t-1} + \beta_2 * GAIN_{i,t-1} * December_{i,t} + \beta_3 * LOSS_{i,t-1} + \\
& \beta_4 * LOSS_{i,t-1} * December_{i,t} + \beta_5 * December_{i,t} + \\
& \beta_6 * GAIN_{i,t-1} * TAX_i + \beta_7 * GAIN_{i,t-1} * December_{i,t} * TAX_i + \beta_8 * LOSS_{i,t-1} * TAX_i + \\
& \beta_9 * LOSS_{i,t-1} * December_{i,t} * TAX_i + \beta_{10} * December_{i,t} * TAX_i + \varepsilon_{i,t},
\end{aligned}
$$

where TAX_i is an indicator variable for stock position i being held in a taxable account. We allow separate baseline hazard rates for taxable and tax-deferred accounts. In this specification, the disposition effect should be reflected in the coefficients β_1 through β_5, while the coefficients on the variables interacted with TAX will reflect the importance of tax-motivated trading. To the extent that psychological motivations like the disposition effect are more pronounced in taxable relative to tax-deferred accounts, the interaction terms of TAX with GAIN and LOSS will understate the magnitude of tax-motivated trading. Whether such motivations are different in different accounts is unclear. Barber and Odean (2004) find a higher turnover rate in taxable accounts than in tax-deferred accounts, suggesting possible differences in the way investors view these accounts.

Table 4 presents our hazard function estimates of equations (4) and (5). The upper left panel analyzes our full sample of all transactions, while each of the other panels considers a subsample of transactions based on the size of the initial purchase. The lower right panel focuses on transactions with an initial purchase of at least $10,000. The findings for the full sample provide explicit

confirmation for many of the effects that we observed in Figure 1. In particular, the coefficient on LOSS for taxable accounts is positive, which implies that in most months a larger loss leads to a lower probability of gain realization. The coefficient for the interaction term LOSS*December, however, is strongly negative, indicating that a loss is more likely to be realized in December than in other months. The LOSS coefficient of 1.03 for the full sample implies that in non-December months the monthly hazard rate for a stock that has lost 25 percent of its value since the date of purchase is 23% lower than that for a stock with no price change; $e^{1.03*(-0.25)} - 1 = -0.23$. But, in December the stock with the accrued loss is 35 percent more likely to be sold than the stock with no price change; $e^{(1.03-2.23)*(-0.25)} - 1 = 0.35$. The coefficient on GAIN is positive for the sample of all transactions, but only one tenth as large as the LOSS coefficient for the sample of all purchases.

The estimates of specification (5) permit a comparison of the hazard model coefficients for taxable accounts and those for tax-deferred accounts. These estimates are presented in the second and third columns for each sub-panel in Table 4. The data for the full sample show a slightly higher probability of realizing gains in taxable than in tax-deferred accounts, and a substantially attenuated probability of holding on to losses. The LOSS*December interaction is substantially smaller in tax-deferred accounts than in taxable accounts. This suggests that tax considerations may explain a substantial part of the year-end trading patterns. Further, by comparing realizations in taxable and tax-deferred accounts we find evidence of tax-loss selling in all months, though the effect is strongest in December. For example, a 25 percent loss is associated with an 11 percent higher monthly hazard rate in taxable accounts relative to tax-deferred accounts in non-December months. i.e., $e^{-0.40*(-0.25)} - 1 = 0.11$, consistent with a desire to realize a tax deduction, while the comparable boost in December is 81 percent, i.e., $e^{(-0.40-1.97)*(-0.25)} - 1 = 0.81$. Controlling for returns, the coefficient on the December indicator variable suggests that the trading rate in taxable accounts is higher in December than it is in other months.

The results in the different sub-panels of Table 4 provide some indication of the sensitivity of the hazard model coefficients to conditioning the sample on initial stock purchase of different sizes. Two patterns stand out. First, the GAIN variable has a positive effect on sale probability for transactions of less than $10,000, but a negative but statistically insignificantly distinguishable from zero effect for transactions of more than $10,000. For gains in taxable accounts, the disposition effect seems to outweigh tax motivations for all transactions other than those in the greater than $10,000 category. We find evidence of a capital gains lock-in effect for purchases of more than $10,000. The GAIN coefficient estimate is–0.09 on the difference between taxable and tax-deferred accounts, and this effect is even stronger, -0.22, during the month of December. This suggests that

previous findings that suggest an important disposition effect may be driven by the behavior of small investors, rather than larger investors who may have more impact on market prices. Second, the LOSS coefficients are reasonably stable across positions of different sizes, but the LOSS*December effect is most pronounced for the transactions of more than $10,000. The coefficient on LOSS*December is -2.23 for the full sample, and -2.72 for the sample of large transactions. The difference between the LOSS*December effects in taxable and tax-deferred accounts is not this large, however, as there appears to be more "tax loss selling" in tax-deferred accounts associated with large stock purchases.

B. Investor- and Stock-Specific Heterogeneity

The results in Table 4 assume that underlying trading probabilities are described by a constant hazard rate that applies to all investors and to all stocks. The richness of our data set makes it possible to allow for a richer structure with respect to the underlying hazard rates, and to consider the possibility that different investors exhibit different underlying rates of stock turnover. In this case, we replace $\gamma(t)$ in specification (3) with investor-specific $\gamma_h(t)$ functions. Gonul and Srinivasan (1993) provide an example of how individual heterogeneity in hazard models can be studied with repeat-spell data. Relatively few economics data sets contain enough repeated observations to make it possible to estimate household-specific hazards.

Our data are also rich enough to allow us to estimate stock-specific baseline hazard rates. In this case, we replace the specification in (3) with

$$(3') \qquad h_{i,j}(t) = \gamma_j(t) * e^{Xi,\, t\, \beta}$$

where $h_{i,j}(t)$ denotes the hazard rate at holding period t for transaction i, which happens to be in stock j. The baseline hazard rate, $\gamma_j(t)$, is now stock-specific; the hazard rate for Cisco can differ from that for General Electric. It is even possible to allow for investor-specific stock-specific baselines that allow for both sources of heterogeneity. In that case, the specification becomes

$$(3'') \qquad h_{h,i,,j}(t) = \gamma_{h,j}(t) * e^{Xi,\, t\, \beta}$$

where $h_{h,i,,j}(t)$ represents the hazard rate for household h's holding of transaction i, which is in firm j. The test proposed by Grambsch and Therneau (1994), for the validity of the proportional hazards model across all variables, rejects the assumption of the same hazard function structure for all investors and for all firms at high confidence levels for tax-deferred accounts (p-value = 0.006) and

marginally for taxable accounts (p-value = 0.092). However, with either investor-specific or stock-specific nonparametric baseline hazards, the test no longer rejects the null hypothesis.

Table 5 presents our findings for different cases with regard to baseline heterogeneity. There are 19,616 distinct households in our sample, purchasing stock in 8,200 distinct companies. When we allow for investor-stock specific baselines, there are 187,193 distinct baselines, so the results are identified off repeat purchases in the same stock by the same investor. The results in Table 5 focus on the sample of trades with values of at least $10,000, so the upper left panel in Table 5, with homogenous baseline hazards, corresponds to the bottom right panel in Table 4. The upper right panel in Table 5 presents results that allow for investor-specific baseline hazards. The one substantial difference with the findings under the homogeneous baseline assumption is that the coefficient on GAIN is positive, as it was for the full sample. Allowing for investor specific baseline weakens the evidence of lock-in if we analyze only taxable accounts. When we focus on the difference between the GAIN effect in taxable and tax-deferred accounts, however, allowing for investor-specific baselines nearly triples the estimated effect, from -0.09 to -0.26. Thus the evidence of lock-in due to tax-related factors becomes much stronger in this case. This pattern continues when we allow for stock-specific baselines, in the lower left panel of Table 5, and for both stock- and investor-specific baselines, in the lower right panel. With both stock- and investor-specific baselines, the difference in the coefficients for taxable and tax-deferred accounts for LOSS and for the LOSS*December interaction are also much larger than for the homogeneous baseline hazard case.

The findings in Table 5 suggest that allowing for heterogeneity has an important effect on the substantive estimates of how taxes affect investor behavior, and that the usual homogeneity assumption attenuates the evidence for tax effects. Moreover, they imply that the correlation between the return performance of a stock and the probability of sale is not simply an artifact of correlated cross-sectional differences in investor acumen and investor trading behavior.

The results in Table 5 emphasize how allowing for heterogeneity in baseline hazards affects our coefficient estimates for GAIN, LOSS, and other variables. They do not convey a sense of the underlying heterogeneity in baseline realization rates. That can be illustrated by considering hazard rates at a given holding period, such as seven months. For that holding period, the interquartile range for the hazard rates when we allow for stock-specific baselines is from a 3.2 percent probability of sale to an 8.3 percent probability. When we allow for investor-specific baselines, the interquartile range is from 4.4 percent to 12.8 percent. These results suggest that there are some households with very low trading rates and other households with much higher rates. The stability of most of our

hazard model coefficients when we allow for baseline heterogeneity is striking in light of the variation in baseline hazard rates.

C. Allowing for Holding Period Effects

The LOSS and GAIN effects estimated so far are averages across all holding periods, yet we know that these effects may differ by holding period. For example, the GAIN effect might be positive shortly after purchase, as high returns induce traders to sell and lock in gains due to the disposition effect, while over the long-term, an investor may be reluctant to realize a sizeable gain as a result of the associated tax penalty. Previous research on loss realizations also suggests that whether losses are long-term or short-term can affect realization decisions. To explore this issue, we generalize equation (4) to allow both GAIN and LOSS effects to differ by holding period. This yields the specification

$$
\begin{aligned}
(6) \qquad X_{i,t}\beta = {} & \beta_1 * GAIN_{i,t-1} + \beta_2 * GAIN_{i,t-1} * (Month \leq 6)_{i,t} + \beta_3 * GAIN_{i,t-1} * (Month\ 7\text{-}12)_{i,t} + \\
& \beta_4 * GAIN_{i,t-1} * December_{i,t} + \beta_5 * GAIN_{i,t-1} * (Month \leq 6)_{i,t} * December_{i,t} + \\
& \beta_6 * GAIN_{i,t-1} * (Month\ 7\text{-}12)_{i,t} * December_{i,t} + \beta_7 * LOSS_{i,t-1} + \\
& \beta_8 * LOSS_{i,t-1} * (Month \leq 6)_{i,t} + \beta_9 * LOSS_{i,t-1} * (Month\ 7\text{-}12)_{i,t} + \\
& \beta_{10} * LOSS_{i,t-1} * December_{i,t} + \beta_{11} * LOSS_{i,t-1} * (Month \leq 6)_{i,t} * December_{i,t} + \\
& \beta_{12} * LOSS_{i,t-1} * (Month\ 7\text{-}12)_{i,t} * December_{i,t} + \beta_{13} * December_{i,t} + \\
& \beta_{14} * December_{i,t} * (Month \leq 6)_{i,t} * + \beta_{15} * December_{i,t} * (Month\ 7\text{-}12)_{i,t} + \varepsilon_{i,t},
\end{aligned}
$$

where variables such as "Month 7-12" are indicator variables that describe a holding period of between 7 and 12 months. This specification permits us to study both the timing of sales relative to the turn of the year and the timing relative to the expiration of the 12th month since purchase, the holding period that qualified for short-term tax status during our sample.

Table 6 reports estimates of equation (6), together with interaction effects between an indicator variable for taxable accounts and each of the variables in (6), along the lines of specification (5). The coefficients imply richer trading patterns based on gains and losses than the estimates in Table 4. Among taxable accounts (the first column of Table 6), for assets with accrued gains, larger gains result in higher sale probabilities in the first six months after acquisition of the asset. This effect is attenuated in the next six months of asset holding and, after twelve months, larger gains exert a <u>negative</u> effect on sale probabilities. Thus, controlling for holding period suggests that the disposition effect is concentrated among short-term holdings, while the capital gains tax lock-in effect prevails at longer holding periods. This finding is consistent with results reported

by Feng and Seasholes (2004), who study a large data base on transaction behavior of individual investors in China. The estimates in Table 6 imply that a capital gain of 25% is associated with a 22% increase in the monthly hazard rate of selling stock in a taxable account during the first six months after purchase, but, conditional on having held the stock for one year, a 25% capital gain is associated with a 6% reduction in monthly hazards rates.

The differential impact of gains on realization behavior over different holding periods suggests that Odean's (1998) disposition effect result is driven by high-frequency traders with short-term horizons. With respect to losses, the negative coefficient on LOSS*December is stronger if the stock was purchased within the prior six months, so that the loss would be treated as short-term under the income tax, than if the holding period is longer.

The second column of Table 6 reports estimates from the same specification pertaining to tax-deferred accounts. The positive effect of GAIN on realization rates at short holding periods is more pronounced in tax-deferred than it is in taxable accounts. The negative effect of accrued gains on realizations after a stock has been held for twelve months is statistically significantly different from zero for taxable accounts, but not for tax-deferred accounts (the difference between the two, amounting to the coefficient estimate of –0.23, is statistically significant). For example, a capital gain of 25% is associated with a 22% increase in the monthly hazard rate of selling stock in a taxable account during the first six months since purchase (28% in tax-deferred accounts), but, conditional on having held the stock for one year, a 25% capital gain is associated with a 6% reduction in monthly hazard rates. There is no relation between past gains and subsequent sales after the stock has been held one year in tax-deferred accounts.

The loss-realization effects in December are particularly strong in taxable accounts, although there is a statistically significant and substantively important effect for tax-deferred accounts as well. This realization of losses in tax-deferred accounts in December cannot be attributed to tax effects and would seem to occur at an inopportune time, given the realization of losses occurring in taxable accounts in December along with the historical boost in January returns for these previous loser stocks. A larger loss reduces the probability of sale in both taxable and tax-deferred accounts, but the reduction is larger for tax-deferred accounts, where there is no tax benefit to realizing the loss, at least at short holding periods.

Table 6 also reports results allowing for investor-specific or stock-specific baseline hazards. The results are similar to those in the first two columns of the table. The richer covariate specification in equation (6), relative to that in (4), reduces the sensitivity of the coefficient estimates to the restriction to a homogeneous baseline hazard.

We explored the sub-sample stability of our results on the differences between realization rates for long- and short-term gains and losses. In 1993, the Omnibus Budget Reconciliation Act increased the top short-term capital gains tax rate from 31 percent to 39.6 percent. The long-term capital gains tax rate was capped at 28 percent throughout our sample period. Thus, the incentive to realize losses short-term and to defer gains until they are long-term was greater in years after 1993 than in earlier years. We find that the coefficients on LOSS*(0-6 month holding period) and LOSS*(7-12 month holding period), interacted with DECEMBER, are between two and three times larger in the high tax-rate regime than they are in the low tax-rate regime. This is consistent with investors having a greater incentive to realize short-term capital losses at year-end in the high tax-rate regime. We also find a lower probability of recognizing short-term gains, particularly for positions held for less than six months, in the regime with the higher tax rate on short-term gains. Households were less apt to realize short-term gains and more apt to realize short-term losses in December after the increase in short-term capital gains tax rates than before.

D. Loss Realization and Investor "Need" for Losses

Investors cannot use more than $3,000 of net losses to offset other income; they must carry such losses forward to offset gains and losses in future years. Poterba (1987) found that relatively few investors faced this limit as a binding constraint in the early 1980s, although Auerbach, Burman, and Siegel (2000) suggest that the number of affected investors has increased since then. For an individual investor who has realized net gains during the year, the incentive to realize losses is greater than that for an investor who has already realized net losses. Poterba and Weisbenner (2001), Grinblatt and Moskowitz (2004), and several other studies find evidence suggesting that at year-end, when investors have more gains they are more likely to realize losses. These studies use a very imperfect measure, the year-to-date return on the aggregate stock market, as a proxy for whether the household has already realized capital gains during the current tax year. The results support the importance of tax-induced year end loss realizations. Grinblatt and Keloharju (2001, 2004) use a unique data set on asset sales and investor tax liability in Finland and find that end-of-year tax-loss selling depends on whether investors have substantial losses or substantial gains from their trading activity earlier in the year.

The present data set permits a direct test of how loss realization responds to an individual's year-to-date portfolio realizations. We can evaluate the net gain or loss realizations in the investor's taxable and tax-deferred accounts up to the current month of the tax year, and then explore whether the pattern of gains or losses helps to predict realization of stocks with gains and stocks with losses.

Our measure of gains and losses is imperfect because we are only aware of the trades executed at the brokerage firm that provided the data and because we do not know the purchase price of some stock positions, particularly those purchased prior to the start of the sample in January 1991. Thus, we focus on the trading activity of those households for whom we know the basis of stocks sold in the year-to-date and can calculate the total realized capital gain or loss.

We augment the specification in (6) by including our measure of net capital gains or losses realized in the tax year to date. Since we expect this variable to have a differential effect on realization of appreciated and depreciated stocks, we interact this variable with GAIN and LOSS. The results provide only mixed support for the importance of realized gains to date as a predictor of trading decisions. Table 7 reports our findings. The results show that, in taxable accounts, investors who have realized more gains to date are more likely to sell stocks, but that this effect is not affected by the gain or loss position of the security. This is likely to be the result of heterogeneity across investors; those who have already realized larger total gains may reveal a higher probability of gain realization. The second column of Table 7 focuses on tax-deferred accounts, where the same pattern emerges. There is also some puzzling evidence that investors who have realized more gains in the year to date in their taxable accounts are less likely to realize losses in their tax-deferred accounts.

The last column of Table 7 reports coefficients that describe the difference in trading probabilities between taxable and tax-deferred accounts. The column shows some evidence that losses in taxable accounts are more likely to be realized, relative losses in tax-deferred accounts, by investors with substantial gains in the year to date. There is no evidence of a decline in realization rates for gains on the part of investors with realized gains to date. The coefficient estimates in the third column thus offer some support for the view that investors consider their developing tax position in determining whether to realize gains and losses.

III. Evidence on Wash Sales and Restarting Tax Options

Capital losses associated with security sales can only be claimed for tax purposes if the investor avoids repurchasing the same security within thirty days of the sale. Such rules, known as "wash sale restrictions," are designed to prevent investors from realizing taxable losses without altering their effective investment positions. There has been very little research on whether investors repurchase securities they have previously sold to realize tax losses. One notable exception is Grinblatt and Keloharju's (2004) analysis of Finnish data, which suggests that a substantial number of investors repurchase stocks that they sell to generate tax losses. However, Finland does not have wash sale restrictions, so an individual can repurchase a share immediately after selling for a tax loss, and the trade will not disallow the tax benefit associated with the loss realization.

Table 8 presents information on repurchase decisions of investors who sell stocks at a loss in our sample. The table considers stocks purchased in both taxable and tax-deferred accounts, it distinguishes sales on which the investor realized a gain from those on which there was a loss, and it considers the differences between sales in December and those in all other months. The first column of Table 8 focuses on sales with realized losses. For sales in taxable accounts in December, there is a 4.5 percent chance that the investor will repurchase the security in the taxable account within thirty days of the sale, thereby voiding the tax benefits associated with loss realization. The analogous probability for sales that occur in months other than December is 8.5 percent, with the differential probability of –4.0 percent being highly significant. We interpret this evidence as suggesting that tax considerations play a more important role in December loss realizations than in sales in other months. These results are also in direct contrast to those in Grinblatt and Keloharju (2004), who find that Finnish investors who realize losses in December are more apt to immediately repurchase the stock than are the investors realizing losses in other calendar months.

The second column of Table 8 presents information on the probability of repurchasing the stock after realizing a gain, which is greater than the respective probability of repurchasing following a tax-loss sale. For December sales in taxable accounts, there is a 10.4 percent chance that the gain-producing stock is repurchased in a taxable account within a month. The third column summarizes the difference between the probabilities of repurchasing a stock when the sale generated a loss and when it generated a gain. For sales in taxable accounts, the difference in the probability of repurchasing a share in a taxable account within 30 days when that share has been sold for a loss and when the share has been sold for a gain is –5.9 percent when the sale occurs in December and –3.6 for sales in non-December months. The difference-in-differences, -2.3, is statistically significantly different from zero.

The right panel of Table 8 presents estimates of the probability a stock that has been sold is repurchased in the second month following the sale. Unlike the repurchase activity in the first month after the sale, which is subject to wash sale rules and is significantly lower for losses realized in December relative to other months, there is no differential in repurchase rates during the second month after purchase. However, if the wash sale rules resulted in pent-up demand to repurchase the stock sold at a loss in December, one might expect a boost in the repurchase rate in the second month following these tax-motivated sales. We find no evidence of such an effect.

We also examined the probability of purchasing a stock in a tax-deferred account following a sale in a taxable account, as well as the probability of repurchasing in a tax-deferred account following a sale in that account. Hermann (2003) notes that the IRS has issued conflicting guidance

about whether purchasing a security in a tax-deferred account can trigger the wash sale limitations for losses claimed in taxable accounts. Moreover, since wash sale rules do not apply to sales and repurchases in tax-deferred accounts, such trading may provide a baseline against which to judge the behavior in taxable accounts. For December loss realizations in a tax-deferred account, there is a 5.7 percent chance of repurchase within thirty days in the same account, compared with a 4.5 percent probability of repurchase for sales in a taxable account. There is a 0.9 percent chance of purchasing stock in a tax-deferred account within thirty days of selling it at a loss in a taxable account. The results suggest that offsetting transactions in taxable and tax-deferred accounts are rare.

IV. Holding Periods and Effective Capital Gains Tax Burdens

Hazard models for stock sale decisions provide insight on investor behavior, and they also offer a building block for analyzing the burden of the capital gains tax. The burden of a realization-based tax depends in part on the behavior of investors, particularly when the tax code provides for basis-step up at death. The foregoing results suggest that investors exhibit high trading rates at short horizons, but that after they have held an asset for a period of several months, turnover rates are low. This is more pronounced for stocks with gains than for stocks with losses.

Figure 4 provides a summary measure of the link between a stock's return experience and investor trading. The figure plots the median holding period for stock purchases under different assumptions about the stock's return profile and conditioning on different short-term holding period experience. It also compares the trading behavior in taxable and tax-deferred accounts. The first two bars shown for each assumed rate of return correspond to stocks that have been held for at least a month. There is little difference between the height of these two bars, or between the corresponding bars for different rates of capital appreciation. This reflects the high turnover rate in the few months immediately after a stock is purchased, regardless of whether the stock is held in a taxable or a tax-deferred account. The median holding period in a tax-deferred account is ten or eleven months, while that in a taxable account is fourteen months for most appreciation assumptions.

The last two bars for each rate of appreciation correspond to stocks that have been held at least six months, and they show very different median holding periods as well as larger disparities between taxable and tax-deferred accounts. For a stock that does not appreciate, the median holding period, conditional on a six month holding, is 42 months in a taxable account and 23 months in a tax-deferred account. This pattern is consistent with Barber and Odean's (2004) finding of higher trading probabilities in tax-deferred than in taxable accounts. Comparing holding periods for stocks that appreciate at different rates also shows, however, the quantitative importance of the lock-in patterns we described above. While the median holding period for a stock in a tax-deferred account

is unaffected by the assumed appreciation rate, a stock in a taxable account that appreciates at a 1.5 percent monthly rate has a median holding period of 58 months, compared with 42 months for a stock that does not appreciate.

The lock-in effect also matters for estimates of the effective tax burden on gain-producing securities. One way to summarize the capital gains tax burden on a long-term investment is to follow Protopapadakis (1983) in computing the effective accrual tax rate on the asset's capital gain. Assuming that the asset yields only gains, and that these gains accrue at rate g, and that the statutory tax rate on realized gains is τ_{cg}, then the effective accrual tax rate σ satisfies

$$e^{(1-\sigma)gT} = e^{gT} - \tau_{cg}*(e^{gT} - 1) \quad (7)$$

where T is the holding period. We can estimate a weighted average effective accrual tax rate by calculating the tax rate for each holding period, and then using our estimate of the empirical distribution of holding periods to weight different tax values.

Table 9 presents our estimates of the effective accrual tax rate, under the assumption that the short-term (< 12 month) capital gains tax rate is 40 percent, and the long term rate is 28 percent. There are the tax parameters that prevailed during most of our sample period. The results show that because of the high turnover rate on stock purchases at short holding periods, the effective capital gains tax rate is high. Many gains are realized as short term gains. When we consider stocks that are held at least one moth, with a one percent per month capital gain accrual, the average tax rate assuming that the stock will be sold after five years if it has not been sold before that is 31 percent. When we assume that stocks that have not been sold by five years from the date of purchase will never be sold, so that the gains will be eligible for basis step up, the effective accrual tax rate falls to 24 percent. The effective accrual tax rates are lower when we assume that the stock is held for at least six months. In this case, the effective capital gains tax rate assuming that any stock not sold in the first five years is sold at the five year anniversary would be 27 percent, compared to 31 percent if we conditioned only on a one month holding period. Assuming that gains held for five years are never sold, the effective capital gains tax rate falls to 15 percent.

The key finding of our analysis with respect to capital gains tax burdens is that turnover rates at short horizons are high. When we compute a transaction-weighted average effective capital gains tax burden, we therefore find values close to the statutory tax rates. A gain-weighted calculation would attach greater weight to the long holdings, and would generate a lower effective accrual tax rate.

V. Conclusion

This paper offers novel evidence on the stock-trading pattern of individual investors. Comparing investors' realizations in their taxable and tax-deferred accounts provides a means to identify the magnitude of tax-motivated trading. Using data from a large discount brokerage house, we find evidence of a lock-in effect for capital gains, i.e., a desire to postpone stock sales and their associated tax liability, in taxable accounts. This effect is more pronounced for larger stock purchases and it stronger for stocks that have been held for a long time. Investors are more likely to realize losses in taxable accounts than in tax-deferred accounts throughout the calendar year, and there is some evidence that households that realize gains in their taxable account earlier in the year are more likely to realize losses later in the year.

Our findings on the path-dependence of stock sale probabilities and the substantial differences between realization rates for appreciated and depreciated stocks suggest that modeling the burden of the capital gains tax must move beyond simple models with a constant probability of asset sale, such as those developed by Bailey (1969) and Protopapadakis (1983). We have illustrated this possibility for the case of assets with constant capital appreciate rates, but the analysis could be enriched by considering a wider range of price paths and trading decisions. Our work suggests the potential for building on recent research in behavioral economics, which offers important insights about investor trading behavior, to inform estimates of capital gains tax burdens.

The heterogeneity in investor trading patterns raises the possibility that some investors are tax-senstive, while others are tax-oblivious. It is not clear how to evaluate the fraction of investors in each category. In our data set, 21 percent of all stock purchases of $10,000 or more resulted in a realized loss within one year, and 38 percent resulted in a realized gain within a year. Forty-five percent of the remaining stock purchases, 18 percent of all purchases, had losses at the end of twelve months that could have been realized, but were not. This suggests that nearly one-half of the stock purchases that could have been used to generate a short-term loss were not liquidated in time to generate this loss. We cannot conclude that investors who did not realize short-term losses were foregoing substantial tax benefits because they might have been unable to use the tax losses to reduce their tax liability, but we suspect that many of these investors could have reduced their tax liability by realizing the losses. Measuring the cost to investors of such tax-inefficient behavior is a clear avenue for future research.

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TABLE 1—SUMMARY STATISTICS ON COMMON STOCK PURCHASES

	All Accounts				*Taxable Accounts*				*Tax-deferred Accounts*			
	# Purchases	*Mean $ Amt.*	*≥ $10K* (in %)	*Sold* (in %)	*# Purchases*	*Mean $ Amt.*	*≥ $10K* (in %)	*Sold* (in %)	*# Purchases*	*Mean $ Amt.*	*≥ $10K* (in %)	Sold (in %)
1991	*61,808*	*7,902* (4,137)	*19* [61]	*69* [75]	*39,337*	*8,712* (4,424)	*22* [65]	*70* [75]	*22,471*	*6,485* (3,750)	*15* [52]	*67* [75]
1992	*61,448*	*8,281* (4,375)	*20* [63]	*66* [74]	*36,830*	*9,279* (4,748)	*23* [67]	*67* [74]	*24,618*	*6,788* (3,866)	*16* [54]	*65* [75]
1993	*66,117*	*8,694* (4,550)	*22* [64]	*62* [70]	*38,522*	*9,865* (4,995)	*25* [69]	*62* [69]	*27,595*	*7,059* (3,974)	*17* [55]	*60* [71]
1994	*58,814*	*8,967* (4,620)	*23* [66]	*53* [64]	*33,664*	*9.920* (5,000)	*25* [69]	*53* [62]	*25,150*	*7,691* (4,125)	*19* [60]	*53* [65]
1995	*74,581*	*10,272* (5,185)	*26* [70]	*49* [60]	*41.500*	*11,635* (5,700)	*30* [74]	*49* [59]	*33,081*	*8,562* (4,740)	*22* [63]	*48* [61]
1996	*91,279*	*10,923* (5,350)	*28* [72]	*28* [38]	*51,193*	*12,240* (5,712)	*31* [76]	*28* [38]	*40,086*	*9,241* (4,974)	*24* [66]	*27* [37]
Total	*414,047*	*9,329* (4,762)	*23* [67]	*52* [60]	*241,046*	*10,404* (5,063)	*26* [71]	*53* [60]	*173,001*	*7,831* (4,310)	*20* [60]	*51* [60]

Notes: Sample consists of 23,877 households that had both taxable and tax-deferred accounts and that purchased at least one stock between 1/91 and 11/96. The values in parentheses are median dollar amounts. Values in brackets are averages that weigh different purchases by the size of the purchase.

TABLE 2—DISTRIBUTION OF CORPORATE STOCK SALES

Panel A: Distribution by Holding Period

	Aggregate Stock Sales Reported on Tax Returns (in percent)				*Stock Sales in Taxable Accounts during 1995 in Brokerage Data (in percent)*	
Length of time held (months)	1985	**1997**	1998	1999	**Full Sample**	Sales of $10,000+ Purchases
1	14.0	**21.3**	27.2	34.6	**21.3**	37.7
2 – 3	11.8	**18.6**	14.6	15.4	**19.3**	22.9
4 – 6	11.8	**14.0**	13.8	12.7	**15.1**	13.7
7 – 12	15.8	**17.5**	17.3	14.6	**14.6**	10.0
13 – 18	13.7	**10.0**	10.3	8.9	**9.7**	6.0
19 – 24	12.3	**6.8**	6.1	5.0	**6.8**	3.7
25 – 36	14.4	**7.4**	7.3	5.8	**8.4**	4.1
37 – 48	6.3	**4.4**	3.4	3.0	**4.9**	1.9

Panel B: Distribution by Holding Period and Calendar Month, Breakdown by Realized Gain or Loss

	Aggregate Stock Sales Reported on Tax Returns in 1997 (in percent)		*Stock Sales in Taxable Account during 1995 in Brokerage Data (in percent)*	
	Percent of Stock Sales by Holding Period			
Length of time held (months)	Sold w/Gain	Sold w/Loss	Sold w/Gain	Sold w/Loss
1	20.4	22.9	21.2	21.3
2 – 3	17.4	20.6	19.7	18.5
4 – 6	13.1	15.7	15.8	13.7
7 – 12	17.4	17.8	15.7	12.6
13 – 18	10.8	8.6	9.4	10.1
19 – 24	7.4	5.9	6.2	8.0
25 – 36	8.7	5.3	7.6	9.8
37 – 48	4.9	3.3	4.4	5.9
	Percent of Stock Sales in December			
Short-term holding period	7.7	12.7	6.6	16.2
Long-term holding period	9.5	17.9	6.4	18.2
All holding periods	8.4	14.2	6.6	16.9

Notes: The aggregate sales of corporate stock reported on tax returns are provided by Auten and Wilson (1999), Wilson (2002), and Wilson (2003) and authors' calculations. The table focuses on stocks held at most four years. Annual S&P 500 returns are as follows: 1985 = 32%, 1995 = 38%, 1997 = 33%, 1998 = 29%, and 1999 = 21%. The short-term holding period is 12 months or less and the long-term holding period is more than twelve months.

TABLE 3—REGRESSION OF MONTHLY HAZARD RATE OF SELLING STOCK UPON CUMULATIVE RETURN ON STOCK ENTERING THE MONTH, PURCHASES ≥ $10,000 (FIGURES 3A AND 3B)

	Probability of selling stock in taxable account			Probability of selling stock in taxable account *relative* to selling stock in tax-deferred account		
Months since Purchase	Constant: baseline	GAIN	LOSS	Constant: baseline	GAIN	LOSS
1 month	23.4***			2.7**		
	(0.8)			(1.4)		
2 months	11.4***	21.7***	9.7***	1.0*	-19.4***	0.7
	(0.4)	(2.6)	(2.2)	(0.6)	(4.6)	(3.6)
3 months	8.7***	11.6***	8.2***	0.1	-8.9***	-2.5
	(0.3)	(1.8)	(1.5)	(0.5)	(3.2)	(2.5)
4 months	6.7***	5.8***	6.4***	-0.5	-6.2***	-1.6
	(0.3)	(1.3)	(1.2)	(0.4)	(2.4)	(2.0)
5 months	5.5***	4.7***	5.0***	-0.7*	-5.4***	-2.5
	(0.2)	(1.1)	(1.0)	(0.4)	(2.2)	(1.7)
6 months	5.4***	0.7	4.6***	-0.5	-6.6***	-0.6
	(0.2)	(0.8)	(0.9)	(0.4)	(1.8)	(1.7)
7 months	4.6***	1.3*	2.7***	-0.4	-4.5***	-2.8**
	(0.2)	(0.8)	(0.9)	(0.4)	(1.6)	(1.4)
8 months	3.7***	0.8	2.1***	-0.6*	-5.5***	-3.2**
	(0.2)	(0.5)	(0.8)	(0.4)	(1.5)	(1.4)
9 months	3.4***	-0.2	0.4	-0.7**	-3.5***	-3.8***
	(0.2)	(0.3)	(0.8)	(0.4)	(1.2)	(1.4)
10 months	3.1***	0.2	1.1	-0.8**	-1.9	-2.1
	(0.2)	(0.4)	(0.7)	(0.4)	(1.3)	(1.3)
11 months	2.9***	-0.4	0.9	-0.6**	-1.9**	-2.4**
	(0.2)	(0.3)	(0.7)	(0.3)	(0.8)	(1.1)
12 months	2.9***	-0.1	0.8	-0.6*	-1.2*	-3.6***
	(0.2)	(0.3)	(0.7)	(0.3)	(0.7)	(1.1)
13 months	3.0***	0.2	2.2***	-0.2	0.3	-0.5
	(0.2)	(0.4)	(0.7)	(0.3)	(0.6)	(1.2)

Notes: Sample restricted to stock purchases of at least $10,000. The specification is:

$$Sell_{i,t} = \alpha_t + \beta_{1,t} * GAIN_{i,t-1} + \beta_{2,t} * LOSS_{i,t-1} + \varepsilon_{i,t},$$

where GAIN = max(return, 0), LOSS = min(return, 0). Standard errors (shown in parentheses) allow for heteroskedasticity as well as correlation across observations of the same household.

***, **, * denote significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

TABLE 4—COX PROPORTIONAL HAZARDS MODEL OF STOCK SALES, BY SIZE OF PURCHASE

	Full Sample			***Original Purchase* $0–4,999**		
		All accounts			All accounts	
	Taxable accounts	*Tax-deferred accounts*	Interaction w/ taxable accounts	Taxable accounts	*Tax-deferred accounts*	Interaction w/ taxable accounts
GAIN	0.11***	0.09***	0.02*	0.14***	0.09***	0.05***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
GAIN*December	-0.02	0.07***	-0.09***	-0.01	0.07***	-0.08***
	(0.03)	(0.02)	(0.03)	(0.02)	(0.02)	(0.03)
LOSS	1.03***	1.42***	-0.40***	1.01***	1.32***	-0.31***
	(0.03)	(0.03)	(0.04)	(0.03)	(0.04)	(0.05)
LOSS*December	-2.23***	-0.26**	-1.97***	-2.11***	-0.31**	-1.80***
	(0.05)	(0.11)	(0.12)	(0.07)	(0.13)	(0.14)
December	0.12***	0.01	0.11***	0.09***	0.04*	0.05*
	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)
# of Observations	3,449,531	5,997,368		1,942,611	3,599,068	

	***Original Purchase* $5,000–9,999**			***Original Purchase at least $10,000***		
		All accounts			All accounts	
	Taxable accounts	*Tax-deferred accounts*	Interaction w/ taxable accounts	Taxable accounts	*Tax-deferred accounts*	Interaction w/ taxable accounts
GAIN	0.14***	0.25***	-0.12***	-0.03	0.06***	-0.09***
	(0.01)	(0.02)	(0.03)	(0.02)	(0.01)	(0.03)
GAIN*December	-0.05	-0.14**	0.10	-0.09	0.13***	-0.22***
	(0.06)	(0.06)	(0.09)	(0.08)	(0.04)	(0.09)
LOSS	0.91***	1.37	-0.47***	1.18***	1.65***	-0.46***
	(0.05)	(0.07)	(0.09)	(0.06)	(0.08)	(0.10)
LOSS*December	-2.28***	0.23	-2.51***	-2.72***	-0.45	-2.27***
	(0.11)	(0.27)	(0.29)	(0.12)	(0.29)	(0.32)
December	0.15***	0.05	0.11**	0.14***	-0.05	0.19***
	(0.03)	(0.03)	(0.04)	(0.03)	(0.04)	(0.05)
# of Observations	829,498	1,395,918		677,422	1,002,382	

Notes: GAIN = max(return, 0) and LOSS = min(return, 0). The Cox proportional hazards model employs a non-parametric estimate of the baseline hazard. Standard errors (shown in parentheses) allow for heteroskedasticity as well as correlation across observations of the same household.

***, **, * denote significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

TABLE 5—COX PROPORTIONAL HAZARDS MODEL OF STOCK SALES, SAMPLE OF LARGE PURCHASES (AT LEAST $10,000), WITH AND WITHOUT HETEROGENEITY IN BASELINE HAZARDS

	One Baseline Hazard Rate			***Investor-Specific Baselines***		
	Taxable accounts	All accounts		Taxable accounts	All accounts	
		Tax-deferred accounts	Interaction w/ taxable accounts		*Tax-deferred accounts*	Interaction w/ taxable accounts
GAIN	-0.03	0.06***	-0.09***	0.11***	0.37***	-0.26***
	(0.02)	(0.01)	(0.03)	(0.03)	(0.05)	(0.06)
GAIN*December	-0.09	0.13***	-0.22***	-0.03	0.32*	-0.35*
	(0.08)	(0.04)	(0.09)	(0.08)	(0.18)	(0.20)
LOSS	1.18***	1.65***	-0.46***	1.98***	2.04***	-0.06
	(0.06)	(0.08)	(0.10)	(0.08)	(0.11)	(0.13)
LOSS*December	-2.72***	-0.45	-2.27***	-2.98***	-0.66*	-2.33***
	(0.12)	(0.29)	(0.32)	(0.16)	(0.37)	(0.40)
December	0.14***	-0.05	0.19***	0.11***	-0.13***	0.24***
	(0.03)	(0.04)	(0.05)	(0.03)	(0.05)	(0.06)
	Stock-Specific Baselines			***Investor-Stock-Specific Baselines***		
	Taxable accounts	All accounts		Taxable accounts	All accounts	
		Tax-deferred accounts	Interaction w/ taxable accounts		*Tax-deferred accounts*	Interaction w/ taxable accounts
GAIN	-0.09***	0.27***	-0.36***	0.19	1.16***	-0.96***
	(0.03)	(0.05)	(0.06)	(0.26)	(0.23)	(0.35)
GAIN*December	-0.05	0.00	-0.05	-0.29	0.68	-0.97
	(0.10)	(0.15)	(0.18)	(0.21)	(0.71)	(0.74)
LOSS	2.09***	2.48***	-0.39***	4.49***	5.67***	-1.17*
	(0.08)	(0.11)	(0.14)	(0.39)	(0.57)	(0.69)
LOSS*December	-3.03***	-0.21	-2.82***	-2.48***	1.40	-3.87***
	(0.17)	(0.33)	(0.37)	(0.80)	(1.37)	(1.59)
December	0.11***	0.00	0.11**	0.18**	-0.12	0.29**
	(0.03)	(0.05)	(0.06)	(0.08)	(0.12)	(0.15)

Notes: GAIN = max(return, 0) and LOSS = min(return, 0). Standard errors (shown in parentheses) allow for heteroskedasticity as well as correlation across observations of the same household. Sample consists of 677,422 monthly sale decisions in taxable accounts and 1,002,382 monthly sale decisions in all accounts.

***, **, * denote significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

TABLE 6—COX PROPORTIONAL HAZARDS MODEL OF STOCK SALES WITH UNIFORM, INVESTOR-SPECIFIC, OR STOCK-SPECIFIC BASELINE HAZARDS FOR LARGE PURCHASES (AT LEAST $10,000)

	Common Baseline		***Investor-Specific Baselines***		***Stock- Specific Baselines***	
	Taxable accounts	*Taxable relative to Tax-deferred accounts*	Taxable accounts	*Taxable relative to Tax-deferred accounts*	Taxable accounts	*Taxable relative to Tax-deferred accounts*
GAIN	-0.24***	-0.23***	-0.09*	-0.10	-0.24***	*-0.17**
	(0.04)	(0.05)	(0.05)	(0.07)	(0.06)	*(0.10)*
GAIN* (w/in 6 mos after purchase)	0.79***	-0.20*	0.83***	-0.37***	0.48***	*-0.31***
	(0.06)	(0.11)	(0.08)	(0.13)	(0.09)	*(0.15)*
GAIN* (mos 7 – 12 after purchase)	0.29***	-0.06	0.18**	-0.12	0.20**	*-0.21*
	(0.06)	(0.08)	(0.08)	(0.14)	(0.09)	*(0.15)*
GAIN*December	-0.08	-0.17	-0.03	-0.59*	0.05	*-0.16*
	(0.15)	(0.17)	(0.14)	(0.35)	(0.17)	*(0.30)*
GAIN*December * (w/in 6 mos after purchase)	0.34	0.37	0.09	0.58	0.11	*0.54*
	(0.23)	(0.29)	(0.23)	(0.50)	(0.26)	*(0.43)*
GAIN*December * (mos 7 – 12 after purchase)	-0.15	-0.27	-0.21	0.19	-0.28	*-0.14*
	(0.26)	(0.35)	(0.31)	(0.59)	(0.31)	*(0.50)*
LOSS	0.86***	-0.23	1.08***	0.04	1.36***	*-0.51***
	(0.10)	(0.16)	(0.14)	(0.22)	(0.16)	*(0.26)*
LOSS* (w/in 6 mos after purchase)	0.74***	0.15	1.51***	0.25	1.28***	*0.48*
	(0.14)	(0.24)	(0.18)	(0.30)	(0.20)	*(0.33)*
LOSS* (mos 7 – 12 after purchase)	0.03	-0.60**	0.40**	-0.65**	0.16	*-0.35*
	(0.15)	(0.26)	(0.20)	(0.34)	(0.22)	*(0.39)*
LOSS*December	-2.59***	-1.55***	-2.45***	-0.91	-3.00***	*-1.87****
	(0.20)	(0.40)	(0.29)	(0.68)	(0.30)	*(0.57)*
LOSS*December * (w/in 6 mos after purchase)	-0.23	-1.82***	-0.40	-1.78**	-0.16	*-2.18****
	(0.31)	(0.72)	(0.40)	(0.92)	(0.41)	*(0.86)*
LOSS*December * (mos 7 – 12 after purchase)	-0.14	-0.86	-0.73*	-1.62	0.02	*-1.03*
	(0.30)	(0.79)	(0.42)	(1.04)	(0.45)	*(0.99)*
December	-0.00	0.13	0.07	0.40**	-0.06	*0.13*
	(0.08)	(0.12)	(0.09)	(0.18)	(0.09)	*(0.15)*
December * (w/in 6 mos after purchase)	0.15*	-0.04	0.07	-0.22	0.18*	*-0.11*
	(0.08)	(0.13)	(0.10)	(0.19)	(0.10)	*(0.17)*
December * (mos 7 – 12 after purchase)	0.20**	0.24	0.05	-0.02	0.24**	*0.13*
	(0.10)	(0.17)	(0.12)	(0.23)	(0.12)	*(0.21)*
Number of Observations	1,002,382		1,002,382		1,002,382	

Notes: GAIN = max(return, 0) and LOSS = min(return, 0). The Cox proportional hazards model employs a non-parametric estimate of the baseline hazard. The second, fourth, and sixth columns present the coefficients obtained from the taxable account sample minus those obtained from the tax-deferred account sample. Standard errors (shown in parentheses) allow for heteroskedasticity as well as correlation across observations of the same household.

***, **, * denote significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

TABLE 7— COX PROPORTIONAL HAZARDS MODEL OF STOCK SALES IN FEBRUARY – DECEMBER ON PRIOR PERFORMANCE INTERACTED WITH HOUSEHOLD'S CAPITAL GAIN/LOSS REALIZATIONS DURING CALENDAR YEAR TO DATE, FOR LARGE PURCHASES (AT LEAST $10,000)

	Taxable accounts	All accounts	
Variable		*Tax-deferred accounts*	Interaction w/ taxable accounts
GAIN	-0.21***	*0.01***	-0.22***
	(0.05)	*(0.03)*	(0.06)
GAIN*(w/in 6 mos after purchase)	0.98***	*0.97***	0.01
	(0.09)	*(0.11)*	(0.14)
GAIN*(mos 7 – 12 after purchase)	0.42***	*0.31***	0.11
	(0.08)	*(0.04)*	(0.09)
LOSS	0.77***	*1.05***	-0.28
	(0.14)	*(0.15)*	(0.21)
LOSS*(w/in 6 mos after purchase)	0.60***	*0.52***	0.08
	(0.24)	*(0.25)*	(0.34)
LOSS*(mos 7 – 12 after purchase)	0.28	*0.79***	-0.51
	(0.25)	*(0.27)*	(0.36)
CG_Realized Calendar Year to Date ($000s)	0.016***	*0.011***	0.004
	(0.001)	*(0.003)*	(0.004)
CG_Realized Calendar Year to Date ($000s) * GAIN	-0.000	*0.001*	-0.001
	(0.002)	*(0.006)*	(0.006)
CG_Realized Calendar Year to Date ($000s) * LOSS	0.007	*0.048***	-0.041*
	(0.011)	*(0.021)*	(0.024)

Notes: GAIN = max(return, 0) and LOSS = min(return, 0). The Cox proportional hazards model employs a non-parametric estimate of the baseline hazard. CG_Realized Calendar Year to Date = net capital gain/loss realized via sales of stock in a taxable account from the start of the calendar year through the end of the previous month. The regressions also include a December indicator variable and interactions of the December variable with GAIN, LOSS, and holding periods. Standard errors (shown in parentheses) allow for heteroskedasticity as well as correlation across observations of the same household.

TABLE 8—PROPENSITY TO REPURCHASE SAME STOCK IN TAXABLE ACCOUNT WITHIN ONE AND TWO MONTHS SINCE SALE IN TAXABLE ACCOUNTS, FOR LARGE PURCHASES (AT LEAST $10,000)

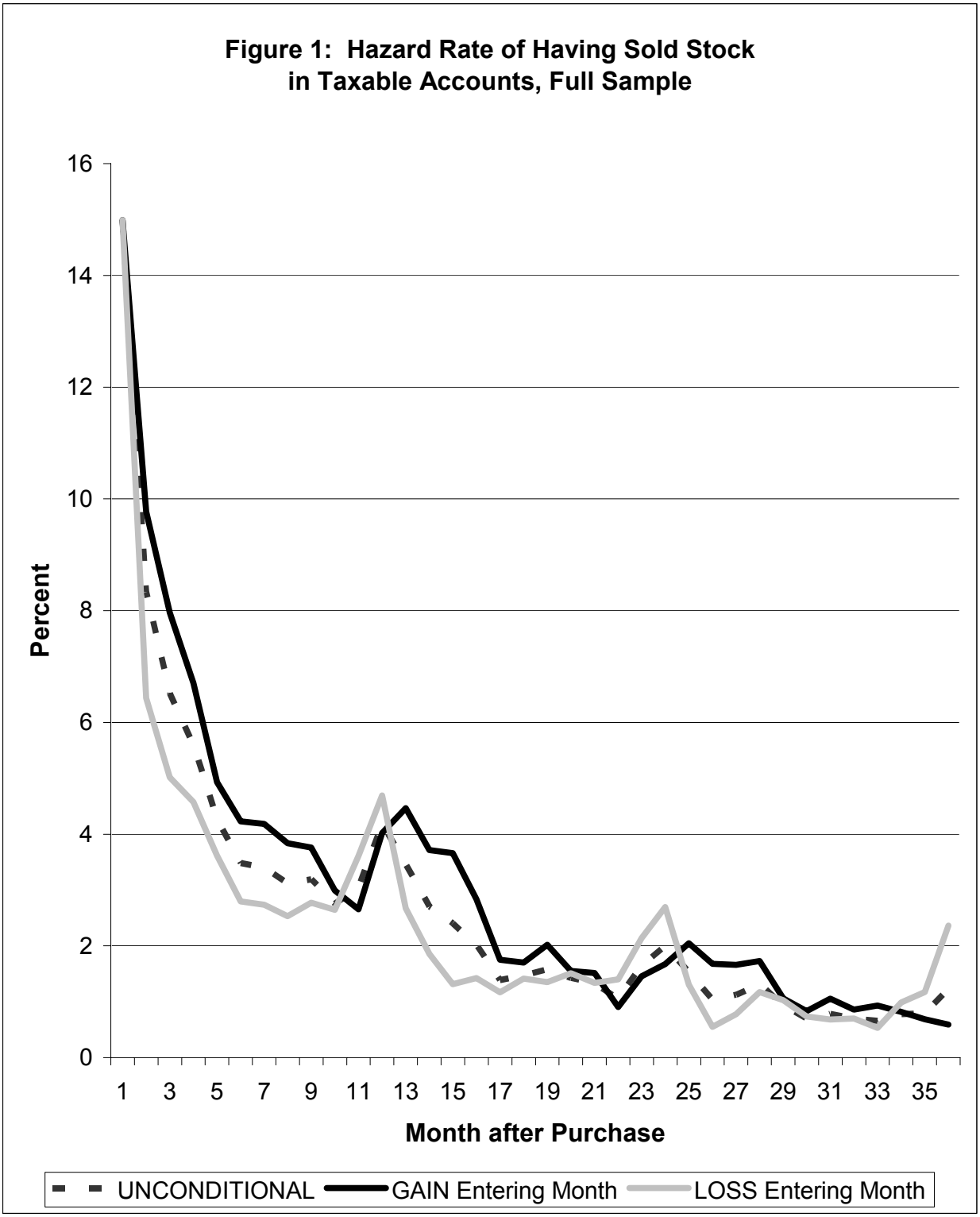
Propensity to Repurchase Stock within One Month since Sale			***Propensity to Repurchase Stock during Second Month since Sale***		
Sale with Realized Loss	Sale with Realized Gain	Difference	Sale with Realized Loss	Sale with Realized Gain	Difference
Sales in December			*Sales in December*		
4.5***	10.4***	-5.9***	4.0***	6.7***	-2.8***
(0.6)	(0.9)	(1.0)	(0.5)	(0.7)	(0.8)
Sales in non-December Months			*Sales in non-December Months*		
8.5***	12.1***	-3.6***	4.9***	7.0***	-2.2***
(0.4)	(0.5)	(0.4)	(0.3)	(0.3)	(0.3)
Difference (December – All Other Months)			*Difference (December – All Other Months)*		
-4.0***	-1.7*	-2.3**	-0.9	-0.3	-0.6
(0.6)	(0.9)	(1.0)	(0.5)	(0.7)	(0.9)

Notes: Sample consists of sales of stock from January 1991 to October 1996, originally purchased for at least $10,000.
***, **, * denote significance at the 1 percent, 5 percent, and 10 percent levels.

TABLE 9—EFFECTIVE CAPITAL GAINS TAX RATE FOR LARGE STOCK PURCHASES (AT LEAST $10,000), BY CAPITAL APPRECIATION OF STOCK

	Median and Average Effective Capital Gains Tax Rate (in percentage points)							
	Conditional on Stock Being Held One Month				*Conditional on Stock Being Held Six Months*			
Assumed Monthly Return	Tax Rate for Median Holding Period	Average Tax Rate Assuming Stock Not Sold After 5 Years is Sold & Gain is Taxed	Average Tax Rate Assuming Stock Not Sold After 5 Years is Sold in 20 Years & Gain is Taxed	Average Tax Rate Assuming Gains are Not Taxed for Stock Held 5+ Years (Basis-Step Up)	Tax Rate for Median Holding Period	Average Tax Rate Assuming Stock Not Sold After 5 Years is Sold & Gain is Taxed	Average Tax Rate Assuming Stock Not Sold After 5 Years is Sold in 20 Years & Gain is Taxed	Average Tax Rate Assuming Gains are Not Taxed for Stock Held 5+ Years (Basis-Step Up)
0.5% per month	27	32	30	24	25	28	25	16
1.0% per month	27	31	28	24	22	27	22	15
1.5% per month	26	30	26	23	19	25	19	15

Notes:
Estimates provided by the proportional hazards Cox model. The short-term capital gains tax rate (applied to stocks held 12 months or less) is assumed to be 40% and the long-term capital gains tax rate (applied to stocks held more than twelve months) is assumed to be 28%. The Cox model estimates are based on a sample of purchases of stocks in taxable accounts of at least $10,000 from 1991-96. The model predicts the likelihood of sale given a stock's capital appreciation since purchase, allowing for a differential relation between sale and past performance by holding period.



Notes: Sample is January purchases of stock 1991-96 in taxable accounts. The hazard rate for stock purchases unconditional on the stock's price performance, as well as conditional on whether the stock has an accrued capital gain or loss entering the month, is displayed.

Figure 2a: Cumulative Probability of Having Sold Stock in Taxable Accounts

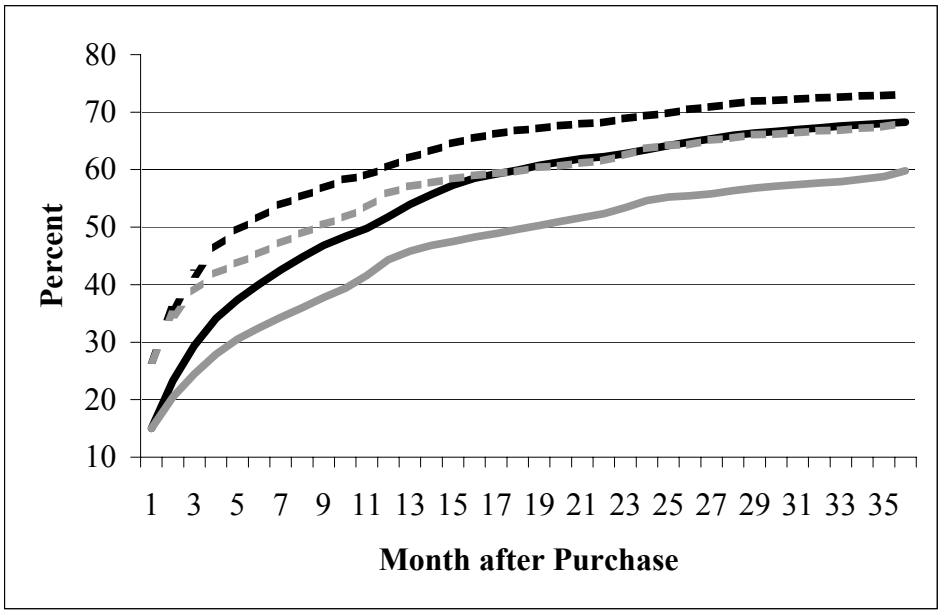


Figure 2b: Cumulative Probability of Having Sold Stock in Taxable Accounts *Relative* to Tax-Deferred Accounts

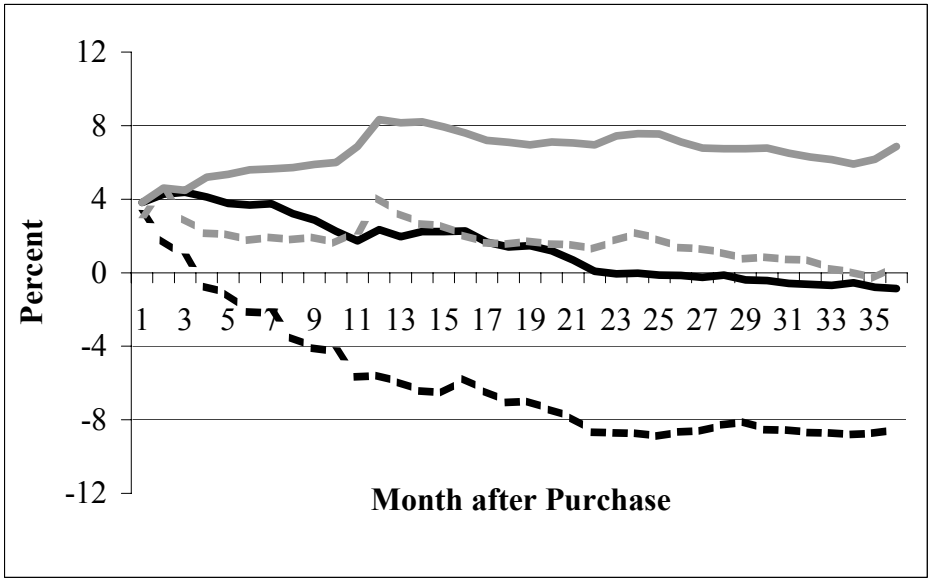


***Figure 2*: Cumulative Probability of Stocks Sale**. Sample is January purchases of stock 1991-96. If h(t) denotes the hazard rate in month t, the probability that the stock is sold by the end of month t is $[\ 1 - (\ \Pi_{s=1,t}\ (1-h(s))\ )\ ]$. Graph 2a presents cumulative probability of sale in taxable accounts for each month since purchase. Graph 2b displays cumulative probability of sale in taxable accounts relative to tax-deferred account for each month since purchase.

Figure 3a: Added Likelihood of Sale in Taxable Accounts With Respect to Stock with Zero Appreciation Since Purchase Date, Original Buy at least $10,000

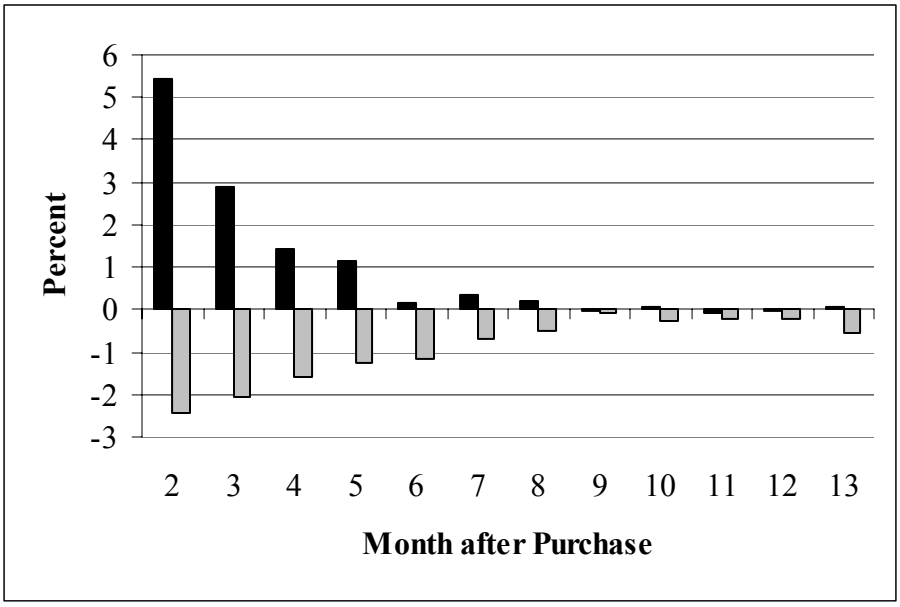


Figure 3b: Added Likelihood of Sale in Taxable Accounts *Relative* to Tax-Deferred Accounts With Respect to Stock with Zero Appreciation Since Purchase Date, Original Buy at least $10,000

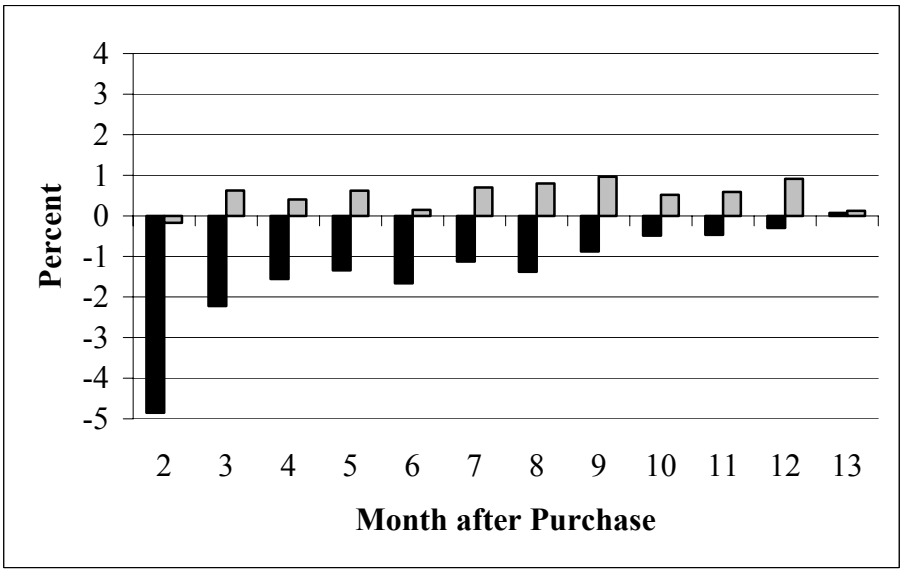


***Figure 3*: Added likelihood of stock sale with respect to stock with zero appreciation since purchase date.** Added likelihood of selling stock with a 25% gain (loss) since purchase with respect to a stock with zero appreciation is estimated from the following regression separately for taxable and tax-deferred accounts:

$$Sell_{i,t} = \alpha_t + \beta_{1,t}*GAIN_{i,t-1} + \beta_{2,t}*LOSS_{i,t-1} + \varepsilon_{i,t},$$

where GAIN = max(return, 0), LOSS = min(return, 0). The added likelihood of sale is expressed as $\beta_{1,t}*GAIN_{i,t-1}$ or $\beta_{2,t}*LOSS_{i,t-1}$. Graph 3a displays the results for taxable accounts. Graph 3b displays the results for taxable accounts relative to the results for tax-deferred accounts.

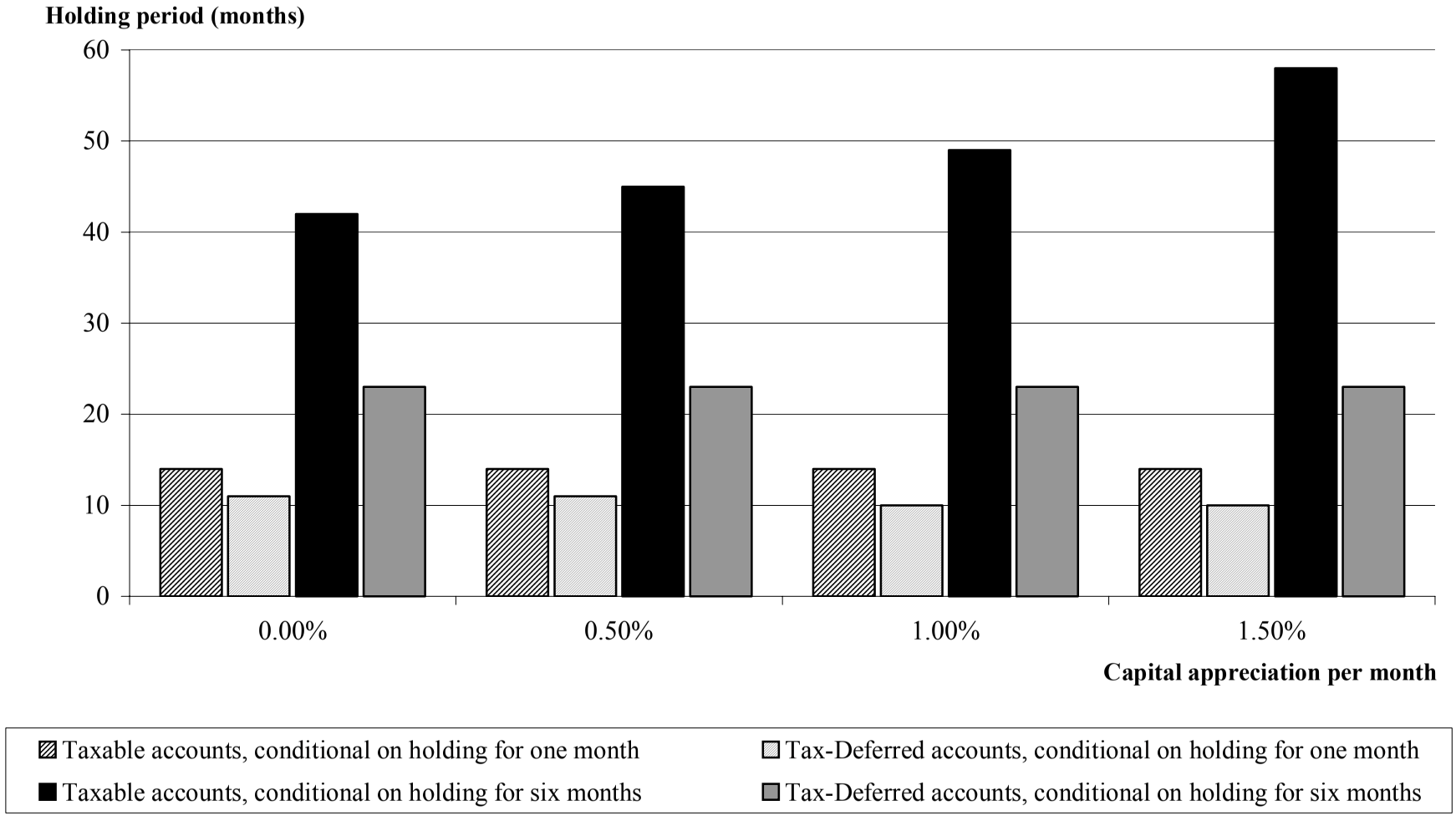


***Figure 4*: Median Holding Period by Capital Appreciation of Stock.** Estimates of median holding periods for stocks with hypothetical performance are provided by a proportional hazards Cox model based on a sample of purchases of stocks in taxable and tax-deferred accounts of at least $10,000 from 1991-96. The model predicts the likelihood of sale given a stock's capital appreciation since purchase, allowing for a differential relation between sale and past performance by holding period.