

The Disposition Effect and Households' Stock Trades: The Importance of Relative Performance and Dividends

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Abstract

Using data on stock purchases made by individual investors through a retail discount broker from 1991 to 1996, we present novel empirical evidence regarding the nature and extent of the disposition effect. We find strong evidence for a disposition effect based on stock performance relative to a market index. In addition, we find that receiving dividends since stock purchase decreases the propensity to sell. Further decreases in the propensity to sell are related to dividend initiations and the receipt of a dividend during the previous month. Once we control for these other factors, higher absolute returns are associated with lower probabilities of sale.

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Abstract

Using data on stock purchases made by individual investors through a retail discount broker from 1991 to 1996, we present novel empirical evidence regarding the nature and extent of the disposition effect. We find strong evidence for a disposition effect based on stock performance relative to a market index. In addition, we find that receiving dividends since stock purchase decreases the propensity to sell. Further decreases in the propensity to sell are related to dividend initiations and the receipt of a dividend during the previous month. Once we control for these other factors, higher absolute returns are associated with lower probabilities of sale.

Reasons why investors sell or hold common stocks or other securities they have previously purchased include the disposition effect, originally proposed by Shefrin and Statman (1985) as an extension of Kahneman and Tversky's prospect theory (1979) to investments, and the capital gains lock-in effect that results from tax timing strategies involving early realization of taxable losses and deferral of taxable gains (see, e.g., Constantinides (1984)). The self-control theory of Thaler and Shefrin (1981), adapted by Shefrin and Statman (1984) to explain dividends, implies that dividends also may play a role in the decision to sell or hold shares. Using data on the stock purchases made by a large number of individual investors through a retail discount broker from 1991 to 1996, we present novel empirical evidence regarding the extent and nature of the disposition effect. In contrast to previous studies that focus on the role of absolute or raw returns, we focus on both absolute performance as well as stock returns relative to a market index and find strong evidence for a disposition effect based on such relative returns. In addition, we find that the propensity to sell stocks is negatively related to various measures of the dividends received since the purchase date. Once we control for these other factors, higher absolute returns are associated with lower probabilities of sale.

The disposition effect asserts that investors have a higher propensity to sell securities on which they have a gain, and conversely a lower tendency to sell those on which they have a loss. Reasons for this include regret aversion and mental accounting. Consistent with the hypothesized effect, Odean (1998) and Grinblatt and Kelaharju (2001) find that individual investors' propensity to sell common stocks is positively related to their past returns.

An issue that arises in empirical study of the disposition effect is that the theory does not specify the appropriate benchmark against which gains and losses should be measured. As Kahneman and Tversky (1979) state, "there are situations in which gains and losses are coded relative to an expectation or aspiration level that differs from the status quo." Two plausible candidates are a benchmark of a return of zero, implying that gains should be measured as absolute or raw returns, and a benchmark consisting of the performance of a market index, implying that gains and losses should be measured relative to how the market has performed since purchase of the stock. In contrast, for tax purposes capital gains and losses are based on absolute, not relative, returns. In the United States, the realization-based capital gains tax provides opposite incentives to hold appreciated and sell depreciated assets. Thus, if one associates the disposition effect with absolute returns, and only includes absolute returns in a regression of stock sales, it may be

difficult to disentangle the disposition and capital gains lock-in effects and assess their relative importance because the two effects have offsetting implications for the effect of past returns on realizations. Unlike past work in this area, we include both raw returns and returns relative to the market in our empirical analyses, and find strong evidence for a disposition effect related to relative returns. Moreover, in some specifications we further consider the stock performance relative to the “high-water mark” since purchase. Specifically, we find that households are much more (less) apt to sell those stocks that are trading close to (away from) the highest price since purchase; it turns out that this disposition effect holds for both stocks with accrued capital gains and accrued capital losses. Moreover, once we control for other plausible benchmarks that may affect trading activity of households (e.g., relative performance, closeness to previous high price since purchase), the relation between absolute returns and the propensity to sell stock switches sign — instead of the disposition effect based on absolute returns documented by Odean (1998), we find that higher absolute returns are associated with *lower* propensity to sell, complementing the evidence of tax-motivated trading presented in Ivković, Poterba, and Weisbenner (2003).

Shefrin and Statman (1984) present a behavioral theory of dividends based on Thaler and Shefrin’s (1981) theory of self-control. Thaler and Shefrin (1981) view each agent as a combination of an “internal planner” with consistent long-run preferences and a “doer” whom the planner seeks to control using devices such as smoking clinics and diet clubs. Shefrin and Statman (1984) argue that dividends fit into this theory of self-control because, by committing to consume only out of dividends, investors avoid deciding how many shares to sell and how much to consume, and thus commit themselves not to consume too much. An investor who faces this self-control problem would therefore prefer dividends to capital gains, and the benefit of the commitment provided by dividends might be large enough to offset their tax disadvantage. Although this theory does not speak directly to the propensity to sell shares, it seems reasonable that a preference for dividends might be manifested in a lower propensity to sell stocks that pay dividends.

Broadly consistent with this theory, we find that having received dividends since stock purchase decreases investors’ propensities to sell stocks. Further significant decreases in the propensity to sell in a given month are related to whether the stock initiated dividend payments since the purchase and the receipt of a dividend during the previous month. The latter is particularly compelling, as, controlling for the amount of dividends the household has received

since purchase, the simple receipt of dividends last month reduces the likelihood the stock will be sold this month. However, these results regarding dividends are not fully consistent with the self-control theory of Shefrin and Statman (1984) because we also find that the receipt of dividends depresses sales in tax-deferred brokerage accounts (from which no current consumption takes place). Regardless of the interpretation of these results regarding dividends, they complement recent work by Baker and Wurgler (2002, 2003), who hypothesize that time-varying investor demand for dividends creates “catering incentives” that companies respond to through dividend initiations, omissions, and changes. The results in this paper provide direct evidence that investors do in fact demand dividends, in the sense that investors are less likely to sell shares that pay dividends.

The results about the effect of dividends on the propensity to sell common stock shed light on the so-called “dividend puzzle” that has been recognized at least since Black (1976). The essence of the dividend puzzle is that dividends are tax-disadvantaged relative to the alternative of distributing cash to shareholders through repurchasing common shares, yet companies nonetheless pay dividends. Black (1976) reviews the then extant arguments about why corporations pay dividends, finds them unconvincing, and concludes that “[w]e don’t know” why companies pay dividends. In an attempt to fill this gap, the last two decades have seen a large number of signaling models in which dividend payments are optimal for at least some companies, but these models have experienced limited success and acceptance. Allen and Michaely (2002; sections 6 and 7) survey both these signaling models and the empirical evidence about them, and write: [T]he empirical evidence provides a strong *prima facie* case against the traditional signaling models” (Allen and Michaely 2002, p. 77). After surveying all of the literature regarding dividends, they conclude that “our understanding of [dividends] is, to say the least, limited” (Allen and Michaely 2002, p. 117). The results in this paper provide an explanation, albeit not a fully rational one, of why some firms pay dividends. Simply put, investors *like* dividends, in the sense that receiving dividends since stock purchase decreases their propensity to sell the stock.

The remainder of this paper is divided into five sections. Section I describes the data and presents summary statistics on common stock purchases made by the 23,877 households that had both taxable and tax-deferred accounts and made at least one common-stock purchase over the sample period. Evidence on the importance of the relative performance of a stock for the

decision to sell is presented in Section II. Section III expands this inquiry to the role dividends play in the propensity to sell stocks. Next, Section IV explores the relation between returns, dividends, and holding periods. Section V concludes.

I. Data Description and Summary Statistics

A. Data Description

Monthly positions and trades of 78,000 households made in the period from January of 1991 to November of 1996 come from a large retail discount brokerage house. These investments are predominantly common stocks (around two-thirds of the overall value of the investments in the sample), followed by mutual funds (a further 18% of the overall value), as well as a broad range of other securities such as government bonds, corporate bonds, foreign securities, and derivatives. Each household can have multiple accounts, ranging up to 21 accounts (the median number of accounts per household is two). Around 24,000 households had both taxable accounts and tax-deferred accounts (IRAs and Keogh plans). Retirement plan accounts provided through work, such as 401(k)-type plans, are not included in the data set. The data set also provides information about the households' locations, that is, their zip codes. For a detailed description of the data set see Barber and Odean (2000).

We focus on trades of common stocks. Stock returns and most stock characteristics come from the Center for Research in Security Prices (CRSP), while other characteristics come from COMPUSTAT. To capture investors' differential behavior regarding capital gain and loss realizations in their taxable accounts and tax-deferred accounts we focus on the stock trades made by the households that had both types of accounts. We include in our data sample all the buys that did not have the matching sells in the sample period, as well as the buys and the sells 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 buys. In the instances in which multiple sales follow a single purchase only the first sale is admitted into the sample, which means that our analyses may understate the actual holding periods for common stocks.

B. Summary Statistics

Table I presents summary information on the number of stock purchases, stock sales, and the dollar values of such trades in our sample. Applying the criteria outlined above resulted in 414,047 buys made over the sample period, representing 23,877 households. Among all the purchases in the sample there were 97,266 stock purchases of \$10,000 or more (henceforth large purchases). These large purchases represent 23% of all buys in the sample (67% dollar-weighted). Just below three-fifths of all stock purchases were executed in taxable accounts (just below two-thirds for large purchases), with the balance executed in tax-deferred accounts. Slightly more than one-half of the purchases (52%, accounting for 60% of the dollar-weighted purchases) were followed by sells before the end of the sample period.

TABLE I ABOUT HERE

Table II presents certain characteristics of stock purchases in taxable accounts conditional on various minimum holding periods ranging from one month to four years. Panel A presents summary statistics for all purchases in the sample, while Panel B considers only large purchases (dollar amount greater than or equal to \$10,000). Each panel shows the respective stock returns and percentages of stocks that experienced gains (losses) since the purchase using both raw and market-adjusted returns. In addition, the table reports summary statistics for some of the key dividend variables we use—whether the stock paid a dividend since the purchase date and the dividend return since the purchase date.

TABLE II ABOUT HERE

Comparison of Panel A to Panel B reveals that the subset of large purchases generally had better performance than the entire sample. For the entire sample, returns relative to the market (i.e., market-relative returns) were negative for every holding period shown in the table. The market return used to calculate market-relative performance is the capital appreciation on the value-weighted CRSP index. Market-relative returns for the subsample of large purchases were also negative for holding periods between one and 24 months, but smaller in absolute value for holding periods of 12 and 24 months, and actually were positive for the holding periods of 36 and 48 months. Turning to the dividend variables, the average dividend return for 12 months

indicates a dividend yield of approximately two percent per year. For longer holding periods, the dividend return increases more than proportionately with the length of the holding period. This is partly due to generally rising stock prices over the sample period, but it also foreshadows the result below that investors have lower propensities to sell stocks with higher dividend payments, implying that such stocks will be held longer and thus will represent a larger fraction of the stocks held for a given holding period as the length of the holding period increases.¹ Roughly three-fifths (58.3% for the entire sample and 64.4% for the subsample of large purchases) of the stocks purchased paid dividends during the first year following purchase, with this percentage increasing steadily as the holding period increases. For example, 72.0% of stocks held at least four years have paid a dividend at least once since purchase (76.3% for large purchases). The increase in the percentage of purchases for which the investor received a dividend as the holding period increases may partly reflect dividend initiations, but again foreshadows the result that investors have lower propensities to sell stocks that initiate dividend payments.

II. Relative Performance and the Disposition Effect

A. Motivation

An issue that arises in empirical study of the disposition effect is that behavioral theories do not specify the benchmark against which gains and losses should be measured. Two natural candidates are a benchmark of a return of zero, implying that gains should be measured as absolute or raw returns, and a benchmark consisting of the performance of a market index, implying that gains and losses should be measured on a market-adjusted or relative basis. We extend previous empirical analyses (e.g., Odean (1998), Grinblatt and Kelaharju (2001)) by including *both* absolute and market-relative returns simultaneously in our analysis. In some specifications we also compute the return using the highest price achieved since purchase as the denominator, that is, using the “high-water mark” as the benchmark. There are two motivations for considering such different benchmarks.

First, the appropriate benchmark against which gains and losses should be measured is an open question. Previous work, such as Odean (1998), has focused on a disposition effect

¹ The dividend return is calculated as the difference between the total cumulative return on the stock and the capital appreciation of the stock, which implicitly assumes that dividends are reinvested in the stock.

regarding raw returns, without addressing the possibility that market-relative returns might better predict the propensity to sell. Second, in the tax code, capital gains and losses are based on absolute, not market-relative returns. The disposition and capital gains lock-in effects have offsetting implications for the effect of past returns on the propensity to sell, and, if one examines only the relation between absolute returns and the propensity to sell, it can be difficult to disentangle the two effects and assess their relative importance. For example, because the disposition and capital gains lock-in effects are confounding, the principal evidence in Ivković, Poterba, and Weisbenner (2003) for a capital gains lock-in effect consists of the differences between the sale propensities estimated from taxable and tax-deferred accounts. To the extent that the disposition effect is based on market-relative returns rather than raw returns, including both variables in the analysis allows for separate identification of the disposition and tax-motivated trading.²

B. Cox Proportional Hazard Models with Nonparametric Baseline Hazards and the Gompertz Parameterization

We model the decision to sell or not sell a stock as a discrete choice.³ Moreover, in our analyses the time until the sale takes place is the critical variable of interest. In such a setting it is natural to use the hazard function approach, commonly used in labor economics, credit risk modeling, biometrics, and a number of other fields. In most analyses we use the Cox (1972) proportional hazard model. We estimate Cox proportional hazard models in which a number of different variables are hypothesized to shift the realization probability.⁴ The key variables of interest are GAIN, defined as the maximum of the stock return since the purchase date and zero (where, unless stated otherwise, return is defined as the capital appreciation of the stock), LOSS, defined as the minimum of the stock return since the purchase date and zero, RELATIVE_GAIN, defined as the maximum of the return relative to the market since the purchase date and zero (where, unless stated otherwise, the market return is defined as the capital appreciation of the value-weighted CRSP index), RELATIVE_LOSS, defined as the minimum

² Of course, even if there is a disposition effect based on market-relative returns (which we find), this does not rule out the presence of one based on raw returns, so the disposition effect may still somewhat offset the capital gains lock-in effect. As a result, our estimates may underestimate the importance of tax-motivated trading.

³ In the data, an investor's sale of part of a position in a stock is rare, so we consider only the first date on which an investor sells any part of his position. Thus, we model only the discrete decision to sell or not sell part of the position.

of the market-relative return since the purchase date and zero, and a range of indicator variables for the characteristics of the holding period. We also include various firm characteristics as controls, and use both household and firm-specific baseline hazard rates to control for unobserved household and firm characteristics. The non-parametric estimation of the baseline hazard rates follows Han and Hausman (1990) and Meyer (1990).

If $h(t)$ denotes the hazard rate in month t (i.e., the probability the stock is sold in month t given it has been held through month $t-1$) the probability that the stock is still held at the end of month t is $\prod_{s=1,t}(1-h(s))$. The probability that the stock is sold in month t is $h(t)*\prod_{s=1,t-1}(1-h(s))$. The proportional hazard specification assumes that $h_i(t)$, the hazard function for sale of purchase i during month t after purchase, is expressed as $\lambda_0(t) \times e^{X\beta_{i,t}}$, where $\lambda_0(t)$ denotes the baseline hazard. For example, the specification we estimate in Table III is as follows:

$$\begin{aligned}
X\beta_{i,t} = & \beta_1 \times \text{GAIN}_{i,t-1} + \beta_2 \times \text{GAIN}_{i,t-1} \times \text{December}_{i,t} + \\
& \beta_3 \times \text{LOSS}_{i,t-1} + \beta_4 \times \text{LOSS}_{i,t-1} \times \text{December}_{i,t} + \beta_5 \times \text{December}_{i,t} + \\
& \beta_6 \times \text{RELATIVE_GAIN}_{i,t-1} + \beta_7 \times \text{RELATIVE_GAIN}_{i,t-1} \times \text{December}_{i,t} + \\
& \beta_8 \times \text{RELATIVE_LOSS}_{i,t-1} + \beta_9 \times \text{RELATIVE_LOSS}_{i,t-1} \times \text{December}_{i,t} + \varepsilon_{i,t}.
\end{aligned} \tag{1}$$

In other analyses, we use a simple parametric restriction of the baseline hazard function, the Gompertz model. This specification constrains the baseline hazard to follow an exponential path:

$$h_i(t) = e^{\gamma t} \times e^{X\beta_{i,t}} \tag{2}$$

Assuming a functional form for the baseline hazard, in this case exponential, allows one to extrapolate within-sample results to estimate expected holding periods, although it does constrain the shape of these functions. The parameter γ is the rate of decay, or growth, of the monthly baseline hazard rates.

C. Results

⁴ The use of hazard models in this context follows Ivković, Poterba, and Weisbenner (2003).

Table III shows the results of estimating the Cox proportional hazard model on the full sample using GAIN, LOSS, RELATIVE_GAIN, RELATIVE_LOSS, a dummy variable taking the value one in December, as well as interaction terms between the gain and loss variables and the December dummy variable, to shift the baseline hazard rate. The first three columns of Table III are based on baseline hazard rates $\lambda_0(t)$ that are the same for different households. The fourth through sixth columns correspond to the first three columns, except that the estimation uses household-specific baseline hazard rates. A comparison across the two sets of columns indicates that some of the estimated coefficients are slightly larger and some slightly smaller, but the general pattern of coefficients is not affected by the use of household-specific baseline hazard rates. Thus, allowing for a fairly general form of heterogeneity among households does not have a substantial effect on the direction and magnitude of our key results. In other words, even after controlling for the possibility that some households may always be more likely to sell stock than others, past absolute and relative performance still are important determinants of stock sales.

TABLE III ABOUT HERE

The first and fourth columns replicate the evidence presented in Ivković, Poterba, and Weisbenner (2003). The specification includes only the variables constructed from raw returns and the December dummy. Consistent with previous work (e.g., Odean (1998), Ivković, Poterba, and Weisbenner (2003)), the two columns show evidence of the disposition effect, as well as some evidence of a tax effect. The positive coefficient on GAIN indicates that, conditional on a positive return since purchase, the propensity to sell is positively related to the amount of capital gain. The positive coefficient on LOSS, on the other hand, suggests that a larger loss is associated with a reduced probability of sale (recall the variable LOSS is negative by construction). Both findings are consistent with a disposition effect (i.e., sell winners and hold losers). In terms of relative magnitudes, the coefficient on LOSS is much larger than the coefficient on GAIN. For example, a 20 percent gain in stock price boosts the monthly hazard rate of sale by 2 percent ($e^{0.11 \times 0.2} - 1$), while a 20 percent loss reduces the monthly hazard rate of sale by 19 percent ($e^{1.03 \times (-0.2)} - 1$). The coefficient on the interaction variable LOSS \times December is negative and significant, indicating that the relation between the loss and the propensity to sell is reversed in December, with losses in December boosting stock sales; these findings are consistent with several previous studies.

The second and fifth columns shows the results for a specification that includes only the variables constructed from relative returns, again plus the December dummy. These results using the relative returns are very similar to those in the first and fourth columns using the raw returns. Finally, the results in the third and sixth columns pertain to a specification that includes variables constructed from both raw and relative returns, and the coefficient estimates are quite different from those for the corresponding variables in the first, second, fourth, and fifth columns. The positive coefficient on the GAIN variable in the first and fourth columns switches sign and becomes significantly negative, while the negative coefficient on the interaction term GAIN×December is enhanced and becomes significant. The magnitudes of these coefficients are much larger than the corresponding coefficients in the first, second, fourth and fifth columns. For example, a 20 percent gain in stock price, controlling for relative performance, is associated with a 13 percent reduction in the monthly hazard rate of stock sale—the estimated reduction is 25 percent for the month of December. These results are the opposite of what a disposition effect based on raw returns would predict, but are consistent with tax-motivated trading, that is, a capital gains lock-in effect. The positive coefficient on LOSS persists after controlling for relative performance, consistent with a disposition effect on absolute losses as well as relative losses.

Turning to the coefficients on the variables constructed using relative returns, the coefficients on RELATIVE_GAIN, RELATIVE_GAIN×December, and RELATIVE_LOSS are all positive and highly significant, consistent with a disposition effect (additionally strengthened for relative gains in December) based on returns relative to the market. The only negative coefficient is on the interaction term RELATIVE_LOSS×December, and in the third column this estimated coefficient is not significantly different from zero at conventional levels. A comparison of the coefficients on GAIN and GAIN×December in the first and fourth columns to the respective coefficients in the third and sixth columns, and the coefficients on RELATIVE_GAIN and RELATIVE_GAIN×December in the second and fifth columns to the respective coefficients in the third and sixth columns suggests that simultaneous inclusion of both raw and relative returns in the specification replaces the apparent disposition effect based on raw returns with a capital gains lock-in effect, while the disposition effect based on relative returns becomes much stronger. Thus, the slightly positive coefficient on GAIN in the parsimonious regression that only includes absolute returns in column (1) actually reflects two

countervailing effects that are manifested in the richer regression in column (4): absolute gains strongly decrease the likelihood that a stock will be sold, while relative gains strongly increase the probability of sale. In short, the inclusion of both raw and relative returns in the hazard rate regressions improves the identification of the disposition effect.

Table IV verifies that these results are robust to the inclusion of other factors such as the performance of the investment over the past month and the return from a “high-water mark” consisting of the maximum stock price achieved since the purchase date, both of which have been shown to affect realization decisions (Grinblatt & Keloharju (2001) and Heath, Huddart, and Lang (1999)). The latter variable, the “high-water mark,” is defined as the price entering the month divided by the maximum of the end-of-month prices since the purchase date; by construction, it takes values between zero and one. Its inclusion allows for the possibility that there is a disposition effect in which the benchmark is the highest price achieved by the stock since purchase.

Consistent with Grinblatt & Keloharju (2001) and Heath, Huddart, and Lang (1999), we find that short-term returns (i.e., returns over the past month) are positively related to individuals’ stock sales. Inclusion of the short-term stock return, however, does not have a material impact on the importance of absolute and relative performance since purchase variables. The strong positive coefficient on the return relative to the high-water mark suggests that, controlling for absolute and relative performance, the price path matters. Specifically, households are much more (less) apt to sell those stocks that are trading close to (away from) the high-water mark.⁵ Once this new variable is included, the coefficient on absolute LOSS becomes *negative*, suggesting larger absolute losses are associated with a *greater* likelihood of stock sale, which is consistent with tax-motivated trading.⁶ Our results for individual stock sales are consistent with Heath, Huddart, and Lang (1999), who find that employee stock option exercises are positively related to short-term returns, negatively related to long-term returns, and

⁵ The disposition effect relative to the high stock price since purchase holds for both stocks with accrued capital gains and accrued capital losses. For example, when the coefficient on the variable defined as the ratio of the price entering the month divided by the maximum of the end-of-month prices since the purchase date is allowed to take on different values by whether the stock has an accrued gain or loss, in the full sample the coefficient for stocks with gains is 1.29 while it is 0.96 for stocks with losses (2.25 and 2.04 for the sample of large purchases, respectively). Thus, if the stock is trading down significantly from its high price since purchase, selling will be depressed regardless of the absolute stock performance since purchase.

⁶ In unreported analyses we verify that these results persist if the sample is restricted only to large initial purchases (purchases of at least \$10,000).

influenced by reference points such as the maximum stock price achieved over the past year. In summary, once we control for other plausible benchmarks that may affect trading activity of households (e.g., relative performance, closeness to previous high price since purchase) we attain a substantially deeper understanding of what drives stock sales and provide evidence that disposition is important, but find that this effect appears to be driven by performance relative to the market and its high-water mark rather than by the absolute performance of the stock.

TABLE IV ABOUT HERE

D. Linear Model Regression and Robustness of Relative Performance Results

In this section, we first present linear model regression results that further confirm the finding that individual investors in the sample tended to sell stocks with gains relative to the market and hold stocks with absolute gains (the capital gains lock-in effect). Specifically, in Table V and Figure 1, we present estimates from simple linear probability models to investigate how the effect of the past returns on the sale probabilities differs across months.⁷ We restrict our attention to the first year following the purchase date. For each calendar month in the first year, we construct an indicator variable taking the value one if the stock was sold during that month, and zero otherwise. We then regress these indicator variables on GAIN, LOSS, RELATIVE_GAIN, and RELATIVE_LOSS, and display the coefficient estimates in Table V.

Table V shows the impact of absolute and relative returns on the probability of sale in each month during the first year since purchase. There is considerable variation across different months in the effects of returns on the sale probabilities; returns seem to have very little impact on the sale probabilities in January, and relatively large impacts in February, March, and November. Nonetheless, there are consistent patterns in the results. Absolute gains have a consistently negative impact on the sale probabilities and absolute losses have a positive effect, consistent with tax motivations to realize losses and capture a tax deduction, and hold gains and defer a tax liability. Relative gains have a consistently positive impact on the sale probabilities and relative losses have a negative effect, indicating a disposition effect based on relative returns.

⁷ While the linear probability model suffers from the well-known limitation of allowing the estimated probabilities to lie outside the range $[0,1]$, its major advantages are that it involves no distributional assumptions and allows for easy interpretation because it gives the marginal effects directly.

FIGURE 1 ABOUT HERE

Figure 1 provides a closer look at the impacts of absolute and relative gains and losses on the sale probabilities, again based on the coefficient estimates from the linear probability model estimated separately by month. For each month, the solid gray bar shows the impact on the probability of sale of an absolute return of 25 percent versus an absolute return of -25 percent, while the solid black bar shows the impact on the probability of a relative return of 25 percent versus a relative return of -25 percent. As expected in light of the regression results from Table V, the solid gray bars are negative, consistent with the presence of tax-motivated trading (hold absolute gains and sell absolute losses), while the solid black bars are positive, suggesting a disposition effect based on relative returns (sell relative gains and hold relative losses).

Figure 1 also illustrates how trading differs across taxable and tax-deferred accounts. Bars with diagonal patterns represent differences between the estimates for taxable accounts (shown via full bars) and the analogous estimates for tax-deferred accounts (computed analogously, but not shown in the figure). With the exception of January, where it is approximately zero, the gray striped bars are consistently negative, indicating that the increased probability of realizing absolute losses relative to absolute gains is more pronounced in the taxable than it is in the tax-deferred accounts. This provides strong evidence of tax-motivated trading. The black striped bars are consistently positive (though fairly small in magnitude), indicating that the disposition effect based on relative returns is also stronger for the taxable accounts. Theory makes no prediction regarding this result; however, it is consistent with the possibility that investors manage their taxable accounts more actively than they manage their tax-deferred accounts (Barber and Odean (2002)).

In sum, the linear model regression results displayed in Table V and Figure 1 support the conclusions reached with the Cox proportional hazard model. Individual investors tended to sell stocks with gains relative to the market and to hold stocks with absolute gains. We next explore the robustness of the relative performance result.

One concern with the interpretation of the relative return variables is that they could simply reflect a non-linear relation between stock sales and absolute gains and losses. A stock with a substantial gain relative to the market is likely to also be a stock with a large absolute gain, and a stock with a substantial loss relative to the market is likely to have a large absolute

loss.⁸ Thus, if quadratic or cubic terms of the absolute GAIN and LOSS variables were included in the model, the relative performance variables might lose their significance.

Table VI presents regression results, focusing on the effect of relative performance, when various functional forms of absolute returns are also included in the model. The left panel of Table VI, Panel A, presents estimates for the Cox model (the base case for full sample replicates column (3) of Table III and the base case for large purchases replicates rightmost column of Table IV), while the right panel (Panel B) presents estimates for the linear model of stock sales by calendar month (base case replicates results in Table V). Both the Cox model and monthly linear regressions include relative returns and absolute returns (and various functions of absolute returns), with the Cox model also including an indicator variable for December and interactions of the return variables with December. Including quadratic and even cubic terms of the absolute GAIN and LOSS variables actually strengthens the positive coefficient on RELATIVE_GAIN in the Cox models, with the coefficient of RELATIVE_LOSS reduced in magnitude, although still positive, and no longer significant for the full sample of purchases. The inclusion of quadratic terms of GAIN and LOSS in the linear regressions of stock sales by calendar month slightly enhances the positive coefficient of RELATIVE_GAIN and slightly reduces the positive coefficient on RELATIVE_LOSS, but the basic conclusion of a strong disposition effect based on market performance since purchase of the stock remains unchanged.

TABLE VI ABOUT HERE

III. Dividends and the Propensity to Sell

A. Motivation

⁸ The sample can be divided into four groups of stocks: (i) those with both absolute and relative gains since the purchase date; (ii) those with absolute gains and relative losses; (iii) those with absolute losses and relative gains; and, finally, (iv) those with both absolute and relative losses. For the full sample of taxable purchases, across all months over which the purchase is included in the Cox model regressions, the stock enters the month in the four absolute/relative return groups with the following frequencies: 39 percent of monthly observations have both absolute and relative gain, 15 percent have absolute gain and relative loss, 0.6 percent have absolute loss and relative gain, and 45.5 percent have both absolute and relative loss. Of these samples, sample (iii), stocks with an absolute loss and a relative gain, clearly has the smallest number of observations. To be included in this group requires a negative market return over the holding period of the stock. The longest holding period over which a stock has a capital loss, but has actually performed better than the market is 22 months for some stocks bought in February of 1993.

This section examines whether dividends paid by a stock affect investors' propensity to sell shares. As discussed in the introduction, this empirical analysis is motivated by Shefrin and Statman's (1984) development of the Thaler and Shefrin (1981) theory of self-control that predicts investors' preference for cash dividends. While the Shefrin and Statman analysis does not speak directly to the propensity to sell, it seems reasonable that a preference for dividends might be manifested in a lower propensity to sell stocks that pay dividends.

B. Results

Table VII reports the results of linear regressions similar to those summarized in Table V. Specifically, for each purchase and each month in the first year after purchase in which the stock is still held in the investor's portfolio, we construct an indicator variable that takes the value one if the stock is sold in that month, and zero if it is not. Then, for each month, we regress these indicator variables on the cumulative stock return from the purchase date to the current month and indicator variables for dividend payments. In Table VII the variable of interest is PAYDIV that takes the value one if the stock paid dividends between the purchase date and the current date. Some specifications feature interaction terms that measure differences between taxable and tax-deferred accounts. For each month's regression, the table reports the coefficient estimate on PAYDIV.

TABLE VII ABOUT HERE

The first column shows the coefficients on PAYDIV for each of the twelve monthly regressions when the model is estimated using taxable accounts only. All of the coefficients on PAYDIV are significantly negative, ranging from -2.5 to -4.0 percent and averaging -3.2 percent across the twelve months. To put this effect into perspective, the predicted probability of sale for a stock with zero appreciation since purchase averages 7.4 percentage points across the twelve months. Thus, simply receiving dividends substantially reduces the likelihood a household will sell the stock. The results in the second and third columns are obtained using the sample of all accounts; the second column reports the coefficient on PAYDIV for tax-deferred accounts and the third column reports the coefficient on an interaction term given by the product of PAYDIV and a dummy variable taking the value one if the account is taxable. Thus, the sum of the coefficients in the second and third columns (tax-deferred and the difference between the

two types of accounts) should be equal to the coefficients reported in the first column (taxable accounts), save for rounding errors. With this specification, the coefficient on PAYDIV measures the effect of dividends on the propensity to sell for the tax-deferred accounts and the sum of this coefficient and that on the interaction term measures the effect of dividends for the taxable accounts. The coefficient on PAYDIV is negative and significant in every month. Moreover, the reduction in the propensity to sell shares due to dividends is slightly greater for the taxable accounts (a 0.4 percentage point additional reduction in taxable account relative to tax-deferred account on average across the twelve months).

The results in Table VII suggest that dividends reduce the propensity to sell in tax-deferred accounts are not captured by the self-control theory of dividends in Shefrin and Statman (1984). A key idea in that theory is that investors exhibit preference for dividend-paying stocks because this enables them to “commit” to consume only out of dividends. But, no current consumption takes place out of the tax-deferred accounts, thus the self-control theory of dividends does not have implications for such accounts.

One plausible explanation for this negative correlation between dividends and the propensity to sell is that “long-term” investors (i.e., investors with lower propensities to sell and thus longer expected holding periods) might prefer stocks that also happen to pay dividends. Thus, the link between selling propensities and dividends may simply reflect omitted stock-specific characteristics. To control for this possibility, we first re-estimate the models with firm fixed-effects. The inclusion of firm fixed-effects is meant to control for stock-specific characteristics such as being a value stock, having a conservative management, having good corporate governance, etc., that may attract buy-and-hold investors and may also be correlated with the payment of dividends. The results for the firm fixed-effects are in the fourth, fifth, and sixth columns of Table VII. The estimated effect of dividends, while it falls slightly, is still highly significant, and amounts to a 2.6 percentage point decline in selling probability on average across the twelve months.

In the seventh through ninth columns of Table VII the specifications include both household fixed-effects as well as firm-specific controls.⁹ In some sense, these regressions “over

⁹ Firm-specific controls include whether the stock is in the bottom or top quintile of market capitalization, book-to-market, and momentum (i.e., past eleven-month return) when purchased, as well as the monthly volatility based on the past 24 months of returns prior to purchase.

control” for the effect of dividends on stock sales, and thus provide a lower bound on their effect, because the dividend effect is identified from the realization behavior of households before and after the household receives a dividend on a particular type of stock (i.e., is a household more apt to sell a large, value stock before the household has received a dividend from the stock than it is after it has received the dividend), and ignores that the past receipt of dividends may influence subsequent purchase decisions and may result in some households becoming buy-and-hold investors in dividend-paying stocks (this effect of dividends on selling propensity is absorbed in the household fixed-effects). The magnitudes of the coefficient estimates decrease once household fixed-effects and stock-specific controls are included, but all of the coefficient estimates for taxable accounts are still significantly different from zero at the one percent level. The results still indicate that dividends have a significant negative impact on the propensity to sell, as having received a dividend since purchase still reduces the probability of sale by one percentage point on average across the twelve months.

In unreported analyses, we estimated regressions identical to those reported in Table VII except that the dummy variable PAYDIV had been replaced by the return due to dividend payments since the purchase date, where the dividend return is defined as the difference in the total stock return less the capital appreciation return. Using this alternative measure of dividends yields qualitatively similar results, indicating once again that the dividend return reduces the propensity to sell.

The results in Table VII suggest that dividends reduce the propensity to sell in tax-deferred accounts; these results are not captured by the self-control theory of dividends in Shefrin and Statman (1984). A key idea in that theory is that investors exhibit preference for dividend-paying stocks because this enables them to “commit” to consume only out of dividends. But no current consumption takes place out of the tax-deferred accounts, so the self-control theory of dividends does not have implications for such accounts.

Table VIII reports results from estimating various specifications of the Cox proportional hazard rate model using the subsample of taxable accounts. The top rows of the table report the coefficients on various measures of dividend payments, the key variables of interest in this section. Following them are coefficient estimates on a range of variables intended to control for differences in firm characteristics. These variables control for the possibility that investors with different expected holding periods may sort themselves on firm characteristics (e.g., value or

growth) that are correlated with dividend payments. The control variables also include the local stock dummy that takes a value one if the headquarters of the company is within 50 miles of the investor's residence. We include this variable because Ivković and Weisbenner (2003) find that it is correlated with investors' holding periods—individual investors tend to hold local stocks longer than non-local ones. Because these variables may not fully control for investor and firm characteristics, we also estimated some of the specifications with firm or household-specific baseline hazard rates. The cases in which we used these are indicated in the last two rows of the table. The table also indicates whether the DECEMBER, GAIN, LOSS, RELATIVE_GAIN, RELATIVE_LOSS, and the return relative to high price since purchase (high-water mark) variables are included, though the estimated coefficients for these variables are not reported.

TABLE VIII ABOUT HERE

The coefficients on the dividend variables provide strong support for the hypothesis that dividend payments reduce the propensity to sell. We first focus on the coefficient on the dummy variable “Received dividend since purchase,” shown in the first row. When there are no other controls in the Cox model of stock sales (column (1)), the receipt of dividends is predicted to reduce the monthly hazard of sale by 21 percent ($e^{-0.23} - 1$). When household-specific baselines (column (2)) or stock-specific baselines (column (3)) are also included in the regression, the receipt of dividends reduces the hazard rate of sale by seven to nine percent. The dummy variable for whether the stock has paid dividends since the purchase date, PAYDIV, is negative and highly significant in all those specifications in which it is the only dividend variable.

We next include five other dividend variables in addition to PAYDIV, the simple dummy variable indicating the receipt of dividends since purchase to see whether the amount and timing of the dividend payments matter. A few consistent patterns emerge. Particularly compelling is the coefficient on the dummy variable “Received dividend last month?” Controlling for whether the stock has paid a dividend since purchase, and the amount of the dividend paid, whether the household received a dividend last month reduces the probability the stock is sold this month by four to six percent, a result that is amazingly robust to all specifications, including those with household and firm-specific baselines. The coefficient on “Dividend return since purchase” is negative and significant in every specification, suggesting the amount of dividends received in

the past matters: a cumulative dividend return of five percent (0.05) reduces the estimated monthly hazard of sale by an additional five to twelve percent.

The dummy variable “Stock did not pay dividend prior to purchase” and the interaction term in the following row appear together in every specification in which they are included, and should be considered together. The positive coefficients on “Stock did not pay dividend prior to purchase” are consistent with some sorting of households in which households with higher propensities to sell are more likely to purchase stocks that do not pay dividends. When this variable is interacted with dividend initiation (the next row of the table) we see that the initiation of dividend payments on a stock that did not previously pay dividends has a significant negative impact on the propensity to sell. The initiation of dividends reduces the monthly hazard rate of stock sale by 12–31 percent across the specifications, suggesting a change in dividend policy by the firm substantially affects the holding period of the stock by individual investors. The interaction of the variable “Stock did not pay dividend prior to purchase” with the dividend return also has a consistently negative (though not significant) impact on the propensity to sell. In interpreting these results, those in columns (7) and (8) stand out, as these specifications include all controls and household and firm-specific baselines, respectively. They, consistent with the results in the other specifications, indicate that dividend initiations and recent receipt of dividends each have a significant effect on the propensity to sell shares.

Table IX investigates whether the strength of the effect of dividends on the propensity to sell shares varies with the time that has passed since the purchase date. It reports the estimated coefficients from two specifications—one with the dividend and key control variables from Table VIII, and the other one in which these variables are interacted with indicator variables that take the value one if the time elapsed since the purchase date is either less than or equal to six months or between seven and 12 months, respectively. The specifications that include the interaction terms (for each size range, the right-hand column) indicate that the time elapsed since purchase plays some role in the relation between dividends and the propensity to sell, but not a particularly large one. The estimated coefficients on the interaction terms involving the variable “Received dividend since purchase?” (second and third rows) are insignificant, indicating that the time elapsed since purchase does not play a role here. However, the estimated coefficients on the interaction terms involving the variable “Received dividend last month” (fifth and sixth rows) suggest that time may play a role—they are both negative, although only the interaction

with the indicator for 7-12 months since purchase is statistically significant. This suggests that the receipt of dividends last month may have a somewhat greater depressant effect on sales of more recently purchased stocks. The time elapsed since the purchase date does appear to play an important role in the momentum and size control variables. Momentum stocks are much more likely to be sold within six months of purchase, and large stocks are less likely to be sold in general, but particularly in the first year after purchase. Overall, however, the picture regarding dividends remains unchanged.¹⁰

TABLE IX ABOUT HERE

IV. Effects of Returns and Dividends on Holding Periods

The analyses presented so far did not include the estimation of the expected holding period because we relied on the Cox model and its non-parametric approach to estimating baseline hazard rates. Estimation of holding periods requires estimates of hazard rates into the indefinite future (i.e., extrapolate within sample results out of sample), which necessitates some parametric assumptions. In particular, we use the Gompertz specification of the hazard rate, which constrains the baseline hazard to follow the exponential path in Equation (2).¹¹

Table X compares the coefficient estimates obtained using the Cox and Gompertz baseline hazard functions. The pattern of positive and negative coefficients on the different variables is very similar. The only notable differences are that the magnitudes the coefficients of GAIN, LOSS, RELATIVE_GAIN, and RELATIVE_LOSS obtained using the Gompertz parametric baseline hazard rates are larger than the magnitudes of the estimates obtained using the non-parametric baseline hazard rates. These differences increase the impact of the respective returns variables on the holding periods we compute below, but do not alter any of the conclusions we draw. If anything, the coefficient estimates based on the Gompertz baseline hazard rates strengthen our conclusions about the disposition effect based on relative returns and the role of the relative return variables in aiding the identification of the capital gains lock-in

¹⁰ In unreported analyses we obtain similar results for large purchases (in excess of \$10,000).

¹¹ As reported in Ivković, Poterba, and Weisbenner (2003), the fit of the Gompertz model is good for both the full sample as well as the subsample of large purchases. A Wilcoxon signed-rank test of deviations between the nonparametric and exponential baselines fails to reject the model, while other commonly used parametric assumptions, such as the hazard rate following a Weibull or Log-Normal distribution, are rejected.

effect. When the return relative to the high price since purchase is also included in the specification (columns five and six), the coefficient on LOSS flips sign, turning significantly negative, suggesting that a larger absolute loss increases the probability of sale.

TABLE X ABOUT HERE

Table XI shows the probabilities that the stock is never sold and the expected holding periods for some illustrative values of absolute returns, returns relative to the market, the indicator variable for a local stock (i.e., headquartered within 50 miles of the household), an indicator variable for receiving dividends since purchase, and the ratio of the current stock price to the maximum stock price since purchase. Thus, this table provides information about the economic importance of these variables in affecting stock sales. The choices for the variables are shown in the first five columns, and the estimated probability the stock is never sold corresponding to those choices is shown in the sixth column. The seventh (rightmost) column also shows the expected holding periods. Specifically, we assume that the stock was purchased in January and that the stock had a return of 50 percent, 0 percent, or –50 percent and a relative return of 25 percent, 0 percent, or –25 percent throughout. The estimates of the probability that the stock is never sold are obtained via the Gompertz model.¹² When calculating the expected holding period of the stock, the probability of no sale is multiplied by 20 years and then added to the product of the expected holding period, conditional on a sale being made (in a probabilistic sense), and the probability of sale as computed from the Gompertz model. Thus, the expected holding periods are computed under the somewhat conservative assumption that the maximum holding period is 20 years.¹³ The top three rows of the table are based on a model in which only the absolute return variables GAIN and LOSS are used to shift the hazard rate functions. Using the estimate from this model, having an absolute return of 50 percent versus an absolute loss of 50 percent decreases the probability of no sale from 52 to 33 percent and the expected holding period from 132 to 89 months. This result is due to the apparent strong disposition effect that is

¹² Because of the exponential baseline, the cumulative probability of sale asymptotes to some constant that is less than or equal to one. One minus this constant reflects the probability the stock is never sold.

¹³ We view the choice of 20 years as conservative; capital gains taxation upon realization and basis step-up at death could lead toward much larger holding periods. Moreover, Ivković, Poterba, and Weisbenner (2003) report that hazard rates of selling stocks decline fairly sharply, approaching zero after only a few years since purchase.

found when the hazard rate models are estimated using only absolute return variables to shift the baseline hazard rates, and is consistent with past work (Odean (1998)).

Analyses in Sections II and III show that considering relative stock performance and its dividend history provides a much richer characterization of the hazard rates, and hence the expected holding periods. The middle three panels Table XI are based on a model that includes GAIN, LOSS, RELATIVE_GAIN, and RELATIVE_LOSS, as well as indicator variables for stocks that are local to the household and stocks that have paid a dividend since the purchase date. Comparing rows with different values of absolute return but the same values of the other three variables indicates a *positive* relation between the absolute return and the probability of *no sale* and the expected holding period. This change in the sign of the relation reflects the fact that the coefficient estimates on the absolute return variables switch sign once market-relative returns are included in the regressions. Having a relative gain versus a relative loss decreases the probability that the stock is never sold by 16 to 26 percentage points and reduces the expected holding period by 41 to 60 months, depending on the values taken by the absolute gain or loss and the dummy variables for locality and receipt of dividends. The dummy variables for locality and receipt of dividends increase the expected holding period as well. For example, when both the absolute and relative returns are zero, receipt of a dividend increases the probability of no sale 14 percentage points, and the expected holding period 33 months. For the same values of returns, the probability of no sale for a local stock is five percentage points greater than it is for a non-local stock, and the expected holding period is 12 months longer.

Finally, the bottom panel of Table XI provides estimates of the economic importance of a disposition effect centered on the maximum stock price since purchase. As the results indicate, the price path of the stock clearly matters, even after controlling for the cumulative absolute return of the stock and its performance relative to the market. For example, the probability that a stock with an absolute return of 50 percent is never sold is 34 percent with an expected holding period of 99 months if the current stock price is at the maximum price since purchase (i.e., the ratio is 1.0), while the probability of no sale for this stock spikes up to 76 percent and the holding period rises to 190 months if the current stock price is only one-half of the maximum price since purchase (i.e., the ratio is 0.5). Controlling for relative performance and the return relative to the high-water mark, absolute gains are realized *less* quickly than absolute losses.

TABLE XI ABOUT HERE

V. Conclusion

The results in this paper provide a novel and rich characterization of the disposition effect and the effect of dividends on the propensity to hold or sell common stocks. We find strong evidence for a disposition effect related to returns relative to the market. Regression results also provide evidence for a disposition effect based on the return from a high-water mark (i.e., the probability of stock sale is reduced the farther away the stock price is from its high since purchase, controlling for absolute and relative performance). Once we include relative returns in the hazard rate regressions, we find absolute gains in stock price are associated with a *reduced* probability of sale. Moreover, once we also include performance relative to the high-water mark in the specification, larger absolute losses are associated with a *greater* likelihood of stock sale. Both these effects are consistent with tax-motivated trading. Thus, once we control for other plausible benchmarks that may affect trading activity of households (e.g., relative performance, closeness to previous high price since purchase) we attain a substantially deeper understanding of what drives stock sales and provide evidence that the disposition effect is important, but find that this effect appears to be driven by performance relative to the market and its high-water mark rather than the absolute performance of the stock. Finally, the specifications including measures of dividends paid on the stock provide robust evidence that dividends affect the propensity to sell. In particular, the propensity to sell is negatively related to whether the stock has paid dividends since the purchase date, whether the stock initiated dividend payments since the purchase date, and whether dividends were paid during the previous month. The latter result is particularly compelling, as, controlling for the amount of dividends the household has received since purchase, the simple receipt of dividends last month reduces the likelihood the stock will be sold this month.

The results regarding the role of relative returns are important because theoretical work on the disposition effect provides no guidance regarding the appropriate benchmark, that is, whether gains should be measured as absolute returns, relative to the performance of a market index, or relative to some other benchmark. The results in this paper provide empirical evidence of disposition effects based on returns relative to the market and returns relative to the maximum stock price since purchase that are strikingly strong.

The results regarding dividends are more of a puzzle. We find that the dividends reduce the propensity to sell in both taxable and tax-deferred accounts. While the self-control theory of dividends due to Shefrin and Statman (1984) does not have direct implications for the propensity to sell, it seems reasonable that a preference for dividends might be manifested in a lower propensity to sell stocks that pay dividends. The estimated relation between having paid a dividend in the previous month and the propensity to sell is also consistent with the Shefrin and Statman (1984) analysis if one thinks that investors need to be reminded of the dividend payments. Thus, the self-control theory seems able to explain the effect of dividends in the taxable accounts. However, a key idea in Shefrin and Statman (1984) is that investors' preference for dividend-paying stocks occurs because this enables them to "commit" to consume only out of dividends, and no current consumption takes place out of the tax-deferred accounts. Hence, the self-control theory of dividends does not address why dividends reduce the propensity to sell in the tax-deferred accounts. We are not aware of any theory that predicts these results.

Regardless of how their interpretation, the results about the effect of dividends on the propensity to sell common stock shed light on the so-called "dividend puzzle" that has been recognized at least since Black (1976). As evidenced by the discussion in Brealey and Myers (2002) and Allen and Michaely (2002), the puzzle still persists. The results in this paper provide an explanation, albeit not a fully rational one, of why some firms pay dividends. It is interesting to note that our direct evidence that investors like dividends is consistent with recent indirect evidence from a survey of financial executives. Brav, Graham, Harvey, and Michaely (2003) survey CFOs and other financial executives about their companies' dividend policies, and find that a large fraction of the financial executives surveyed believe that retail investors like dividends. The perception of these financial executives seems to be correct—individual investors in fact do *like* dividends, in the sense that receiving dividends since stock purchase decreases the propensity to sell the stock.

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Table I: Summary Statistics of Common Stock Purchases 1991-1996

	Number of Buys	Average \$ Amount of Buys (Median)	Percentage of Buys \geq \$10K [\$ weighted]	Percentage of Buys Sold During the Sample Period [\$ weighted]
All Accounts	414,047	9,329 (4,762)	23 [67]	52 [60]
Taxable Accounts	241,046	10,404 (5,063)	26 [71]	53 [60]
Tax-Deferred Accounts	173,001	7,831 (4,310)	20 [60]	51 [60]

Sample consists of 23,877 households that had both taxable and tax-deferred accounts and had at least one stock purchase over the sample period 1/91 though 11/96. Median dollar amount of purchase is reported in parentheses. Dollar weighted averages are reported in brackets for the fraction of purchases that are at least \$10,000 and the probability a stock is sold by the end of the sample (November 1996).

Table II: Characteristics of Stock Purchases in Taxable Accounts Given Minimum Holding Period

<i>Panel A: All Stock Purchases in Taxable Accounts</i>						
	After 1 Month	After 6 Months	After 12 Months	After 24 Months	After 36 Months	After 48 Months
Return (in %)	0.7	2.3	6.4	15.7	26.8	41.3
% Gain	49.7	50.6	52.3	55.0	58.0	63.8
% Loss	48.2	48.8	47.3	44.7	41.9	36.1
Return Relative to Market (in %)	-0.4	-3.2	-4.9	-5.1	-2.8	-5.9
% Relative Gain	47.0	41.9	39.2	37.6	37.3	33.1
% Relative Loss	52.9	58.1	60.8	62.4	62.7	66.9
Received Dividend?	15.9	53.1	58.3	63.8	67.5	72.0
Dividend Return (in %)	0.1	0.9	2.0	4.9	8.4	14.2
# Observations	200,941	130,898	91,631	54,122	33,669	19,065
<i>Panel B: Stock Purchase in Taxable Accounts of at least \$10,000</i>						
	After 1 Month	After 6 Months	After 12 Months	After 24 Months	After 36 Months	After 48 Months
Return (in %)	0.1	2.3	8.3	20.1	32.2	51.6
% Gain	49.2	51.3	54.6	57.9	60.9	68.1
% Loss	49.3	48.1	45.1	41.9	38.9	31.9
Return Relative to Market (in %)	-0.8	-3.4	-3.6	-1.0	2.5	4.5
% Relative Gain	46.0	41.9	40.3	39.4	40.1	36.3
% Relative Loss	54.0	58.1	59.7	60.6	59.9	63.7
Received Dividend?	18.0	59.4	64.4	69.6	72.7	76.3
Dividend Return (in %)	0.1	0.9	2.1	5.3	9.1	15.5
# Observations	45,897	26,436	17,760	10,119	6,201	3,485

Table III: Cox Model of Selling Stock on Prior Absolute Performance and Relative Performance, Full Sample

<i>Variable</i>	Model estimated with taxable accounts					
	(1)	(2)	(3)	(4)	(5)	(6)
GAIN	0.11 ^{***} (0.01)		-0.70 ^{***} (0.06)	0.21 ^{***} (0.01)		-0.70 ^{***} (0.07)
GAIN*December	-0.02 (0.02)		-0.71 ^{***} (0.16)	-0.06 ^{**} (0.03)		-0.58 ^{***} (0.18)
LOSS	1.03 ^{***} (0.03)		0.75 ^{***} (0.07)	1.38 ^{***} (0.03)		1.20 ^{***} (0.08)
LOSS*December	-2.23 ^{***} (0.05)		-1.98 ^{***} (0.15)	-2.35 ^{***} (0.06)		-1.85 ^{***} (0.18)
December	0.12 ^{***} (0.01)	0.11 ^{***} (0.01)	0.13 ^{***} (0.01)	0.10 ^{***} (0.01)	0.08 ^{***} (0.01)	0.10 ^{***} (0.02)
RELATIVE_GAIN		0.11 ^{***} (0.01)	0.82 ^{***} (0.06)		0.22 ^{***} (0.01)	0.96 ^{***} (0.07)
RELATIVE_GAIN* December		0.00 (0.02)	0.75 ^{***} (0.17)		-0.03 (0.04)	0.59 ^{***} (0.20)
RELATIVE_LOSS		0.79 ^{***} (0.02)	0.39 ^{***} (0.06)		1.09 ^{***} (0.02)	0.28 ^{***} (0.07)
RELATIVE_LOSS* December		-1.69 ^{***} (0.04)	-0.20 (0.13)		-1.86 ^{***} (0.05)	-0.45 ^{***} (0.16)
Household-specific baseline?	No	No	No	Yes	Yes	Yes

GAIN = max(stock return, 0), LOSS = min(stock return, 0), RELATIVE_GAIN = max(stock return less market return since purchase date, 0), and RELATIVE_LOSS = min(stock return less market return since purchase date, 0). The stock return is defined as the capital appreciation of the stock. The Cox proportional hazards model employs a non-parametric estimate of the baseline hazard, $\lambda_0(t)$, (i.e., the probability of selling stock month t after the buy conditional on no prior sale). All regressions estimated over 3,449,531 observations. Standard errors (shown in parentheses) allow for heteroskedasticity as well as correlation across observations of the same household. ^{***}, ^{**}, ^{*} Significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

Table IV: Cox Proportional Hazards Model of Stock Sales, Stock Sale Related to Performance Since Purchase and Over the Last Month, Taxable Accounts

<i>Variable</i>	<i>Full Sample</i>	
GAIN	-0.70 ^{***} (0.06)	-0.84 ^{***} (0.06)
GAIN*December	-0.77 ^{***} (0.16)	-0.80 ^{***} (0.16)
LOSS	0.56 ^{***} (0.07)	-0.26 ^{***} (0.08)
LOSS*December	-2.09 ^{***} (0.16)	-1.89 ^{***} (0.20)
RELATIVE_GAIN	0.80 ^{***} (0.06)	0.94 ^{***} (0.06)
RELATIVE_GAIN*December	0.79 ^{***} (0.17)	0.82 ^{***} (0.17)
RELATIVE_LOSS	0.44 ^{***} (0.06)	0.32 ^{***} (0.06)
RELATIVE_LOSS*December	-0.11 (0.13)	0.02 (0.14)
Price Entering Month / Maximum Price Since Purchase		1.15 ^{***} (0.06)
(Price Entering Month / Maximum Price Since Purchase)*December		-0.41 ^{**} (0.17)
GAIN (last month)	0.41 ^{***} (0.04)	0.41 ^{***} (0.04)
GAIN (last month)*December	0.51 ^{***} (0.09)	0.51 ^{***} (0.09)
LOSS (last month)	0.56 ^{***} (0.06)	0.05 (0.07)
LOSS (last month)*December	-0.01 (0.15)	0.28 [*] (0.15)
December	0.11 ^{***} (0.02)	0.52 ^{***} (0.16)
# Observations	3,449,531	3,449,531

^{***}, ^{**}, ^{*} Significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

GAIN = max(return, 0), LOSS = min(return, 0), RELATIVE_GAIN = max(stock return less market return since purchase date, 0), and RELATIVE_LOSS = min(stock return less market return since purchase date, 0). The stock return is defined as the capital appreciation of the stock. Variables are also created based on the stock return over the last month, as opposed to being measured since the purchase date. “Price Entering Month / Maximum Price Since Purchase” is defined as the price entering the month divided by the maximum of the end-of-month prices since the purchase date, and thus takes on values between zero and one. The Cox proportional hazards model employs a non-parametric estimate of the baseline hazard, $\lambda_0(t)$, (i.e., the probability of selling stock month t after the buy conditional on no prior sale). Standard errors (shown in parentheses) allow for heteroskedasticity as well as correlation across observations of the same household.

Table V: Regression of Hazard Rate of Selling Stock (in Percent) by Calendar Month upon Absolute Return on Stock Entering the Month and Cumulative Return Relative to the Market

	Constant: Baseline	Coefficient: GAIN	Coefficient: LOSS	Coefficient: RELATIVE_GAIN	Coefficient: RELATIVE_LOSS
1 st January	7.5 ^{***} (0.2)	-4.9 ^{***} (1.9)	0.4 (1.7)	7.9 ^{***} (2.1)	9.5 ^{***} (1.6)
1 st February	8.1 ^{***} (0.2)	-27.3 ^{***} (1.8)	-17.7 ^{***} (1.9)	30.6 ^{***} (2.0)	27.2 ^{***} (1.8)
1 st March	8.0 ^{***} (0.2)	-34.4 ^{***} (2.2)	-28.9 ^{***} (2.0)	38.3 ^{***} (2.3)	36.2 ^{***} (1.9)
1 st April	6.6 ^{***} (0.2)	-17.9 ^{***} (2.1)	-7.9 ^{***} (1.6)	21.1 ^{***} (2.2)	16.1 ^{***} (1.4)
1 st May	6.5 ^{***} (0.2)	-23.7 ^{***} (1.9)	-3.9 ^{**} (1.6)	26.6 ^{***} (2.1)	12.7 ^{***} (1.5)
1 st June	5.8 ^{***} (0.2)	-17.0 ^{***} (1.5)	-8.5 ^{***} (1.4)	18.7 ^{**} (1.7)	14.3 ^{***} (1.3)
1 st July	5.7 ^{***} (0.1)	-15.6 ^{***} (1.5)	-0.5 (1.2)	17.6 ^{***} (1.6)	7.6 ^{***} (1.2)
1 st August	6.0 ^{***} (0.1)	-14.4 ^{***} (1.6)	-2.6 [*] (1.4)	17.2 ^{***} (1.8)	11.0 ^{***} (1.4)
1 st September	5.9 ^{***} (0.1)	-18.3 ^{***} (1.6)	-9.9 ^{***} (1.4)	20.4 ^{***} (1.7)	16.7 ^{***} (1.4)
1 st October	6.3 ^{***} (0.1)	-21.7 ^{***} (1.4)	-9.9 ^{***} (1.4)	23.9 ^{***} (1.5)	16.9 ^{***} (1.3)
1 st November	6.5 ^{***} (0.2)	-30.3 ^{***} (1.5)	-18.2 ^{***} (1.5)	32.7 ^{***} (1.7)	23.0 ^{***} (1.4)
1 st December	6.1 ^{***} (0.2)	-16.3 ^{***} (1.3)	-19.6 ^{***} (2.0)	16.7 ^{***} (1.5)	12.6 ^{***} (1.8)

Sell During Calendar Month_{i,t} = $\alpha_t + \beta_{1,t} * GAIN_{i,t-1} + \beta_{2,t} * LOSS_{i,t-1} + \beta_{3,t} * RELATIVE_GAIN_{i,t-1} + \beta_{4,t} * RELATIVE_LOSS_{i,t-1} + \varepsilon_{i,t}$

GAIN = max(stock return, 0), LOSS = min(stock return, 0), RELATIVE_GAIN = max(stock return less market return since purchase date, 0), and RELATIVE_LOSS = min(stock return less market return since purchase date, 0). The stock return is defined as the capital appreciation of the stock. Standard errors (shown in parentheses) allow for heteroskedasticity as well as correlation across observations of the same household. ^{***}, ^{**}, ^{*} Significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

Table VI: Robustness of Relative Return Results to Inclusion of Nonlinear Functions of Absolute Returns, Taxable Accounts

<i>Panel A: Cox Model of Selling Stock on Prior Relative Performance and Absolute Performance</i>				<i>Panel B: Linear Regression of Probability of Selling Stock Sale (in percent) by Calendar Month</i>			
<i>Functional form of GAIN and LOSS included in regression:</i>				<i>Basic Specification: GAIN/LOSS included</i>		<i>Quadratic terms for GAIN/LOSS also included</i>	
	Base case: GAIN & LOSS only	Quadratic terms	Cubic terms	Coefficient: RELATIVE GAIN	Coefficient: RELATIVE LOSS	Coefficient: RELATIVE GAIN	Coefficient: RELATIVE LOSS
<i>Full Sample</i>							
RELATIVE_GAIN	0.82 ^{***} (0.06)	1.57 ^{***} (0.07)	1.70 ^{***} (0.07)	1 st January: 7.9 ^{***}	9.5 ^{***}	11.8 ^{***}	7.1 ^{***}
RELATIVE_LOSS	0.39 ^{***} (0.06)	0.08 (0.06)	0.06 (0.06)	1 st February: 30.6 ^{***}	27.2 ^{***}	36.3 ^{***}	23.1 ^{***}
				1 st March: 38.3 ^{***}	36.2 ^{***}	41.5 ^{***}	33.8 ^{***}
				1 st April: 21.1 ^{***}	16.1 ^{***}	25.3 ^{***}	15.0 ^{***}
				1 st May: 26.6 ^{***}	12.7 ^{***}	31.8 ^{***}	11.3 ^{***}
				1 st June: 18.7 ^{**}	14.3 ^{***}	23.3 ^{**}	12.7 ^{***}
				1 st July: 17.6 ^{***}	7.6 ^{***}	19.8 ^{***}	7.4 ^{***}
				1 st August: 17.2 ^{***}	11.0 ^{***}	20.9 ^{***}	10.4 ^{***}
				1 st September: 20.4 ^{***}	16.7 ^{***}	24.6 ^{***}	14.6 ^{***}
				1 st October: 23.9 ^{***}	16.9 ^{***}	27.6 ^{***}	14.4 ^{***}
				1 st November: 32.7 ^{***}	23.0 ^{***}	36.3 ^{***}	20.5 ^{***}
				1 st December: 16.7 ^{***}	12.6 ^{***}	16.4 ^{***}	12.9 ^{***}
<i>Purchase at least \$10,000</i>							
RELATIVE_GAIN	1.13 ^{***} (0.13)	1.57 ^{***} (0.16)	1.65 ^{***} (0.15)				
RELATIVE_LOSS	0.36 ^{***} (0.13)	0.24 [*] (0.13)	0.25 [*] (0.13)				

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

GAIN = max(stock return, 0), LOSS = min(stock return, 0), RELATIVE_GAIN = max(stock return less market return since purchase date, 0), and RELATIVE_LOSS = min(stock return less market return since purchase date, 0). The stock return is defined as the capital appreciation of the stock.

The Cox proportional hazards model employs a non-parametric estimate of the baseline hazard, $\lambda_0(t)$, (i.e., the probability of selling stock month t after the buy conditional on no prior sale). All Cox models include relative gains and losses, absolute gains and losses, an indicator variable for December, and interactions of the return variables with December. The model may also include quadratic and cubic terms of the absolute gain and loss variables, also interacted with December. Standard errors (shown in parentheses) allow for heteroskedasticity as well as correlation across observations of the same household.

The linear model regressions are of the form:

$$\text{Sell During Calendar Month}_{i,t} = \alpha_t + \beta_{1,t} * \text{GAIN}_{i,t-1} + \beta_{2,t} * \text{LOSS}_{i,t-1} + \beta_{3,t} * \text{RELATIVE_GAIN}_{i,t-1} + \beta_{4,t} * \text{RELATIVE_LOSS}_{i,t-1} + \varepsilon_{i,t}$$

GAIN = max(stock return, 0), LOSS = min(stock return, 0), RELATIVE_GAIN = max(stock return less market return since purchase date, 0), and RELATIVE_LOSS = min(stock return less market return since purchase date, 0). The stock return is defined as the capital appreciation of the stock. The linear models may also include quadratic terms of the absolute gain and loss variables. Standard errors (not shown) allow for heteroskedasticity as well as correlation across observations of the same household.

Table VII: Regression of Hazard Rate of Selling Stock (in Percent) by Calendar Month upon Cumulative Return on Stock and Whether have Received Dividends Entering the Month, Coefficient on PAYDIV reported, Full Sample

	Basic Specification			Firm Effects Included			Household Effects Included		
	Taxable accounts	All accounts		Taxable accounts only	All accounts		Taxable accounts only	All accounts	
		<i>Tax-deferred accounts</i>	Interaction w/ taxable accounts		<i>Tax-deferred accounts</i>	Interaction w/ taxable accounts		<i>Tax-deferred accounts</i>	Interaction w/ taxable accounts
1 st January	-4.0 ^{***} (0.2)	-3.8 ^{***} (0.2)	-0.2 (0.3)	-3.4 ^{***} (0.3)	-2.9 ^{***} (0.4)	-0.5 (0.5)	-1.2 ^{***} (0.3)	-0.7 ^{**} (0.3)	-0.5 (0.4)
1 st February	-3.9 ^{***} (0.2)	-3.3 ^{***} (0.2)	-0.6 ^{**} (0.2)	-3.2 ^{***} (0.3)	-2.6 ^{***} (0.3)	-0.6 (0.4)	-1.2 ^{***} (0.2)	-1.1 ^{***} (0.3)	-0.2 (0.4)
1 st March	-3.6 ^{***} (0.2)	-2.9 ^{***} (0.2)	-0.7 ^{***} (0.2)	-2.6 ^{***} (0.3)	-2.1 ^{***} (0.3)	-0.6 (0.4)	-0.8 ^{***} (0.2)	-0.9 ^{***} (0.3)	0.1 (0.3)
1 st April	-3.4 ^{***} (0.2)	-2.6 ^{***} (0.2)	-0.8 ^{***} (0.2)	-2.9 ^{***} (0.3)	-1.9 ^{***} (0.3)	-1.0 ^{***} (0.4)	-1.0 ^{***} (0.2)	-0.7 ^{***} (0.3)	-0.2 (0.3)
1 st May	-3.5 ^{***} (0.2)	-2.9 ^{***} (0.2)	-0.5 ^{**} (0.2)	-2.5 ^{***} (0.3)	-1.8 ^{***} (0.3)	-0.7 [*] (0.4)	-1.5 ^{***} (0.2)	-0.7 ^{***} (0.2)	-0.8 ^{***} (0.3)
1 st June	-2.5 ^{***} (0.1)	-1.9 ^{***} (0.2)	-0.6 ^{***} (0.2)	-2.2 ^{***} (0.2)	-1.4 ^{***} (0.2)	-0.9 ^{***} (0.3)	-0.6 ^{***} (0.2)	-0.1 (0.2)	-0.5 [*] (0.3)
1 st July	-2.8 ^{***} (0.2)	-2.7 ^{***} (0.2)	-0.1 (0.2)	-2.8 ^{***} (0.3)	-1.7 ^{***} (0.3)	-1.1 ^{***} (0.4)	-1.1 ^{***} (0.2)	-1.1 ^{***} (0.2)	-0.1 (0.3)
1 st August	-2.8 ^{***} (0.2)	-2.5 ^{***} (0.2)	-0.4 [*] (0.2)	-2.2 ^{***} (0.3)	-1.7 ^{***} (0.3)	-0.5 (0.4)	-1.0 ^{***} (0.2)	-0.8 ^{***} (0.2)	-0.2 (0.3)
1 st Sept.	-2.9 ^{***} (0.1)	-2.5 ^{***} (0.2)	-0.3 (0.2)	-2.2 ^{***} (0.3)	-1.4 ^{***} (0.2)	-0.8 ^{**} (0.3)	-1.0 ^{***} (0.2)	-0.5 ^{**} (0.2)	-0.4 (0.3)
1 st October	-3.2 ^{***} (0.2)	-2.8 ^{***} (0.2)	-0.4 ^{**} (0.2)	-2.4 ^{***} (0.3)	-2.1 ^{***} (0.3)	-0.4 (0.4)	-1.3 ^{***} (0.2)	-0.2 (0.2)	-1.1 ^{***} (0.3)
1 st Nov	-2.8 ^{***} (0.2)	-2.9 ^{***} (0.2)	0.0 (0.2)	-2.3 ^{***} (0.2)	-2.1 ^{***} (0.3)	-0.2 (0.3)	-0.9 ^{***} (0.2)	-1.1 ^{***} (0.2)	0.2 (0.3)
1 st Dec	-2.7 ^{***} (0.2)	-2.3 ^{***} (0.2)	-0.3 (0.2)	-2.7 ^{***} (0.3)	-2.1 ^{***} (0.3)	-0.6 (0.4)	-0.7 ^{***} (0.3)	-0.0 (0.3)	-0.7 ^{**} (0.4)

Sell During Calendar Month_{i,t} = $\alpha_1 + \beta_{1,t} * \text{GAIN}_{i,t-1} + \beta_{2,t} * \text{LOSS}_{i,t-1} + \beta_{3,t} * \text{PAYDIV}_{i,t-1} + \varepsilon_{i,t}$, where GAIN = max(return, 0), LOSS = min(return, 0), and PAYDIV = 1 if received any dividends on stock (0 otherwise). The stock return is defined as the capital appreciation of the stock. Model estimated by OLS. Standard errors (shown in parentheses) allow for heteroskedasticity as well as correlation across observations of the same household. Specifications with household effects also include stock-specific controls for past momentum, book-to-market, size, and volatility. ***, **, * Significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

Table VIII: Cox Model of Stock Sales on Dividends Received, Absolute Performance, Relative Performance, and Locality of Purchase, Sample is Taxable Accounts

<i>Variable</i>	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Received dividend since purchase? (PAYDIV)	-0.23*** (0.01)	-0.09*** (0.01)	-0.07*** (0.02)	0.06*** (0.01)	0.10*** (0.02)	0.07*** (0.02)	0.05** (0.02)	0.07*** (0.03)
Received dividend last month?				-0.05*** (0.01)	-0.06*** (0.01)	-0.05*** (0.01)	-0.04*** (0.01)	-0.04*** (0.02)
Dividend return since purchase				-1.27*** (0.10)	-1.02*** (0.15)	-1.33*** (0.16)	-2.60*** (0.26)	-1.08*** (0.39)
Stock did not pay dividend prior to purchase?				0.25*** (0.01)	0.16*** (0.02)	0.16*** (0.02)	0.07*** (0.02)	0.14*** (0.04)
Stock did not pay div. prior to purchase? * Received dividend since purchase?				-0.13*** (0.05)	-0.25*** (0.06)	-0.24*** (0.06)	-0.18*** (0.07)	-0.37*** (0.08)
Stock did not pay div. prior to purchase? * Dividend return since purchase				-1.49 (1.08)	-0.72 (1.23)	-0.43 (1.24)	0.30 (1.52)	-1.11 (1.31)
Local stock (within 50 miles of HH)					-0.16*** (0.01)	-0.16*** (0.01)	-0.09*** (0.02)	-0.17*** (0.02)
Bottom Quintile Mom.					0.02* (0.01)	0.03*** (0.01)	0.05*** (0.01)	-0.06*** (0.01)
Top Quintile Momentum					0.16*** (0.01)	0.17*** (0.01)	0.06*** (0.01)	0.08*** (0.01)
Bottom Quintile B/M					-0.07*** (0.01)	-0.08*** (0.01)	-0.05*** (0.01)	-0.10*** (0.02)
Top Quintile B/M					0.03 (0.02)	0.04** (0.02)	0.01 (0.02)	0.01 (0.03)
Bottom Quintile Size					-0.19*** (0.01)	-0.17*** (0.01)	-0.16*** (0.02)	-0.02 (0.03)
Top Quintile Size					-0.26*** (0.01)	-0.27*** (0.01)	-0.16*** (0.01)	-0.28*** (0.03)
Monthly Volatility					1.35*** (0.09)	1.57*** (0.09)	0.78*** (0.10)	1.59*** (0.18)
DEC, GAIN/LOSS controls included?	No	No	No	No	Yes	Yes	Yes	Yes
REL. GAIN/LOSS, high-water included?	No	No	No	No	No	Yes	Yes	Yes
HH-specific baseline?	No	Yes	No	No	No	No	Yes	No
Firm-specific baseline?	No	No	Yes	No	No	No	No	Yes

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

GAIN = $\max(\text{stock return}, 0)$, LOSS = $\min(\text{stock return}, 0)$, RELATIVE_GAIN = $\max(\text{stock return less market return since purchase date}, 0)$, RELATIVE_LOSS = $\min(\text{stock return less market return since purchase date}, 0)$, high-water refers to the “Price Entering Month / Maximum Price Since Purchase” variable which is defined as the price entering the month divided by the maximum of the end-of-month prices since the purchase date, and DEC = indicator for month of December. The stock return is defined as the capital appreciation of the stock. See text for discussion of dividend variables. The Cox proportional hazards model employs a non-parametric estimate of the baseline hazard, $\lambda_0(t)$, (i.e., the probability of selling stock month t after the buy conditional on no prior sale). Standard errors (shown in parentheses) allow for heteroskedasticity as well as correlation across observations of the same household.

Table IX: Cox Proportional Hazards Model of Stock Sales in Taxable Accounts (inclusion of whether received dividend and locality interacted with holding period)

<i>Variable</i>	(1)	(2)
Received dividend since purchase?	-0.13 ^{***}	-0.14 ^{***}
	(0.01)	(0.02)
Rec. dividend? * (w/in 6 months of buy)		0.03
		(0.03)
Rec. dividend? * (mos. 7 – 12 of buy)		0.02
		(0.03)
Received dividend last month?	-0.08 ^{***}	-0.04
	(0.01)	(0.02)
Rec. div. last month * (w/in 6 mos. of buy)		-0.04
		(0.03)
Rec. div. last month * (mos. 7 – 12 of buy)		-0.08 ^{**}
		(0.04)
Local stock (within 50 miles of hh)	-0.16 ^{***}	-0.16 ^{***}
	(0.01)	(0.03)
Local stock * (w/in 6 mos. of buy)		0.02
		(0.03)
Local stock * (mos. 7 – 12 of buy)		-0.04
		(0.04)
Top Quintile Momentum	0.21 ^{***}	0.03 [*]
	(0.01)	(0.02)
Top Quintile Momentum * (w/in 6 mos. of buy)		0.27 ^{***}
		(0.02)
Top Quintile Momentum * (mos. 7–12 of buy)		0.06 ^{**}
		(0.03)
Top Quintile Size	-0.27 ^{***}	-0.13 ^{***}
	(0.01)	(0.02)
Top Quintile Size * (w/in 6 mos. of buy)		-0.19 ^{***}
		(0.02)
Top Quintile Size * (mos. 7 – 12 of buy)		-0.15 ^{***}
		(0.03)

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

Other variables included in the model are GAIN = max(stock return, 0), LOSS = min(stock return, 0), an indicator variable for December, interactions of the return variables with December, and interactions of all of these aforementioned variables with indicators for whether the observation is within 6 months of the purchase date and within 7 – 12 months of the purchase date. The stock return is defined as the capital appreciation of the stock. The Cox proportional hazards model employs a non-parametric estimate of the baseline hazard, $\lambda_0(t)$, (i.e., the probability of selling stock month t after the buy conditional on no prior sale). Standard errors (shown in parentheses) allow for heteroskedasticity as well as correlation across observations of the same household.

Table X: Cox and Gompertz Proportional Hazard Models of Stock Sales, Taxable Accounts

	Cox	Gompertz	Cox	Gompertz	Cox	Gompertz
GAIN	0.11 *** (0.01)	0.08 *** (0.01)	-0.72 *** (0.07)	-1.68 *** (0.08)	-0.93 *** (0.08)	-1.99 *** (0.08)
GAIN*December	-0.02 (0.02)	-0.06 * (0.03)	-0.72 *** (0.21)	-0.68 *** (0.22)	-0.71 *** (0.21)	-0.64 *** (0.22)
LOSS	1.03 *** (0.03)	1.21 *** (0.03)	1.20 *** (0.09)	0.70 *** (0.09)	-0.28 *** (0.11)	-1.54 *** (0.11)
LOSS*December	-2.23 *** (0.05)	-2.23 *** (0.05)	-2.23 *** (0.21)	-2.01 *** (0.21)	-2.19 *** (0.27)	-2.10 *** (0.28)
December	0.12 *** (0.01)	0.12 *** (0.01)	0.14 *** (0.02)	0.11 ** (0.02)	0.30 (0.22)	0.16 (0.23)
RELATIVE_GAIN			0.81 *** (0.08)	1.75 *** (0.08)	1.01 *** (0.08)	2.04 *** (0.08)
RELATIVE_GAIN* December			0.77 *** (0.22)	0.71 *** (0.23)	0.75 *** (0.22)	0.66 *** (0.23)
RELATIVE_LOSS			0.25 *** (0.08)	1.08 *** (0.08)	0.09 (0.08)	0.88 *** (0.08)
RELATIVE_LOSS* December			-0.10 (0.17)	-0.31 * (0.18)	0.00 (0.18)	-0.18 (0.18)
Price Entering Month / Max. Price Since Purchase					1.88 *** (0.08)	2.73 *** (0.08)
(Price Entering Month / Max. Price)*December					-0.16 (0.23)	-0.05 (0.24)
Received dividend since purchase?			-0.32 *** (0.01)	-0.43 *** (0.01)	-0.37 *** (0.01)	-0.48 *** (0.01)
Local Stock?			-0.15 *** (0.01)	-0.16 *** (0.01)	-0.15 *** (0.01)	-0.15 *** (0.01)
Constant		-2.75 *** (0.01)		-2.52 *** (0.01)		-5.17 *** (0.08)
Gamma (rate of decay γ)		-0.060 *** (0.001)		-0.039 *** (0.001)		-0.030 *** (0.001)
# Observations	3,449,531	3,449,531	1,760,586	1,760,586	1,760,586	1,760,586

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

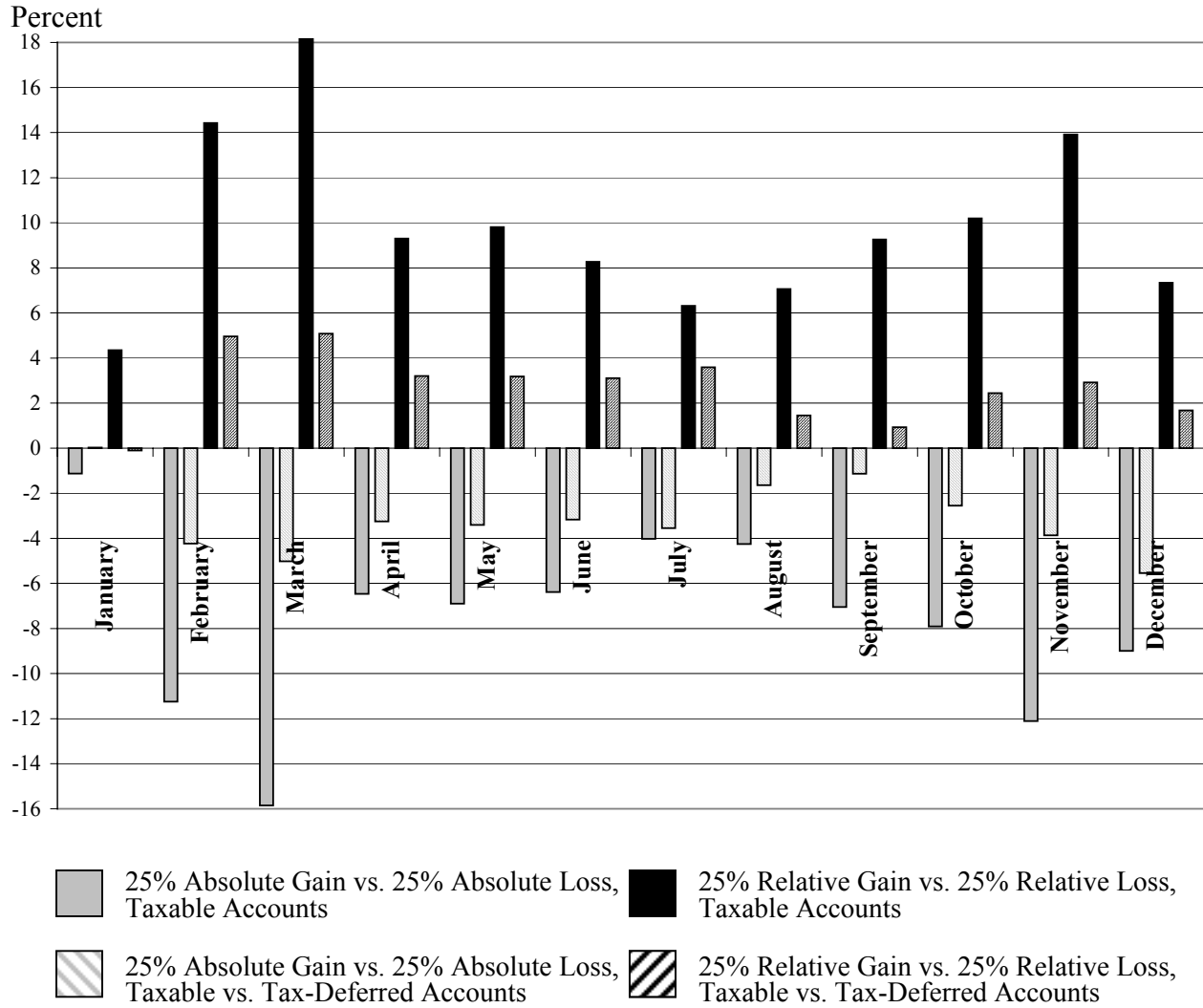
GAIN = $\max(\text{return}, 0)$, LOSS = $\min(\text{return}, 0)$, RELATIVE_GAIN = $\max(\text{stock return less market return since purchase date}, 0)$, RELATIVE_LOSS = $\min(\text{stock return less market return since purchase date}, 0)$, “Price Entering Month / Maximum Price Since Purchase” is defined as the price entering the month divided by the maximum of the end-of-month prices since the purchase date, and a local stock is stock of a firm headquartered within 50 miles of the household. The stock return is defined as the capital appreciation of the stock. The Cox proportional hazards model employs a non-parametric estimate of the baseline hazard, $\lambda_0(t)$, (i.e., the probability of selling stock month t after the buy conditional on no prior sale). The Gompertz proportional hazards model employs a parametric estimate of the baseline hazard, e^{γ^*t} (i.e., the probability of selling stock month t after the buy conditional on no prior sale). Standard errors (shown in parentheses) allow for heteroskedasticity as well as correlation across observations of the same household.

Table XI: Expected Holding Period for Taxable Purchases, Conditional on Return Experience, Relative Performance, Locality, and Receipt of Dividends

Absolute Return (%)	Return Relative to Market (%)	Local Stock?	Received Dividend?	Current Price/Max. Price Since Purchase	Prob. Stock <i>Not Sold</i> (%)	Expected Holding Period (months)
50					33	89
0					35	93
-50					52	132
50	0	No	No		42	114
50	0	<i>Yes</i>	No		47	125
50	0	No	<i>Yes</i>		57	147
50	0	<i>Yes</i>	<i>Yes</i>		61	156
50	25	No	No		25	74
50	25	No	<i>Yes</i>		41	111
50	-25	No	No		51	134
50	-25	No	<i>Yes</i>		65	164
0	0	No	No		12	43
0	0	<i>Yes</i>	No		17	55
0	0	No	<i>Yes</i>		26	76
0	0	<i>Yes</i>	<i>Yes</i>		31	88
0	25	No	No		4	21
0	25	No	<i>Yes</i>		12	43
0	-25	No	No		20	62
0	-25	No	<i>Yes</i>		35	98
-50	0	No	No		19	60
-50	0	<i>Yes</i>	No		24	73
-50	0	No	<i>Yes</i>		34	95
-50	0	<i>Yes</i>	<i>Yes</i>		40	109
-50	25	No	No		7	30
-50	25	No	<i>Yes</i>		17	56
-50	-25	No	No		27	79
-50	-25	No	<i>Yes</i>		43	116
50	0	No	No	1.0	34	99
50	0	No	No	0.5	76	190
0	0	No	No	1.0	5	27
0	0	No	No	0.5	47	128
-50	0	No	No	0.5	15	55

It is assumed that the stock was purchased in January and that the stock had a return of 50%, 0%, or -50% throughout. The probability that the stock is never sold is estimated by the proportional hazards Gompertz model. When calculating the expected holding period of the stock, the probability of no sale is multiplied by 20 years and then added to the product of the expected holding period, conditional on a sale being made (in a probabilistic sense), and the probability of sale as estimated by the proportional hazards Gompertz model.

Figure 1: Likelihood of Sale for Various Scenarios of Absolute and Relative Performance



Full gray bars depict differences in selling probabilities between 25% absolute gains vs. 25% absolute losses for taxable accounts, assuming that the return relative to the market is equal to 0. Analogously, full black bars depict differences in selling probabilities between 25% relative gains vs. 25% relative losses for taxable accounts, assuming that the stock return is equal to 0. The stock return is defined as the capital appreciation of the stock. The relevant regression specification is:

$$\text{Sell During Calendar Month}_{i,t} = \alpha_t + \beta_{1,t} * \text{GAIN}_{i,t-1} + \beta_{2,t} * \text{LOSS}_{i,t-1} + \beta_{3,t} * \text{RELATIVE_GAIN}_{i,t-1} + \beta_{4,t} * \text{RELATIVE_LOSS}_{i,t-1} + \varepsilon_{i,t}$$

Coefficient estimates are reported in Table V. For each month, full gray bars display $(0.25\beta_{1,t} - 0.25\beta_{2,t})$ and full black bars display $(0.25\beta_{3,t} - 0.25\beta_{4,t})$. Bars with diagonal patterns represent differences between the estimates for taxable accounts (shown via full bars) and the analogous estimates for tax-deferred accounts (computed analogously, but not shown in the figure).