Investment Taxation and Portfolio Performance

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Abstract

Most financial research mistakenly assumes that growth/value and market capitalization portfolios command similar tax burdens. The ability to defer capital gains creates more heterogeneity in after-tax returns then previously recognized. We use the 1926 to 2002 Federal Tax code to generate tax-optimized after-tax returns that investors at different income levels would have realized on a set of benchmark portfolios. For an investor at the 95% income level, the historical tax cost of holding SMB and HML is, respectively, almost 3 and 17 times greater than the cost on the market premium.

1. Introduction

Investors face both dividend taxes and capital gains taxes. Dividend taxes are incurred when corporations make cash distributions to shareholders, and capital gains taxes are incurred when securities are sold. From recent data, Sialm (2006) estimates that 55% of U. S. equity is held in a taxable account.[1] Even though the majority of equity is subject to taxation, the finance literature has not produced any after-tax stock indices. This paper considers the direct impact of both types of taxation on various portfolio strategies. Our calculations assume realistic optimizing tax-realization strategies, with the highest-basis shares of given companies sold before lower-basis shares. Our results provide new evidence on the impact of investment taxation on investment performance. Contrary to the view that dividend yield is a sufficient statistic for measuring tax burden, we find that capital gains tax-timing options induce differences in tax burdens that are related to portfolio style and composition method.

The optimal tax-trading strategy is to sell stocks that have lost value relative to their tax basis and hold stocks that have gained value relative to their basis. Because of this, different portfolio strategies, which differ in the degree to which gains and losses are deferred and harvested, will have specific style and composition-related tax burdens. For example, portfolio strategies that involve maintaining equal position weights, small market capitalization stocks, and value stocks induce capital gains realizations in positions that have done well, and defer realization in stocks that have done poorly. This creates a high capital gains tax burden for taxable investors who follow these portfolio strategies. On the other hand, portfolios where holdings are value weighted, portfolios of large market capitalization stocks, and portfolios of growth stocks correspond more closely to the optimal tax-trading strategy. Thus, the differences that we document in the after-tax returns to different strategies come not only from differences in the patterns of pre-tax returns, but from differences in the pattern of capital gains realizations induced by the need to maintain these particular portfolio strategies.

We calculate the after-tax returns to a set of benchmark portfolios that includes a value-weighted index, an equally-weighted index, portfolios of small and large firms, portfolios of value and growth firms, and portfolios sorted by dividend yield. Taxation has a large impact on portfolio returns and wealth accumulation. Our analysis shows that an investor, taxed over the

[1] This statistic underestimates the historical importance of equity taxation since personal tax-deferred accounts are a recent phenomena.

1926-2002 period at the rates prevailing at the 95th percentile of income, and holding an equal weighted portfolio of NYSE stocks, accumulates a portfolio worth only 26.9% as much as a tax-exempt investor holding the same portfolio over the same period. Given the tax rates prevailing at the 99.5th percentile of the income distribution, the estimated terminal portfolio value is only 14.1% of as much as a tax-exempt investor.

In addition to calculating the return to portfolios with only positive holdings of stocks, we calculate the returns to strategies that have both long and short components, for instance the Fama-French benchmark SMB and HML strategies. For each of these portfolios, we calculate after-tax returns for 7 different levels of investor income. Income level affects after-tax returns due to the progressive nature of the tax system, in which higher income levels are associated with higher marginal tax rates. In addition to estimating portfolio returns given the changing structure of tax rates over the period, we also evaluate the after-tax portfolio returns that investors would have earned had the tax rates prevailing in December 2000 prevailed through the entire period.

Our analysis provides new benchmarks for evaluating investment performance. While the average pre-tax log return to the strategy of investing in a value-weighted portfolio of NYSE stocks between 1927 and 2002 was 9.63 percent per year, the realized after-tax returns enjoyed by an investor who faced the tax rates prevailing at the 99th percentile of income was 8.00 percent per year. Because a value-weighted portfolio involves low amounts of trading, the bulk of this effective tax burden comes from the taxation of dividends coming from the portfolio. Of the annual tax cost of 16.97% $\left(\frac{8.00-9.63}{9.63}\right)$, dividends induce a tax cost of 14.82% and capital gains induce a tax cost of 1.74%. These individual costs do not add up to the total cost due to a "Fisher effect."

The equal-weighted portfolio of NYSE stocks, over the same period, had an average log return of 11.98 percent per year. Because maintaining an equally-weighted portfolio involves more trading activity than maintaining a value-weighted portfolio, the relative burden of capital gains taxes actually experienced by investors is much greater for this portfolio. The after-tax return experienced by an investor who faced the marginal tax rates observed at the 99th percentile of the income distribution was 9.71 percent; the tax cost of 18.94% comes from a 10.11% annual

cost of dividend taxes and a 7.73% capital gains cost. Comparing the tax cost for the equal versus value-weighted strategy, the equal weighted strategy has higher a relative tax cost, despite that is has much lower dividend tax costs than the value-weighted strategy. The benefit of the equal weighted strategy's lower exposure to dividends is more than off-set by its increased exposure to capital gains taxation.

This and other results suggest that taxation has an impact on investment performance that is substantial and differs significantly across investment strategies. Analysis of the returns to portfolios that both include many securities and that assume optimal capital gains realization behavior has been absent from the literature.[2] This absence is surprising, given the extent of tax burdens; the costs documented here are larger than a variety of other transactions costs documented in the literature. Realistic modeling of these costs is an important innovation. Our results show that optimal tax realization induces higher performance for all portfolios that we consider. For high-tax rate investors who replicate an equal-weighted index, the benefit is particularly large, inducing performance that is over a third larger than that of the sub-optimal strategy.

The results documented in this paper are all partial equilibrium results. We take portfolio strategies, pretax returns, and the structure of tax rates as given, and estimate the after-tax returns enjoyed by tax-paying investors. We do not argue that all investors pay taxes, or directly present evidence on the equilibrium impact of taxes on pre-tax returns. Our innovation in this paper is to offer a first, precise estimate of the after-tax returns of standard portfolio, and to illustrate the impact that tax-deferral options has on portfolio performance.

2. Why does capital gains deferral matter?

If capital gains tax rates are constant, the ability to defer capital gains taxes reduces the burden they impose. Deferral allows investors to earn an extra return on assets that would have already been taken by the government, had capital gains been taxed upon accrual rather than upon realization.

[2] See Dammon, Spatt, and Zhang 2001 'Optimal Consumption and Investment with Capital Gains Taxes' for a simulations that assume, when shares are sold, that the basis of the shares sold is the average basis of all shares ever purchased. This paper also simplifies the problem by considering only one risky asset. An unpublished theoretical paper by Dybvig and Koo (1996) assumes the optimal selection of high-basis shares, but also simplifies the problem by considering only one asset.

We examine the returns to portfolio strategies that that are based on annual rebalancing, for instance due to individual stocks moving in and out of book-market or size-related categories. Most of our rebalancing occurs annually, although events such as delisting and dividends payments cause some month-to-month rebalancing. To the extent that month-to-month rebalancing induces realization of short-term capital gains, we use the appropriate short-term rate. Long-term and short-term capital gains tax rates have generally diverged during our sample period. In our simulations, the required portfolios are determined by the strategies (value-weight, equal-weight, small firm, large firm, etc). While we account for optimal management of share bases, conditional on trades, and we apply the correct tax rate given the holding period observed, we do not consider extra trading beyond the trading motivated by the goal of maintaining the simple strategies under consideration. Constantinides (1983, 1984) shows that the strategy of selling short-term losers and holding long-term winners creates value. Because we do not consider this strategy, our results under-estimate the importance of capital gains taxation.

While we do not consider tax-timing strategies designed to take advantage of differences in the tax rates applied to long-term and short-term capital gains, our results do capture a different part of the value transferred to investors through tax-deferral. The ability to defer the payment of taxes, and effectively earn a rate of return on accrued by unrealized capital gains taxes, is quite large. A simple example, which follows from Chay, Choi, and Pontiff (2006), illustrates the value of this option to defer the payment of capital gains taxes. Let r denote the expected return from an asset, and t be the tax rate on realized capital gains. Consider an investor with \$1. If he realizes capital gains every period, the investor's expected terminal wealth after n periods, W_{real}, will be,

$$W_{real} = \left(1 + r(1-t)\right)^n .$$

This can be rewritten as

$$W_{real} = \sum_{i=0}^{n} \binom{n}{i} \left(r^i\right)(1-t)^i .$$

For an investor who defers realization, terminal wealth W_{def} of the \$1 investment will be

$$W_{def} = (1+r)^n - t\left((1+r)^n - 1\right)$$

or,

$$W_{def} = t + \sum_{i=0}^{n} \binom{n}{i} (r^i)(1-t).$$

The expected value of the difference between these two strategies is

$$W_{def} - W_{real} = t + \sum_{i=0}^{n} \binom{n}{i} (r^i)\left((1-t) - (1-t)^i\right).$$

For $n>1$ and $0<t<1$, this difference will be positive, and thus, deferring capital gains realization will produce higher levels of expected wealth.

The discount rate of this strategy corresponds to the after-tax return that is associated with realizing every period, $r(1-t)$. Assuming various nominal rates on capital gains, and a pre-tax return of 9.76% (the arithmetic average return of our value-weighted index between 1926 and 2002), figure 1 shows the impact of holding period on the net present value of capital gains deferral. The net present values associated with deferral are substantial. For example, if the capital gains rate is 25%, the decision to hold the stock for eight years, versus realizing a gain every year, is equivalent to 10 percent of the current investment's value. This option to defer accruing capital gains is at the heart of the analysis in the sections that follow.

3. Constructing tax rates, 1927-2002

Our tax rates for the period between 1927 and 2002 are based on data from a variety of sources. Because we are interested in constructing the portfolio returns enjoyed by investors at different parts of the income distribution, we collect data both on the structure of taxes over the period, and on the income distribution.

The different percentiles of the income distribution are taken from Piketty and Saez (2003)[3]. Piketty and Saez present data on the level of income (defined as gross income, excluding capital gains and before taxes) at the 90th, 95th, 99th, 99.5th, 99.9th, and 99.99th percentiles of the income distribution back to 1916. Their percentiles are measured in constant (2000) dollars; we use the CPI to deflate these figures to current dollars. Because the Piketty-Saez series end in 2000; incomes percentiles for 2001 and 2002 are assumed to equal (in real dollars) those in 2000. Table 1 presents data on the income levels at different percentiles near the

[3] The income level data for the different percentiles come from an appendix in the earlier working paper version (NBER WP 8467, available at www.nber.org/papers/W8467).

top of the income distribution between 1926 and 2002. We use these marginal tax rates to assess the investment tax cost for various investors at different percentiles of gross income.

Because stock ownership is concentrated among high-income households, we focus on the top of the income distribution. Table 2, based on data from the 2001 Survey of Consumer Finances (SCF), demonstrates the concentration in the possession of stocks and dividends. Our measures of equity holdings include only securities held outside of tax-deferred accounts; assets held within IRA and 401(k) retirement savings plans would be excluded from these measures. Indirectly-held equities are held through mutual funds. Table 2 shows a variety of thresholds as well as the share of families who report Adjusted Gross Income (AGI) in excess of each of these thresholds. The table also shows the share of directly-held equity and the share of directly and indirectly-held equity reported by households above each AGI threshold, as well as the share of dividends reported by households above each threshold. These results suggest that in 2000 (the reference year for the 2001 SCF), the median family reported an AGI of between $25,000 and $50,000. In that same year, the median dollar of direct stockholdings was held by a household with AGI between $275,000 and $300,000. This is close to the $288,350 breakpoint between the region where income is taxed at a 36 percent rate and the region where the marginal tax rate on income is 39.6 percent.

Including equities held indirectly through mutual funds creates a somewhat more egalitarian picture: the median dollar of direct and indirect equity is held by a household reporting AGI between $200,000 and $225,000. Dividends are even more evenly distributed: the median dollar of dividends reported in the 2001 SCF was reported by a household with AGI between $150,000 and $175,000. Dividends are still remarkably concentrated, however: the household receiving the median dollar of dividends still reported more income than 95 percent of households. This concentration is the reason for our focus on calculating the after-tax returns for investors in the top decile of the income distribution.

We use a variety of sources to calculate income and capital gain tax rates at each of these income percentiles in each year. Table 3 documents some of the changes to relevant federal tax rates during our sample period. We calculate marginal tax rates separately for dividends and for capital gains. In addition, we separately measure capital gains tax rates by holding period, with holding periods of 1-5 months, 6-11 months, 12-17 months, 18-23 months, 2-5 years, 5-10 years,

and more than 10 years each potentially being subject to a different rate of taxation. These distinctions are necessary because of the variety of tax regimes observed over time.

For example, 1997 saw a special medium-term capital gain tax rate, distinct from the short term capital gain tax rate and the long-term capital gain tax rate, applied to the sale of assets held for between 12 and 18 months. The period between 1934 and 1937 also saw a variety of effective tax rates applied to capital gains on securities, with different rates for stocks held for less than 1 year, less than 2 years, less then five years, less than ten years, and for more than ten years.

Information used to construct our marginal tax rates for the period between 1926 and 1943 comes from the 1954 IRS Statistics of Income publication.[4] These marginal tax rates reach a minimum in 1929, when the tax rate on income for investors at the 90^{th} percentile of income as 0.5 percent. The maximum marginal tax rates come in 1944, when the total federal tax rate on an income for an investor at the 99.99^{th} percentile of income was 92 percent.

The marginal tax rates between 1944 and 1987 come from Pechman's (1987) reference on American income taxes. Marginal tax rates in the period after 1987 are derived from the Instructions to form 1040 for each of the years during that period.

We assume that all capital losses in the portfolio can be used in the current year. This can be a counterfactual assumption; capital losses can be used to offset capital gains in the current year, and currently $3,000 worth of capital losses can be used to offset ordinary income. In reality, capital losses that are realized, but cannot be used to offset capital gains or ordinary income (because they exceed the limit of total capital gains, plus $3,000 in ordinary income) may be carried forward. Our assumption that capital losses can always be used to offset capital gains in the current year is appropriate for an investor who also has a separate large portfolio on which capital gains are continuously being realized.

Due to the variation in state tax codes, we ignore state taxes. We expect that this omission will produce results that understate the importance of taxation.

[4] Special thanks to Clemens Sialm for sending his copies of these data publications.

4. Return data

Our data on stock prices, splits, distributions, mergers, and delistings come from the CRSP database. For distributions and delistings, we apply the appropriate tax rates for the given hypothetical investor.

4.1. Constructing portfolios

Portfolios are constructed on the basis of market equity, book-to-market ratio, and firms' dividend policies. Book equity for the period since 1962 come from Compustat, and measures of book equity are constructed according to the procedures detailed in Davis, Fama, and French (2000). For the period prior to Compustat coverage book equity data come from the US Historical Book Equity data that are available on Ken French's website.[5]

We divide firms into groups based on size and based on the ratio of book equity to market equity. The cutoffs for the different deciles of size and book-market come also from Ken French's data library, and are constructed based on the sample of firms listed on the New York Stock Exchange. Firms are sorted into size breakpoints based on their market equity capitalization at the end of the most recently completed month of June. For the months of July through December are sorted into book-market breakpoints based on their ratio of book equity to market equity as of the end of the previous year. For the months of January through June, firms are sorted into BE/ME breakpoints based on their level as of the next-to-last December.

This method of constructing the portfolios induces heavy trading in the month of July of each year, when the portfolios are reassigned. For a given portfolio, changes in weights between June and July reflect the movement of stocks into and out of the boundaries set by the market equity and book-market cutoff values.

Dividend-based portfolios are constructed based on firms' dividend policies in the most recent completed years. Firms are allocated first to portfolios of dividend-payers versus non-dividend payers. Among dividend paying firms, firms are broken down into firms whose dividend policies in the previous year place them among the top half of dividend paying firms (in terms of the dividend payout ratio to lagged share price), and those whose dividend policies place them among the bottom half of dividend-paying firms. The policy of assigning firms to

[5] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

dividend-based portfolios based only on the information in the subsequent years makes these portfolios somewhat more trading-intensive than would be the case if we constructed portfolios based on longer patterns of dividend events.

4.2. Constructing portfolio returns

All portfolios include only stocks listed on the NYSE. This restriction eliminates drastic portfolio changes when NASDAQ data enter the CRSP dataset. The analysis starts in June of 1927, with a portfolio of $100 in long positions and $100 in short positions. Focusing on the long side, the $100 is allocated across the stocks in the NYSE, depending on the strategy chosen. For instance, if the strategy chosen is a value-weighted portfolio of the smallest half of the shares in the market, then the weights within this portfolio are set accordingly. All long portfolios are totally self-financing, thus all distributions are reinvested in the portfolio and all taxes are paid through partial liquidation of positions. We also consider strategies that involve both a long and a short portfolio. For these strategies, the value of the short portfolio is re-adjusted every month to equate to the long portfolio, causing the short portfolio to consume or generate cashflow.

The long portfolio's value in July 1927 depends on the pattern of distributions, delistings, and changes in price over the preceding month. The program that calculates the portfolio return first accounts for all of these distributions and delistings, paying the appropriate taxes and recording the amount of cash on hand after these distributions are made. Then, the appropriate portfolio weights for the next month are chosen. These portfolio weights may be different from the preceding month, in particular if stocks have moved into or out of the portfolio under consideration. For instance, if we are analyzing the return to the small firm strategy, and a firm moves beyond the relevant market equity size breakpoint, then its weight starting in the month that it moves out of the relevant group will be zero.

The long portfolio is reallocated according to the new desired portfolio weights. Reallocation involves the realization of some capital gains or losses, since some stocks are being purchased and some sold. The realization of capital gains, for a taxable investor, means that the reallocation to the new desired portfolio weights imposes a new round of taxes in the simulation. This round of taxes is in addition to the taxes that were involuntary, based on the distribution of dividends and on capital gains realized through the removal of companies from the test portfolio.

In our simulation, the taxes paid on these gains change the size of the portfolio in that month, leading to a new round of capital gains realizations. These capital gains realizations, in turn, create a new set of taxes. Our approach is to iterate three times down this path. Three iterations bring us very close to the fixed point where the capital gains taxes that must be paid are precisely payable given the cash taken from the portfolio from the net sale of stock in the long portfolio.

The simulation routine keeps track of the basis of each of the shares in the test portfolio, adjusting the per-share basis as necessary for distributions and for corporate events such as stock splits. To calculate the long-portfolio returns, we make the assumption that tax-minimizing behavior (conditional on the portfolio weights) is optimal: the simulation routine preferentially liquidates the high-basis shares, in order to defer the realization of capital gains.

The simulation routine is also capable of considering portfolios with short components. Examples are zero-investment portfolios such as the Fama-French SMB and HML portfolios. Each period the size of the short portfolio is adjusted to equal the size of the long portfolio, through the sale or purchase of the right number of shares (keeping the portfolio weights as appropriate.) This reallocation either requires an infusion or withdrawal of cash. Adding cash to the short portfolio is necessary when the value of the short portfolio has fallen relative to the value of the long portfolio; we therefore consider the net cash added to the short portfolio, in each period, as a measure of the performance of the long portfolio relative to the short.

The other difference in the short portfolio is the assumption we make regarding the tax basis of the shares moved into and out of the portfolio. We make the assumption that, as shares move out of the portfolio, the low-basis shares are chosen. In contrast the long portfolio returns are constructed assuming that the high-basis shares are liquidated first. This approach allows us to construct a measure of the importance of tax-efficient allocation of the basis of shares sold. For a given portfolio, if we consider a test where the portfolio weights are the same for the long and short portfolios, the only difference between the two is that the high-basis shares are preferentially moved out of the long portfolio and the low basis shares are preferentially moved out of the short portfolio. The difference in the returns of these portfolios reflects the value created by the most-efficient basis management, relative to the least-efficient tax basis management.

We assume that the capital gains rate that applies to the short portfolio is the same rate as the rate that would apply to the positions holding period. This treatment departs from stand-alone taxation of short sales, for which all short-sales are taxed as short-term gains. This treatment is correct to the extent that the investor also holds a large long portfolio that includes long positions in the shorted stocks. Thus, our tax rate assumption assumes that the investor holds the market and deviates slightly with long-short portfolios, such that the next exposure is long. The next version of this paper will consider stand alone short portfolios for which all gains are taxed at the short rate.

4.3. Portfolio values, liquidation values, and continuation values

Calculating an after-tax return to a portfolio strategy requires an assumption about the after-tax value of the capital gains that accrue but remain unrealized in the portfolio. Two polar approaches are available. One approach is to construct a return based on the value of the stocks held in the portfolio. This approach assumes a zero effective rate of taxation on the accrued but undistributed capital gains in the portfolio. This assumption would be appropriate for an investor who planned to pass the assets to heirs through an estate and thereby enjoy the famous step-up in capital gains that investors enjoy at death. An opposite polar assumption would be to calculate in each month the value of the cash that the investor would have after liquidating the portfolio and paying the appropriate capital gains taxes on the accrued capital gains. This assumption is appropriate for an investor with a very short horizon.

Approaches between these two polar cases calculate a value of the portfolio that assumes that the effective tax rate on accrued but unrealized capital gains is lower than statutory rates but higher than zero, due to the investor's option to defer the realization of gains. Our results in the sections that follow are based on a calculation of the 'effective' value of the portfolio, which is based on an assumption between these polar cases:

Effective value = After-tax liquidation value

+ 0.07 x (Pre-tax portfolio value – After-tax liquidation value) (1)

It is important to note that taxes have still had an impact on the 'pre-tax portfolio value'; capital gains taxes have been paid over time due to transactions resulting from the need to rebalance the portfolio in order to keep appropriate weights. For each of these measures of the value of the portfolio (after-tax liquidation value, pre-tax portfolio value, and effective value), a log long return measure is constructed as the change in the log of this measure. The scaler, 0.07, is an estimate of the value of tax-timing from Chay, Choi, and Pontiff (2006). This estimate assumes that investors value unrealized capital gains at 93% of the realized tax cost.

We also describe the returns to short portfolios as well as long-short portfolios. Unlike the long portfolios, which are entirely self-financed, the short portfolios are subject to monthly cash inflows and outflows, which reset the pre-tax short portfolio value to that of the long portfolio. The short portfolio return is calculated as the difference of the log of the sum of the current period's cash flow to the portfolio and the current period's effective value, minus the log of last period's effective value.

For the long-short portfolio return we first add the effective value of the long portfolio with the cashflow generated from the short, and subtract from this the change in short portfolio's effective value. We divided this measure by the last period's effective value on the long portfolio. We use the log of this ratio as our long-short return.

In addition to being influenced by the assumption about the horizon of the portfolio, the return series are also affected by the date at which the simulation is assumed to start. This influence comes because the tax basis of shares in the portfolio is determined by when the shares were purchased, which, in turn, is affected by the date at which the portfolio began. In additional tests we explored the sensitivity of our results to a variety of assumptions about the start date of the different portfolios. These sensitivity tests included starting our portfolio simulations at the start of each decade, as well as at cyclical peaks and at cyclical troughs. Our results are not sensitive to impact that the portfolio start date has on the basis of shares held in the portfolio. These simulations have therefore been excluded from the current draft of the paper for the sake of brevity.

In addition to calculating measures of portfolio value and measures of returns, we can also calculate a measure of the 'capital gains overhang' for each portfolio. This overhang is the normalized difference between the pre-tax portfolio value and after-tax liquidation values:

Overhang = (Pre-tax portfolio value – After-tax liquidation value)/Pre-tax portfolio value (2)

This overhang will increase as the share of accrued but unrealized capital gains in the portfolio rises, and as the statutory capital gains tax rates rise. Over time, a strategy that successfully defers realizing capital gains (thereby decreasing the present value of the tax burden) will create a portfolio with a substantial overhang of unrealized capital gains.

Since we use continuously compounded (natural log) returns, a comparison between returns for various strategies reveals the actual performance difference between the strategies. Along these lines, for each tax level associated with each strategy, we compute a relative tax burden, and a relative burden that is associated with capital gains taxation and dividend taxations. The relative tax burden is computed by dividing the difference of the log return of a tax exempt investor and the log return of a taxed investor, by the log return of the tax exempt investor. Thus, the relative tax burden measure describes the proportion of tax exempt investor's performance that would have been consumed by taxes if the investor were taxed at various levels. The capital gains and the dividend tax cost are calculated in a similar manner. For the capital gains (dividend) tax cost, we calculate the log return of a taxable investor, under the assumption that the investor is rebated all dividend (capital gains) taxes each period. We calculate the difference between this return measure and the tax exempt return, and divide by the tax-exempt return. Since the performance differences between the tax exempt and taxable investor are caused entirely by either dividend or capital gains taxes, this measure calculates the actual impact of these taxes on performance. Since we measure the percentage difference of log returns, the capital gains tax cost and dividend tax cost do not add up to the total relative tax cost. The discrepancy is caused by a "Fisher" effect.

5. Results

This section presents three different types of results. The first subsection (subsection 5.1., and Table 4), investigates the impact that selection of the basis of shares to sell has on the returns to different portfolio strategies. These results illustrate both the impact that taxation has on the

returns to our different strategies, and the impact of the assumption that investors optimize in the selection of high-basis shares for sale.

The next subsections describe the impact of taxation on the returns to different benchmark portfolios. The tables in these subsections have two panels. The first panels (A) report the actual after-tax return an investor would have received, assuming that the investor paid taxes according to the federal tax code at the time. The A panels provide a historical record of the actual after-tax performance of the investment strategy. The tax-burdens that we calculate in the A panels are influenced by intertemporal changes in the tax code. For example, a strategy that realizes capital gains in time period where nominal capital gains rates dropped will have a lower historical tax burden than a strategy that realizes gains after an increase in nominal rates. The second panels (B) examine the after-tax returns that investors would have earned under the counterfactual assumption that tax rates were fixed throughout the period at rates prevailing in 2000.

5.1. The impact of optimal basis selection

Table 4 investigates the importance of optimal selection of basis when selling shares of stock, and assesses the impact that this assumption has across a number of different portfolio strategies. We evaluate the importance of optimal selection of basis by comparing the performance of portfolios under two alternative assumptions about basis selection. Under the "optimal selection" assumption, high-basis shares are sold preferentially. Under the "suboptimal selection" assumption, low-basis shares are sold first. Each pair of portfolios is the same in every other way: returns are taxed at the same statutory rates and portfolio shares allocated to different stocks are precisely the same. Table 4 reports the percentage improvement of the log return of the optimal tax strategy, which involves selling the highest bias stocks first, over the log return of the sub-optimal strategy, which involves selling the lowest bias stocks first.

Table 4 shows that the optimal tax strategy has a material impact on investment performance. For an investor at the 99% income level, the return advantage of investing in a tax-optimal value-weighted portfolio is 3.15% greater than the sub-optimal tax strategy. From this number, an investor who expects to earn 8% from a tax-sub-optimal value-weighted strategy would expect to earn 8 x 1.0315 = 8.25% from a tax-optimized strategy. The long portfolio for

which optimal basis selection confers the greatest is the equal-weighted portfolio strategy. For an investor at the 99% income level, the tax-optimized strategy produces a 12.71% improvement in the performance of this investment strategy. The long portfolio with the least advantage of the tax-optimized strategy over the sub-optimal strategy is the high dividend yield portfolio, with a 0.95% advantage.

Optimal basis selection is particularly important for the equally-weighted portfolio strategy because this strategy dictates that individual shares of stock are constantly being purchased and sold in order to maintain the appropriate equal portfolio weights. While portfolio strategies that focus on large or small firms also have high turnover, with individual stocks moving in and out of these portfolios, optimal basis selection is less important for these types of strategies. This is because an investor following a 'large firm' or a 'small firm' strategy sells all of the shares of a given stock as the stock moves beyond the cutoffs for the given portfolio.

The decision to follow the tax-optimal versus non-optimal strategy has remarkable impact on long-short portfolios returns. For some investors, the optimal tax strategy underperforms the sub-optimal tax strategy. For example, an investor at the 95% income level would have generated investment performance with the optimal strategy that was 7.94% worse than that of the sub-optimal strategy. Our conjecture is that this difference in performance is caused by intertemporal changes in the tax code that correspond with changes in portfolio overhang. For example, an investor who delays capital gains realization may eventually realize the gain in a tax regime with higher marginal rates. To the extent that changes in the tax-code are unpredictable, the tax-optimal strategy is still *ex-ante* optimal, although not always *ex-post* optimal. The last three columns of table 4 lend support to our conjecture. We generate portfolio returns assuming that the 2000 tax code holds through out the 1926-2002 period. The performance of HML and SMB are both drastically improved by utilizing the tax-optimal strategy. For an investor at the 99% income level, tax-optimizing delivers SMB performance that is over 37% greater than the sub-optimal performance and over 15.5% greater than HML performance

5.2. Fundamental Long Strategies.

Table 5 reports the after-tax returns to value-weighted portfolios and equally-weighted portfolios of stocks. As a reference, the table also presents the after-tax return to a strategy of holding 3-month treasury bills, our reference 'risk-free' asset. For each portfolio, Table 5 presents four different results. The first set of results is the average of the log of after-tax returns on each of the different portfolios. Our primary measure of returns is the change in the effective value of the portfolio, which is a weighted average of the pre-tax portfolio value and after-tax liquidation value in each period.[6]

Panel A shows that, historically, the Treasury bill is most tax disadvantaged, the equal weighted portfolio is the second most tax disadvantaged, and the value-weighted portfolio is the most tax advantaged. This result contradicts the common assumption that dividend yield proxies for tax burden, since the value-weighted portfolio has a higher dividend yield than the equal weighted portfolio. Regardless of the income level of the investor, the tax burden of the equal weighted portfolio is always higher than that of the value-weighted portfolio. For both portfolios dividend taxation represents a larger portion of the total tax cost, although the role of capital gains taxation is very different between these portfolios. For the case of an investor in the 99% income level, the capital gains tax cost of the value weighted portfolio is 1.74% versus 7.73% for the equal weighted portfolio. This difference is more extreme for higher income levels. At the highest income level the difference in portfolio type is associated with an over ten-fold differences in capital gains tax costs--0.83% versus 8.72%.

Although total relative tax is increasing in income level for both the equal and value-weighted index, the three highest income levels exhibit a decrease in capital gains tax burden. This seemingly-odd result is ubiquitous for almost all portfolios that we consider. This result is attributable to the fact that during our sample capital gains tax rates reach maximum levels for lower income levels than dividend tax rates. Because of this, investors with higher income levels re-invest a lower proportion of a portfolio's dividends. Lower dividend reinvestment decreases

[6] For the sake of comparison, we also computed the average of the log return where the return is calculated based on the change in the pre-tax portfolio values, and the average log return where the return is calculated based on the change in the after-tax liquidation value of the portfolios. These alternative measures are close to the portfolio return based on the effective value of the portfolio.

the total value of future capital gains relative to the tax-exempt portfolio, creating a crowding-out effect on the capital gains tax burden.

While Panel A calculates returns based on the historically prevailing tax rates, Panel B presents the returns that investors would have earned had the rates prevailing in 2000 prevailed throughout the period. This counterfactual assumption produces lower tax burdens across the board. The risk free security continues to have the highest tax burden. The value-weighted index is now more tax burdensome than the equal weighted index.

Figure 2 shows the value of the equally-weighted portfolio across time. This portfolio is financed by the $100 initial investment, and no subsequent inflows or outflows. Figure 3 shows the value of the value-weighted portfolio across time, again with no inflows or liquidations beyond the $100 initial investment. While the numbers in Table 5 report the monthly returns based on an intermediate assumption about the effective tax rate on accruing, but unrealized capital gains, Figures 2 and 3 assume full reinvestment and no liquidation across time. Figure 4 reports the after-tax values of the different portfolios, as a share of the values of these portfolios in the hands of a tax-exempt investor. Figure 4 illustrates the impact that taxation has had on wealth accumulated by these different strategies over time. Figures 2 and 3 plot portfolio returns for tax exempt investors, as well as investors with AGI at the 95th and 99.5 percentiles. Figure 2 in particular demonstrates the impact that taxes can have on wealth accumulation. The tax-exempt equal weighted portfolio grows from $100 to over $800,000 by 2002, whereas the equal-weighted portfolio for the 95th and 99.5 percentile investors grow to $215,000 and $113,000, respectively. The tax-exempt value-weighted portfolio grows to $137,000, whereas the portfolio value for investors at the 95 and 99.5 percentiles grows to $55,000 and $34,000, respectively. The tax-induced performance differences are minimal until the mid 1940s. Indeed, during the 1930s taxable portfolios were more valuable than the non-taxable portfolios. This is a consequence of the extreme negative performance of the stock market during this period and our assumption of unlimited tax-deductibility of capital losses. By 2002, all the taxable portfolios have values less than 40% of their tax-exempt equivalents.

5.3. Dividend Strategies

Table 6 reports the results of exercises that assess the return to portfolios that focus on stocks that pay different levels of dividends. Stocks that did not pay a dividend in the preceding year are placed in the no-dividend portfolio. The remaining stocks are placed in a high or low dividend portfolio depending on whether their dividend yield is above or below median. Note that the no-dividend portfolio has a dividend yield, since some stocks that did not pay dividends in the previous year, initiate dividends in the current year.

Many papers form dividend portfolios to proxy for tax costs.[7] Consistent with these papers the no-dividend portfolio has the lowest tax burden, followed by the low dividend portfolio, which is followed by the high dividend portfolio. A dividend proxy for tax cost understates the tax burden in the case of the no-dividend portfolio since this portfolio has the highest capital gains cost. The high capital gains cost is likely to occur since non-dividend payers who initiate dividend payments are likely to have price appreciation in the initiation year. Since the dividend initiation forces them out of the no-dividend portfolio, the rebalancing induced by the need to maintain a no-dividend portfolio strategy is suboptimal from the standpoint of tax management.

5.4. Style Portfolios.

Table 7 reports the after-tax return to portfolios that focus on different investment styles. The small (large) market capitalization portfolio is determined by whether the firm's previous year market capitalization placed it in the bottom (top) 20% of the NYSE. Similarly, the value (growth) portfolio contain the firms whose book-to-market ratios placed it in the top (bottom) 20% of the NYSE.

With two minor exceptions, the historical tax burden ordering in panel A, from highest to lowest, is Value, Small, Growth, and Large. The large differences seem to be between the highly-taxed Value and Small strategies, and the more lightly-taxed Growth and Large strategies. For an investor at the 95 percentile of AGI, the relative tax cost for a portfolio of large stocks is 13.14%. For a portfolio of growth stocks, the relative tax cost is 13.78%, for small stocks this figure is 16.69% and for value stocks the figure is 18.58%. The percentage increase in tax burden for small over large is 27.0%--even though large stock have a higher dividend yield. The

[7] See, for instance, Litzenberger and Ramaswamy (1979).

increase in tax burden for value over growth is 34.8%. The value portfolio's tax inefficiency results from its higher dividends and its less advantageous pattern of capital gains realizations. The historical differences in relative tax costs are more pronounced for the moderately rich–those investors who were taxed at the rates prevailing at the 95th and 99th percentiles of income, than for the extremely rich–those who faced the tax rates prevailing at the very top of the income distribution.

Panel B documents the differences assuming that the 2000 tax code held throughout the 1927-2002 period. Although the general pattern remains with Small and Value having the largest tax burdens, the Growth portfolio edges out the Large portfolio as having the lightest tax burden.

5.4. Long-Short Portfolios

Fama and French (1993) propose a multi-factor model of stock returns that is based on three factors: the return of the a value-weighted market index minus the risk free rate (VWRET-RF), the return of small minus big market capitalization stocks (SMB), and the return of high minus low (HML) market-to-book stocks. The typical formulation of the Capital Asset Pricing Model (CAPM) relies on a single market factor, VWRET-RF. The ability of the Fama-French 3-factor model to provide an improvement in explaining cross-sectional return variation depends upon the factors HML and SMB are expected to yield non-zero returns.

We construct the after tax performance for all three of the Fama-French factors. The construction of the factors identically follows Fama and French (1993). Table 8 reports the after-tax performance of these portfolio strategies. Both the SMB and HML portfolios face a higher burden from taxation than does the market premium (VWRET-RF) portfolio. For an investor taxed at the rates prevailing at the 95th percentile of income, the tax cost of the SMB portfolio was 2.8 times the tax cost of the market premium (2.87/1.01). For this same investor, the tax cost of HML was 16.6 times that of the market premium (16.79/1.01). The differences between the relative tax cost of the SMB portfolio and the SMB portfolio have been less extreme for the most highly-taxed investors. For example for an investor with an AGI at the 99.99% level, the tax cost of SMB is 42% greater than the market premium (17.24/12.14), and the tax cost of HML is 218% greater than that of the market premium.

While Panel A of Table 8 considers the returns given the tax rates that have prevailed through the period, Panel B presents a counterfactual: the returns that investors would have earned had the 2000 income tax rates prevailed over the entire period. Again, investors focusing on the SMB and HML portfolio strategies face much larger tax burdens than an investor limited to investing in the market risk premium.

6. Conclusion

Taxes have a profound impact on portfolio performance. For example, over the last 80 years, an investor at the 99.5 AGI percentile would have enjoyed portfolio performance on an equal weighted portfolio that was only 14% of the performance of tax-exempt investor. We have documented the historical, after-tax performance of various investment portfolios. This exercise demonstrates that capital gains tax-timing options induce variation in tax burdens that are related to portfolio style. Specifically, equal weighted portfolios, small stock portfolios, and value portfolios tend to have higher exposure to capital gains taxation, whereas value-weighted portfolios, large stock portfolios, and growth portfolios tend to have lower exposure to capital gains taxation. These tax costs erode the estimated returns premiums associated with SMB and HML.

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Figure 1. Net Present Value of Capital Gains Deferral
Assuming an expected return of 9.76% per period

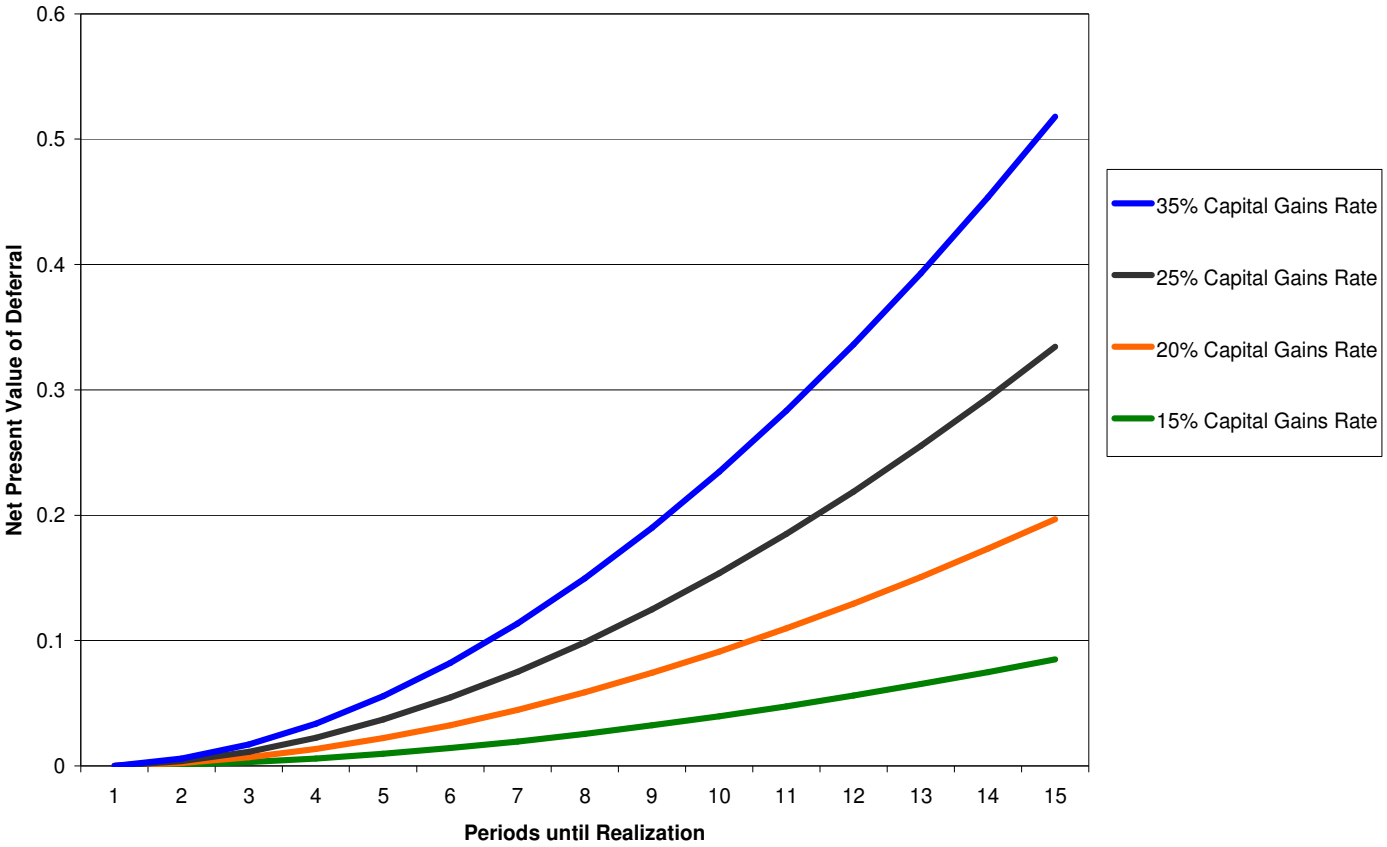
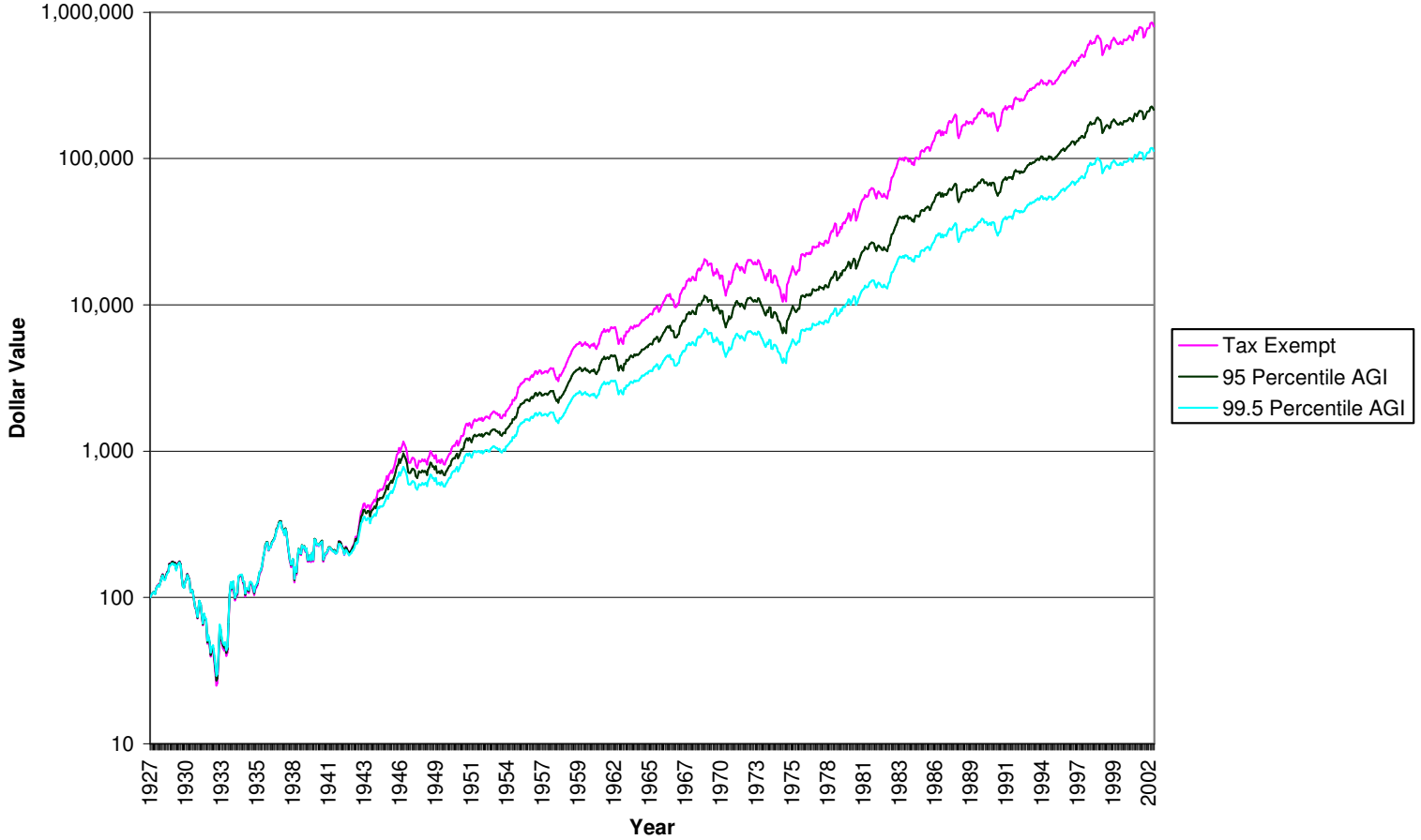


Figure 2.
Equal-weighted self-financed tax-optimized portfolio value



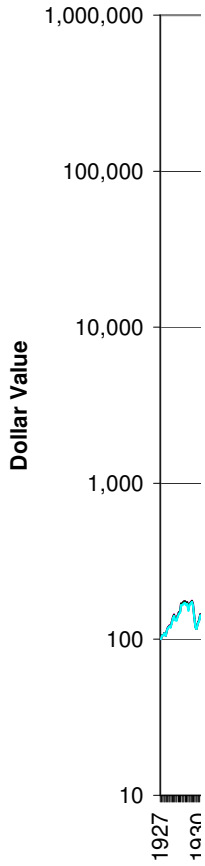


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Figure 3.
Value-weighted self-financed tax-optimized portfolio value

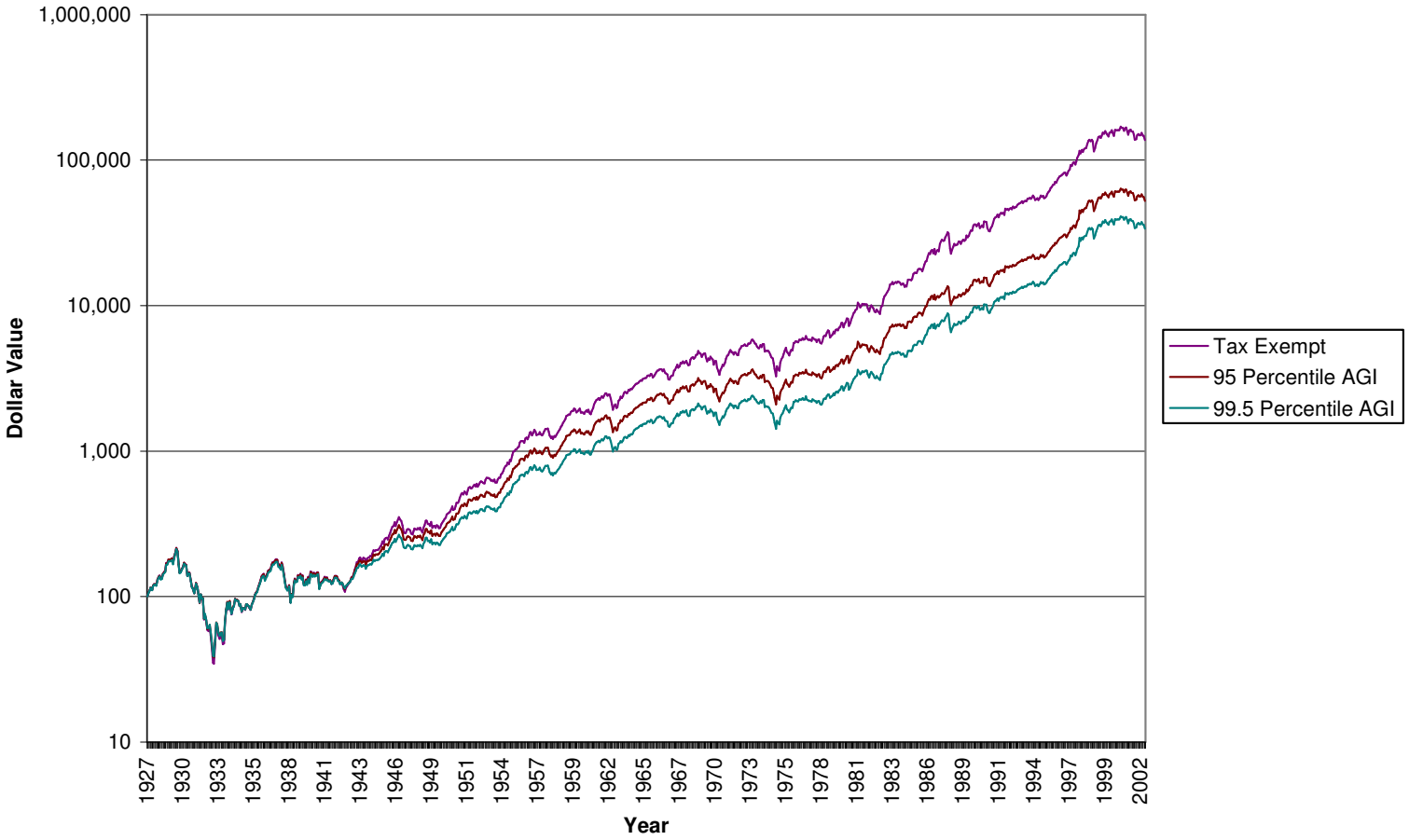

Figure 4.
Relative value of taxable self-financed portfolios to untaxed portfolios

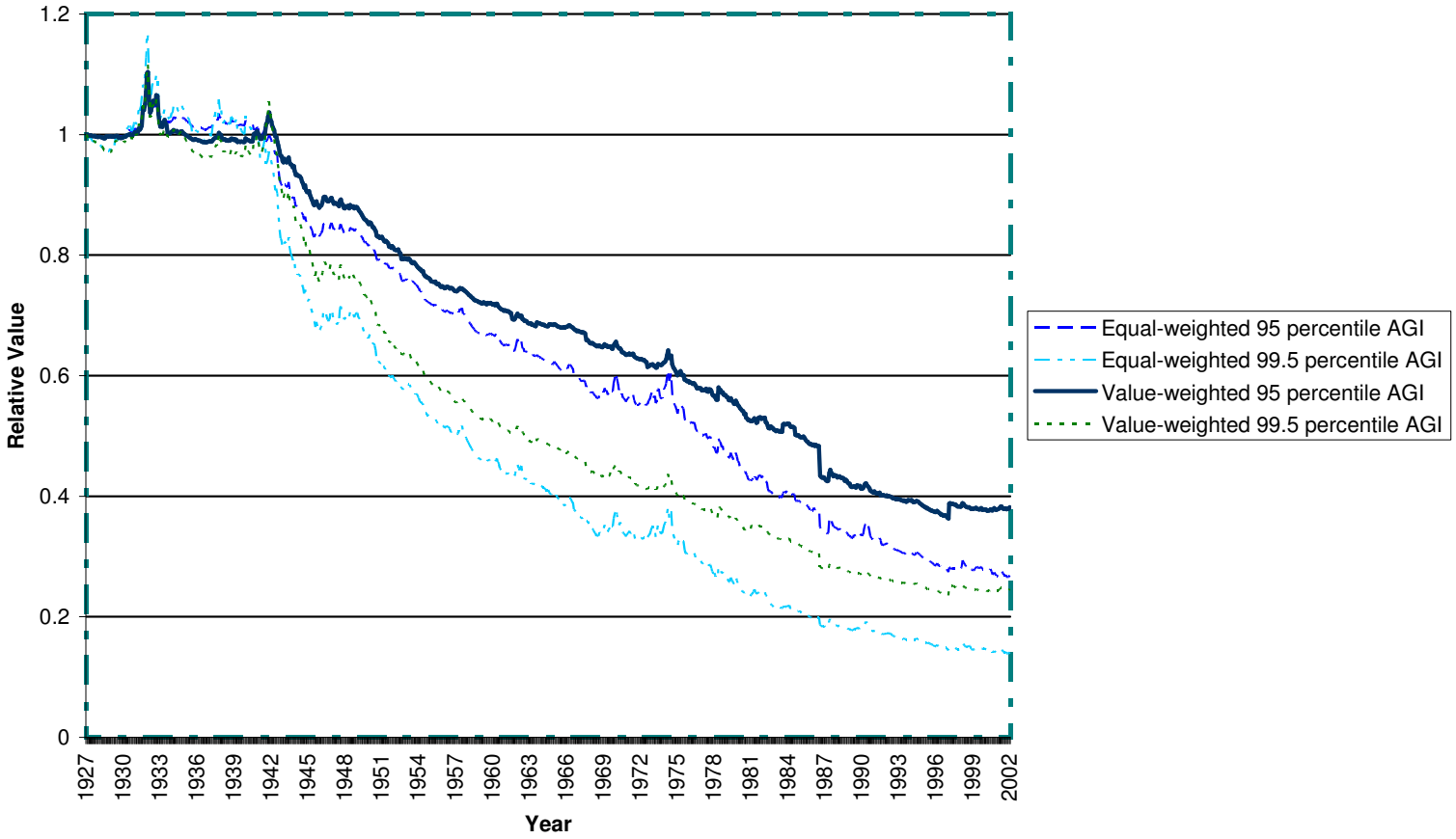

Table 1. Income percentiles, 1925-2000, measured in 2000 dollars.

Year	CPI adjustment factor	Income percentiles, in 2000 dollars					
		90th	95th	99th	99.5th	99.9th	99.99th
1925	9.86	26,908	35,107	84,772	133,296	371,004	1,234,448
1926	9.76	26,231	34,059	88,016	137,074	381,973	1,314,427
1927	9.95	26,717	34,930	90,013	139,501	391,000	1,461,038
1928	10.08	27,473	36,156	92,635	140,549	398,849	1,663,634
1929	10.08	26,821	35,783	93,212	141,408	375,522	1,497,802
1930	10.34	26,425	33,794	82,484	123,812	330,914	1,179,656
1931	11.33	26,121	32,777	74,729	110,152	275,828	972,445
1932	12.64	17,916	30,599	63,929	91,812	242,064	912,951
1933	13.31	17,426	28,102	62,184	89,323	233,920	875,641
1934	12.88	21,113	29,926	69,207	102,300	276,580	941,704
1935	12.56	23,187	32,904	72,540	106,916	290,011	1,026,737
1936	12.44	25,038	35,694	84,469	128,939	365,151	1,321,440
1937	12.01	26,534	35,625	84,458	129,458	362,903	1,238,572
1938	12.24	25,992	34,524	76,791	112,612	287,396	864,334
1939	12.41	29,310	38,703	84,011	123,701	322,147	1,060,151
1940	12.29	32,521	38,311	88,255	134,219	350,361	1,119,860
1941	11.70	33,642	41,539	96,381	149,724	394,831	1,228,466
1942	10.57	34,226	41,518	95,294	149,818	395,821	1,214,441
1943	9.97	34,952	45,285	101,798	160,607	409,838	1,063,653
1944	9.80	38,163	45,257	104,782	158,588	388,225	1,077,031
1945	9.58	36,765	44,856	111,865	171,054	385,720	942,331
1946	8.83	35,841	45,834	115,557	172,562	384,820	933,052
1947	7.72	33,151	41,805	103,859	153,757	339,895	872,865
1948	7.16	34,872	45,541	105,841	159,286	362,917	982,569
1949	7.23	35,458	46,375	102,007	151,059	345,651	949,269
1950	7.16	38,315	47,664	109,696	169,176	382,547	850,449
1951	6.64	39,208	48,240	112,813	163,618	364,032	956,134
1952	6.49	41,885	51,443	111,623	164,547	341,772	854,558
1953	6.44	43,152	52,916	112,143	161,222	328,227	783,254
1954	6.41	43,389	52,952	114,157	163,664	330,869	793,588
1955	6.43	46,348	57,888	119,965	171,144	332,290	816,406
1956	6.34	48,280	60,403	128,267	174,215	344,427	822,401
1957	6.12	49,338	61,267	126,950	174,446	349,011	836,867
1958	5.96	49,353	61,550	123,540	166,936	329,444	790,031
1959	5.91	52,196	66,041	131,822	185,339	336,636	774,633
1960	5.82	53,145	60,897	130,664	171,842	322,380	760,141
1961	5.76	53,493	66,683	134,693	167,999	312,850	744,612
1962	5.70	56,466	69,202	138,709	180,559	326,335	735,796
1963	5.63	58,304	72,208	140,356	182,815	331,025	750,780
1964	5.56	60,834	72,836	141,138	190,541	337,960	723,597
1965	5.46	62,588	76,540	143,784	199,261	347,474	729,812

Table 1 continued on next page

Note. Data taken from Piketty and Saez (2001), Table A4. CPI adjustment factor is based on the CPI-U, taken from the Bureau of Labor Statistics.

Table 1. Income percentiles, 1925-2000, measured in 2000 dollars (continued).

Year	CPI adjustment factor	Income percentiles, in 2000 dollars					
		90th	95th	99th	99.5th	99.9th	99.99th
Table 1 continued from previous page							
1966	5.31	65,302	80,616	156,320	215,278	388,463	901,232
1967	5.16	66,464	82,344	161,554	220,447	397,851	926,701
1968	4.95	69,149	85,095	166,653	222,221	409,986	897,699
1969	4.70	71,189	88,067	165,256	223,220	386,676	823,209
1970	4.44	71,352	88,771	162,919	220,267	394,825	885,756
1971	4.25	71,796	89,440	164,494	218,164	384,949	850,452
1972	4.12	75,074	92,513	170,935	226,166	399,314	879,542
1973	3.88	76,472	95,408	176,515	231,870	412,007	941,876
1974	3.49	74,726	95,148	173,514	230,550	452,041	1,084,508
1975	3.20	72,381	90,350	163,281	217,724	405,028	971,625
1976	3.03	74,006	92,112	164,832	218,316	406,247	993,887
1977	2.84	74,816	93,310	165,621	219,708	411,622	995,550
1978	2.64	76,053	94,588	169,213	224,190	426,111	1,080,089
1979	2.37	74,663	92,580	165,014	220,046	417,859	1,000,177
1980	2.09	72,337	89,561	159,550	211,339	407,446	1,073,110
1981	1.90	71,071	88,316	152,839	199,979	393,534	1,038,057
1982	1.79	70,568	86,910	152,699	199,288	396,572	1,156,024
1983	1.73	70,976	87,729	152,581	200,027	400,455	1,281,305
1984	1.66	72,799	90,755	158,720	208,356	426,435	1,464,608
1985	1.60	73,881	92,421	163,609	212,480	466,297	1,474,672
1986	1.57	75,332	93,779	165,738	215,503	413,283	1,446,071
1987	1.52	77,183	96,546	183,174	253,797	583,952	1,995,591
1988	1.46	78,167	99,541	201,118	292,472	760,032	2,990,710
1989	1.39	78,206	100,903	202,677	294,367	726,568	2,634,026
1990	1.32	77,162	99,591	201,580	297,867	741,897	2,779,977
1991	1.27	76,571	99,785	195,893	282,697	661,106	2,518,315
1992	1.23	76,215	98,895	202,907	300,790	744,084	2,998,135
1993	1.19	75,625	97,891	202,010	285,984	685,509	2,518,817
1994	1.16	76,477	99,872	206,507	292,539	696,932	2,591,735
1995	1.13	78,043	102,274	213,522	306,873	734,783	2,864,031
1996	1.10	77,137	104,412	225,096	330,718	827,931	3,335,778
1997	1.07	79,481	107,270	234,125	347,216	909,273	3,784,581
1998	1.06	81,980	111,576	247,662	367,829	968,584	4,299,189
1999	1.03	84,381	115,473	258,610	385,486	1,045,718	4,764,927
2000	1.00	87,334	120,212	277,983	397,949	1,134,849	5,349,795

Note. Data taken from Piketty and Saez (2001), Table A4. CPI adjustment factor is based on the CPI-U, taken from the Bureau of Labor Statistics.

Table 2. Direct and indirect taxable ownership of equity by family AGI, 2001 SCF.

Level of family AGI	Share of families above threshold	Share of direct taxable equity above threshold	Share of direct + indirect taxable equity above threshold	Share of dividends above threshold
0	88.1%	99.9%	99.6%	98.6%
25,000	59.7	97.3	96.3	93.3
50,000	31.9	90.3	87.4	82.4
75,000	17.3	80.9	77.4	70.5
100,000	9.7	74.5	69.8	61.8
125,000	6.7	69.5	63.9	55.9
150,000	4.9	65.8	59.1	51.6
175,000	3.7	62.6	55.3	45.6
200,000	3.0	60.0	52.5	42.2
225,000	2.6	55.7	48.8	38.1
250,000	2.2	52.7	45.6	36.6
275,000	2.0	51.4	44.5	35.8
300,000	1.7	44.6	38.8	34.9
325,000	1.6	42.6	36.8	33.7
350,000	1.4	40.4	35.0	32.8
375,000	1.3	40.0	34.5	31.6
400,000	1.1	38.2	33.0	30.6

Note. From the 200? Tax code, income below 26,250 taxed at 15%, income below 63,550 taxed at 28%, income below 132,600 taxed at 31%, income below 288,350 taxed at 36%, income above that taxed at 39.6%.

Table 3: Overview of Investment Tax Implications

Panel A: 1927-1969

This table summarizes the U.S. federal taxation of investment income for individual investors since 1927. Data from IRS Statistics of Income publications, from Burman (1999), from Poterba and Weisbenner (2002), Shackelford (2000) and Barclay, Holderness, and Sheehan (2003). From 1933 to 1941 capital gains taxes were assessed at ordinary income tax rates, with up to 50 percent (1938-1941) or 70 percent (1933-1937) of the capital gain excluded from income, depending on holding period. During 1997, a medium-term rate for holding periods of greater than 12 months and less than 18 months was temporarily instituted.

	1927-1933	**1934-1941**	**1942-1953**	**1954-1969**
Max. Ordinary Income Rate	1927-1928: 25% 1929: 24% 1930: 25% 1931: 24% 1932: 42% 1933: 38%	1934: 43% 1935: 49% 1936-1937: 62% 1938: 47% 1939: 55% 1940: 60% 1941: 69%	1940: 60% 1941: 69% 1942-1943: 85% 1944: 92% 1945: 90% 1946-1947: 84.6% 1948-1949: 68.6% 1950: 68.25% 1951: 82% 1952-1953: 80%	1954-1963: 78% 1964: 68.5% 1965: 64% 1966-1967: 68% 1968: 74.175% 1969: 14.8%
Dividends	Ordinary income	Ordinary income	Ordinary income	Ordinary income
Long-Term Capital Gain/Loss	12.5%	Ordinary income minus 1933-1937: 70 percent 1938-1941: 50 percent	Ordinary income minus 50%	Ordinary income minus 50%
Medium-Term Capital Gain/Loss	None	None	None	None
Short-Term Capital Gain/Loss	Ordinary income	Ordinary income	Ordinary income	Ordinary income

Table 3: Overview of Investment Tax Implications

Panel B: 1970-2002

	1970-1986	1987-1996	1997	1998-2002
Max. Ordinary Income Rate	1970: 71.75% 1971-1981: 70% 1982-1986: 50%	1987: 38.5% 1988-1990: 28% 1991-1992: 31% 1993: 36% 1994-1996: 39.6%	39.6%	1998-2001: 39.6% 2002: 38.6%
Dividends	Ordinary income	Ordinary income	Ordinary income	Ordinary income
Long-Term Capital Gain/Loss	1970-1978: Ordinary income minus 50% 1979-1986: Ordinary income minus 60%	28% max.	28% max. before or on May 6. 20% max. after May 6.	20% max. 2001-2002: 20% or 18% for 5-year holding periods.
Medium-Term Capital Gain/Loss	None	None	28%	None
Short-Term Capital Gain/Loss	Ordinary income	1987: Ordinary income 1988-1990: 28% max. 1991-1992: 31% max. 1993-1996: Ordinary income	Ordinary income	Ordinary income

Table 4. Tax Benefit of Optimal Capital Gains Realization--06/1927 to 06/2002

This table presents the relative advantage of the optimal strategy over the suboptimal strategy. The percentage benefit is calculated as the average log return of the optimal divided by the average log return of the suboptimal strategy, minus one. All returns are expressed as annualized by multiplying by 12. The optimal strategy is to sell the highest-basis shares first, and the suboptimal strategy is to sell the lowest-basis shares first.

Strategy	Using tax rates that correspond to the return period						Using tax rates that correspond to the 2000 tax code		
	90th % Income	95th % Income	99th % Income	99.5% Income	99.90% Income	99.99 % Income	90% to 95% Income	99th % Income	99.5% to 99.99% Income
VWRET	2.12	2.28	3.15	3.67	4.24	4.64	3.41	3.47	3.51
EWRET	7.85	8.44	12.71	15.18	20.60	32.53	19.33	22.13	24.31
No Dividend Portfolio	1.53	1.70	2.38	2.78	3.65	4.84	4.01	4.28	4.48
Low Dividend Portfolio	2.04	2.20	3.02	3.48	4.00	4.56	3.35	3.39	3.41
High Dividend Portfolio	0.95	1.04	1.51	1.79	2.13	2.96	1.65	1.76	1.84
Large	2.07	2.24	2.99	3.41	3.87	4.30	3.27	3.32	3.35
Growth	2.10	2.28	3.07	3.46	4.18	5.00	3.93	4.11	4.25
Small	1.48	1.61	2.43	2.89	3.85	5.64	3.43	3.84	4.15
Value	1.10	1.19	1.73	2.08	2.55	3.41	2.31	2.51	2.67
VWRET-RF	3.11	3.32	4.42	5.07	5.74	6.20	5.08	5.06	5.03
SMB	-7.16	-7.94	-5.33	-4.99	5.87	45.02	27.34	37.16	45.83
HML	0.03	-0.15	1.86	2.78	8.36	22.16	11.74	15.52	18.49

Table 5. Tax impact of long strategies--06/1927 to 06/2002
Panel A: Uses tax rates from the tax code that correspond to the return period.

Return is the average annualized log return, which is computed by multiplying 12 times the log of Effective Value dividend by last months Effective Value, where Effective Value = After tax Liquidation Value + 0.07*(Pre-tax Portfolio Value - After tax Liquidation Value). Positive Tax Frequency is the percentage of contiguous twelve month periods which involve positive total tax expenses. CG Relative Tax Cost is the percentage difference between the after tax return and the return of a taxed portfolio that reinvests dividend taxes that otherwise would have been paid. Div Tax Cost is the percentage difference between the after tax return and the return of a taxed portfolio that reinvests capital gains taxes that otherwise would have been paid. Relative Tax Cost is the percentage loss of taxable return relative to the tax exempt return.

Strategy Statistic	Tax Exempt	90th % Income	95th % Income	99th % Income	99.5% Income	99.90% Income	99.99 % Income
VWRET							
After Tax Return	9.63	8.43	8.36	8.00	7.78	7.33	6.81
Dividend Yield	4.01						
Avg Overhang	0.00	7.29	7.78	9.64	10.69	11.42	11.36
Positive Tax Frequency	0.00	81.78	81.78	82.56	82.90	89.76	95.61
CG Relative Tax Cost	0.00	2.20	2.13	1.74	1.47	1.02	0.83
Div Relative Tax Cost	0.00	10.61	11.31	14.82	16.93	21.31	26.50
Total Relative Tax Cost	0.00	12.42	13.19	16.97	19.28	23.93	29.36
EWRET							
After Tax Return	11.98	10.36	10.24	9.71	9.38	8.89	8.39
Dividend Yield	3.67						
Avg Overhang	0.00	4.96	5.28	6.80	7.75	8.68	9.50
Positive Tax Frequency	0.00	82.12	82.45	86.50	88.30	89.99	91.79
CG Relative Tax Cost	0.00	6.03	6.41	7.73	8.54	8.78	8.72
Div Relative Tax Cost	0.00	7.30	7.77	10.11	11.49	14.40	16.61
Total Relative Tax Cost	0.00	13.58	14.56	18.94	21.73	25.82	30.00
Risk Free Bill							
After Tax Return	3.75	2.63	2.54	2.22	2.07	1.84	1.64
Avg Overhang	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Positive Tax Frequency	0.00	100.00	100.00	100.00	100.00	100.00	100.00
CG Relative Tax Cost	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Div Relative Tax Cost	0.00	29.80	32.31	40.65	44.78	51.02	56.36
Total Relative Tax Cost	0.00	29.80	32.31	40.65	44.78	51.02	56.36

Table 5. Tax impact of long strategies--06/1927 to 06/2002
Panel B: Uses the tax rates that correspond to the 2000 tax code.

Return is the average annualized log return, which is computed by multiplying 12 times the log of Effective Value dividend by last months Effective Value, where Effective Value = After tax Liquidation Value + 0.07*(Pre-tax Portfolio Value - After tax Liquidation Value). Positive Tax Frequency is the percentage of contiguous twelve month periods which involve positive total tax expenses. CG Relative Tax Cost is the percentage difference between the after tax return and the return of a taxed portfolio that reinvests dividend taxes that otherwise would have been paid. Div Tax Cost is the percentage difference between the after tax return and the return of a taxed portfolio that reinvests capital gains taxes that otherwise would have been paid. Relative Tax Cost is the percentage loss of taxable return relative to the tax exempt return.

Strategy	Statistic	Tax Exempt	90% to 95% Income	99th % Income	99.5% to 99.99% Income
VWRET					
	After Tax Return	9.63	8.14	7.93	7.78
	Dividend Yield	4.01			
	Avg Overhang	0.00	7.75	7.82	7.88
	Positive Tax Frequency	0.00	93.70	95.05	95.95
	CG Relative Tax Cost	0.00	1.67	1.59	1.54
	Div Relative Tax Cost	0.00	14.10	16.18	17.67
	Total Relative Tax Cost	0.00	15.48	17.64	19.20
EWRET					
	After Tax Return	11.98	10.20	9.96	9.79
	Dividend Yield	3.67			
	Avg Overhang	0.00	6.77	6.83	6.88
	Positive Tax Frequency	0.00	89.76	90.10	90.40
	CG Relative Tax Cost	0.00	4.73	5.11	5.40
	Div Relative Tax Cost	0.00	8.69	9.99	10.92
	Total Relative Tax Cost	0.00	14.85	16.88	18.35
Risk Free Bill					
	After Tax Return	3.75	2.59	2.40	2.27
	Avg Overhang	0.00	0.00	0.00	0.00
	Positive Tax Frequency	0.00	100.00	100.00	100.00
	CG Relative Tax Cost	0.00	0.00	0.00	0.00
	Div Relative Tax Cost	0.00	30.95	35.94	39.54
	Total Relative Tax Cost	0.00	30.95	35.94	39.54

Table 6. Tax Impact of Dividend Portfolio Strategies--06/1927-06/2002
Panel A: Uses the tax rates from the tax code that correspond to the return period.

Return is the average annualized log return, which is computed by multiplying 12 times the log of Effective Value dividend by last months Effective Value, where Effective Value = After tax Liquidation Value + 0.07*(Pre-tax Portfolio Value - After tax Liquidation Value). Positive Tax Frequency is the percentage of contiguous twelve month periods which involve positive total tax expenses. CG Relative Tax Cost is the percentage difference between the after tax return and the return of a taxed portfolio that reinvests dividend taxes that otherwise would have been paid. Div Tax Cost is the percentage difference between the after tax return and the return of a taxed portfolio that reinvests capital gains taxes that otherwise would have been paid. Relative Tax Cost is the percentage loss of taxable return relative to the tax exempt return.

Strategy Statistic	Tax Exempt	90th % Income	95th % Income	99th % Income	99.5% Income	99.90% Income	99.99 % Income
No Dividend Portfolio							
After Tax Return	7.43	6.67	6.64	6.42	6.24	6.19	6.11
Dividend Yield	0.61						
Avg Overhang	0.00	3.41	3.57	4.26	4.72	4.80	4.67
Positive Tax Frequency	0.00	67.60	67.83	73.23	74.35	77.95	82.12
CG Relative Tax Cost	0.00	8.69	9.09	11.39	13.16	12.62	12.13
Div Relative Tax Cost	0.00	0.87	0.87	1.13	1.31	1.97	1.94
Total Relative Tax Cost	0.00	10.17	10.65	13.71	16.04	16.75	17.75
Low Dividend Portfolio							
After Tax Return	9.66	8.46	8.38	8.01	7.78	7.34	6.83
Dividend Yield	4.09						
Avg Overhang	0.00	7.51	8.00	10.02	11.17	12.12	12.47
Positive Tax Frequency	0.00	81.78	81.78	82.57	83.80	90.66	94.49
CG Relative Tax Cost	0.00	2.11	2.05	1.69	1.46	0.75	0.11
Div Relative Tax Cost	0.00	10.77	11.47	14.99	17.09	21.46	26.67
Total Relative Tax Cost	0.00	12.43	13.23	17.09	19.48	23.98	29.27
High Dividend Portfolio							
After Tax Return	11.84	9.89	9.76	9.14	8.75	8.19	7.58
Dividend Yield	5.45						
Avg Overhang	0.00	2.65	2.83	3.65	4.17	4.46	4.51
Positive Tax Frequency	0.00	83.47	83.47	85.71	87.40	91.00	94.04
CG Relative Tax Cost	0.00	5.69	6.02	7.28	8.03	7.86	7.28
Div Relative Tax Cost	0.00	10.62	11.31	14.90	17.05	21.49	26.57
Total Relative Tax Cost	0.00	16.50	17.59	22.85	26.08	30.82	35.99

Table 6. Tax Impact of Dividend Portfolio Strategies--06/1927-06/2002
Panel B: Uses the tax rates that correspond to 2000 tax code.

Return is the average annualized log return, which is computed by multiplying 12 times the log of Effective Value dividend by last months Effective Value, where Effective Value = After tax Liquidation Value + 0.07*(Pre-tax Portfolio Value - After tax Liquidation Value). Positive Tax Frequency is the percentage of contiguous twelve month periods which involve positive total tax expenses. CG Relative Tax Cost is the percentage difference between the after tax return and the return of a taxed portfolio that reinvests dividend taxes that otherwise would have been paid. Div Tax Cost is the percentage difference between the after tax return and the return of a taxed portfolio that reinvests capital gains taxes that otherwise would have been paid. Relative Tax Cost is the percentage loss of taxable return relative to the tax exempt return.

Strategy	Statistic	Tax Exempt	90% to 95% Income	99th % Income	99.5% to 99.99% Income
No Dividend Portfolio					
	After Tax Return	7.43	6.71	6.72	6.69
	Dividend Yield	0.61			
	Avg Overhang	0.00	3.47	3.47	3.46
	Positive Tax Frequency	0.00	77.84	78.29	78.52
	CG Relative Tax Cost	0.00	6.60	6.66	6.71
	Div Relative Tax Cost	0.00	0.39	0.60	0.73
	Total Relative Tax Cost	0.00	9.17	9.65	9.99
Low Dividend Portfolio					
	After Tax Return	9.66	8.22	8.01	7.85
	Dividend Yield	4.09			
	Avg Overhang	0.00	8.79	8.89	8.96
	Positive Tax Frequency	0.00	93.48	94.04	94.15
	CG Relative Tax Cost	0.00	0.69	0.62	0.57
	Div Relative Tax Cost	0.00	14.27	16.37	17.88
	Total Relative Tax Cost	0.00	14.86	17.09	18.70
High Dividend Portfolio					
	After Tax Return	11.84	9.50	9.22	9.01
	Dividend Yield	5.45			
	Avg Overhang	0.00	3.18	3.22	3.25
	Positive Tax Frequency	0.00	91.34	91.56	92.01
	CG Relative Tax Cost	0.00	5.10	5.14	5.17
	Div Relative Tax Cost	0.00	13.85	16.09	17.71
	Total Relative Tax Cost	0.00	19.75	22.16	23.90

Table 7. Tax impact of long style strategies--06/1927-06/2002
Panel A: Uses the tax rates from the tax code that corresponds to the return period.

Return is the average annualized log return, which is computed by multiplying 12 times the log of Effective Value dividend by last months Effective Value, where Effective Value = After tax Liquidation Value + 0.07*(Pre-tax Portfolio Value - After tax Liquidation Value). Positive Tax Frequency is the percentage of contiguous twelve month periods which involve positive total tax expenses. CG Relative Tax Cost is the percentage difference between the after tax return and the return of a taxed portfolio that reinvests dividend taxes that otherwise would have been paid. Div Tax Cost is the percentage difference between the after tax return and the return of a taxed portfolio that reinvests capital gains taxes that otherwise would have been paid. Relative Tax Cost is the percentage loss of taxable return relative to the tax exempt return.

Strategy Statistic	Tax Exempt	90th % Income	95th % Income	99th % Income	99.5% Income	99.90% Income	99.99 % Income
Large							
After Tax Return	9.34	8.19	8.12	7.76	7.55	7.12	6.63
Dividend Yield	4.03						
Avg Overhang	0.00	7.61	8.10	10.07	11.18	12.09	12.34
Positive Tax Frequency	0.00	81.89	81.89	82.57	82.90	89.54	93.59
CG Relative Tax Cost	0.00	1.72	1.61	1.05	0.71	-0.00	-0.77
Div Relative Tax Cost	0.00	11.01	11.75	15.38	17.55	22.03	27.36
Total Relative Tax Cost	0.00	12.36	13.14	16.91	19.25	23.79	29.01
Growth							
After Tax Return	8.77	7.63	7.57	7.26	7.05	6.71	6.38
Dividend Yield	3.38						
Avg Overhang	0.00	6.27	6.66	8.39	9.42	10.33	10.88
Positive Tax Frequency	0.00	76.60	76.94	78.18	80.65	86.61	87.96
CG Relative Tax Cost	0.00	4.30	4.35	4.23	4.25	3.28	1.08
Div Relative Tax Cost	0.00	8.42	8.98	12.03	13.88	18.04	23.03
Total Relative Tax Cost	0.00	12.94	13.66	17.21	19.59	23.50	27.24
Small							
After Tax Return	11.17	9.43	9.30	8.70	8.32	7.93	7.50
Dividend Yield	2.86						
Avg Overhang	0.00	0.03	0.09	0.31	0.49	-0.03	-0.68
Positive Tax Frequency	0.00	79.64	79.64	83.58	83.58	84.14	86.39
CG Relative Tax Cost	0.00	8.87	9.53	12.48	14.28	14.88	15.93
Div Relative Tax Cost	0.00	6.78	7.22	9.37	10.70	13.00	14.56
Total Relative Tax Cost	0.00	15.53	16.69	22.11	25.51	29.00	32.89
Value							
After Tax Return	12.45	10.31	10.15	9.49	9.08	8.57	8.15
Dividend Yield	4.11						
Avg Overhang	0.00	1.86	2.00	2.49	2.83	2.87	2.54
Positive Tax Frequency	0.00	82.22	82.22	86.39	87.63	89.54	90.55
CG Relative Tax Cost	0.00	8.24	8.79	11.00	12.27	12.81	12.77
Div Relative Tax Cost	0.00	8.18	8.82	11.56	13.21	16.34	18.51
Total Relative Tax Cost	0.00	17.21	18.47	23.84	27.10	31.21	34.57

Table 7. Tax impact of long style strategies--06/1927-06/2002
Panel B: Uses the tax rates that correspond to 2000 tax code.

Return is the average annualized log return, which is computed by multiplying 12 times the log of Effective Value dividend by last months Effective Value, where Effective Value = After tax Liquidation Value + 0.07*(Pre-tax Portfolio Value - After tax Liquidation Value). Positive Tax Frequency is the percentage of contiguous twelve month periods which involve positive total tax expenses. CG Relative Tax Cost is the percentage difference between the after tax return and the return of a taxed portfolio that reinvests dividend taxes that otherwise would have been paid. Div Tax Cost is the percentage difference between the after tax return and the return of a taxed portfolio that reinvests capital gains taxes that otherwise would have been paid. Relative Tax Cost is the percentage loss of taxable return relative to the tax exempt return.

Strategy	Statistic	Tax Exempt	90% to 95% Income	99th % Income	99.5% to 99.99% Income
Large					
	After Tax Return	9.34	7.97	7.77	7.62
	Dividend Yield	4.03			
	Avg Overhang	0.00	8.69	8.78	8.84
	Positive Tax Frequency	0.00	92.91	93.59	94.15
	CG Relative Tax Cost	0.00	1.71	1.61	1.05
	Div Relative Tax Cost	0.00	11.01	11.75	15.38
	Total Relative Tax Cost	0.00	14.71	16.89	18.45
Growth					
	After Tax Return	8.77	7.54	7.39	7.28
	Dividend Yield	3.38			
	Avg Overhang	0.00	7.94	8.00	8.05
	Positive Tax Frequency	0.00	84.14	84.93	86.16
	CG Relative Tax Cost	0.00	1.27	0.89	0.62
	Div Relative Tax Cost	0.00	12.07	13.93	15.27
	Total Relative Tax Cost	0.00	14.04	15.73	16.95
Small					
	After Tax Return	11.17	9.07	8.80	8.60
	Dividend Yield	2.86			
	Avg Overhang	0.00	-1.26	-1.26	-1.15
	Positive Tax Frequency	0.00	84.93	85.60	85.93
	CG Relative Tax Cost	0.00	10.81	11.97	12.80
	Div Relative Tax Cost	0.00	6.28	7.44	8.28
	Total Relative Tax Cost	0.00	18.79	21.24	23.01
Value					
	After Tax Return	12.45	10.00	9.71	9.50
	Dividend Yield	4.11			
	Avg Overhang	0.00	2.21	2.23	2.24
	Positive Tax Frequency	0.00	88.19	89.20	89.20
	CG Relative Tax Cost	0.00	9.18	9.83	10.30
	Div Relative Tax Cost	0.00	8.76	10.18	11.19
	Total Relative Tax Cost	0.00	19.67	22.02	23.72

Table 8. Tax impact of long-short strategies
Panel A: Uses the tax rates from the tax code that corresponds to the return period.

Return is the average annualized log return, which is computed by multiplying 12 times the log of Effective Value dividend by last months Effective Value, where Effective Value = After tax Liquidation Value + 0.07*(Pre-tax Portfolio Value - After tax Liquidation Value). CG Relative Tax Cost is the percentage difference between the after tax return and the return of a taxed portfolio that reinvests dividend taxes that otherwise would have been paid. Div Tax Cost is the percentage difference between the after tax return and the return of a taxed portfolio that reinvests capital gains taxes that otherwise would have been paid. Relative Tax Cost is the percentage loss of taxable return relative to the tax exempt return.

Strategy	Statistic	Tax Exempt	90% Income	95% Income	99% Income	99.5[t]% Income	99.90% Income	99.99% Income
VWRET-Rf								
	Total Return	5.89	5.81	5.83	5.78	5.71	5.50	5.18
	Long Return	9.63	8.44	8.36	8.00	7.78	7.33	6.81
	Short Return	3.75	2.63	2.54	2.22	2.07	1.84	1.63
	Avg Overhang	0.00	7.29	7.77	9.64	10.69	11.42	11.36
	CG Tax Cost	0.00	3.59	3.47	2.83	2.38	1.64	1.31
	Div Tax Cost	0.00	-1.32	-2.07	-1.65	-0.82	2.37	7.47
	Relative Tax Cost	0.00	1.34	1.01	1.88	3.04	6.67	12.14
SMB								
	Total Return	1.61	1.58	1.57	1.48	1.41	1.41	1.34
	Long Return	11.32	9.59	9.49	8.89	8.53	8.09	7.57
	Short Return	10.28	8.41	8.29	7.71	7.36	6.83	6.27
	Avg Overhang	0.00	1.28	1.42	2.22	2.71	3.31	4.06
	CG Tax Cost	0.00	10.94	12.90	21.32	26.60	29.17	36.55
	Div Tax Cost	0.00	7.94	8.08	9.26	10.78	13.51	13.07
	Relative Tax Cost	0.00	1.84	2.87	8.37	12.43	12.79	17.24
HML								
	Total Return	3.38	2.86	2.81	2.62	2.50	2.42	2.49
	Long Return	12.21	10.14	9.99	9.33	8.92	8.46	8.08
	Short Return	9.27	7.74	7.64	7.16	6.85	6.38	5.80
	Avg Overhang	0.00	0.58	0.66	1.09	1.35	1.66	1.97
	CG Tax Cost	0.00	5.99	6.66	10.21	12.66	14.04	13.50
	Div Tax Cost	0.00	10.11	10.90	13.71	15.21	16.82	16.59
	Relative Tax Cost	0.00	15.33	16.79	22.54	26.20	28.49	26.41

Table 8. Tax impact of long-short strategies--06/1927-06/2002
Panel B: Uses the tax rates that correspond to 2000 tax code.

Return is the average annualized log return, which is computed by multiplying 12 times the log of Effective Value dividend by last months Effective Value, where Effective Value = After tax Liquidation Value + 0.07*(Pre-tax Portfolio Value - After tax Liquidation Value). CG Relative Tax Cost is the percentage difference between the after tax return and the return of a taxed portfolio that reinvests dividend taxes that otherwise would have been paid. Div Tax Cost is the percentage difference between the after tax return and the return of a taxed portfolio that reinvests capital gains taxes that otherwise would have been paid. Relative Tax Cost is the percentage loss of taxable return relative to the tax exempt return.

Strategy	Statistic	Tax Exempt	90% to 95% Income	99th % Income	99.5% to 99.99% Income
VWRET-Rf					
	Total Return	5.89	5.56	5.54	5.52
	Long Return	9.63	8.14	7.93	7.78
	Short Return	3.75	2.59	2.40	2.27
	Avg Overhang	0.00	7.75	7.82	7.88
	CG Tax Cost	0.00	2.71	2.57	2.49
	Div Tax Cost	0.00	3.35	3.57	3.72
	Relative Tax Cost	0.00	5.61	5.97	6.24
SMB					
	Total Return	1.61	1.41	1.36	1.32
	Long Return	11.32	9.27	9.00	8.80
	Short Return	10.28	8.00	7.77	7.59
	Avg Overhang	0.00	2.85	2.91	2.95
	CG Tax Cost	0.00	23.45	28.21	31.64
	Div Tax Cost	0.00	22.39	20.74	19.53
	Relative Tax Cost	0.00	12.91	15.94	18.13
HML					
	Total Return	3.38	2.78	2.74	2.72
	Long Return	12.21	9.92	9.65	9.44
	Short Return	9.27	7.31	7.07	6.90
	Avg Overhang	0.00	1.29	1.32	1.34
	CG Tax Cost	0.00	11.95	11.91	11.88
	Div Tax Cost	0.00	12.00	12.66	13.15
	Relative Tax Cost	0.00	17.91	18.85	19.53