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ASSET LOCATION FOR RETIREMENT SAVERS

James M. Poterba  
John B. Shoven  
Clemens Sialm

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### **ABSTRACT**

This paper uses data on actual returns on taxable bonds, tax-exempt bonds, and a small sample of equity mutual funds over the 1962-1998 period to compare two asset location strategies for retirement savers. The first strategy gives priority to holding equities, through equity mutual funds, in a saver's tax-deferred account, while the second strategy gives priority to holding fixed-income investments in the tax-deferred account. We consider high-income taxable individual investors who saved in each year and invested in one of actively-managed funds in our sample. Over the thirty-seven year span that we consider, such savers would have accumulated a larger stock of wealth if they had held their equity mutual fund in their tax-deferred account than if they had held the fund in a conventional taxable form. The explanation for this apparent contradiction of the often-stated "bonds in the tax-deferred account" prescription has two parts. First, many equity mutual funds impose substantial tax burdens on their investors. This raises the effective tax rate on investing in equities through mutual funds rather than in a buy-and-hold personal portfolio. Second, taxable investors who wish to hold fixed income assets can do so by holding tax-exempt bonds as well as by holding taxable bonds. The interest rate differential between taxable and tax-exempt bonds suggests that the effective tax rate on fixed income investments may be lower than the statutory tax rate for high-income investors.

James M. Poterba  
Department of Economics  
MIT, E52-350  
50 Memorial Drive  
Cambridge, MA 02142  
and NBER  
poterba@mit.edu

John B. Shoven  
NBER  
30 Alta Road  
Stanford, CA 94305  
and Stanford University  
shoven@leland.stanford.edu

Clemens Sialm  
Department of Economics  
Stanford University  
Stanford, CA 94305

Asset allocation, the decision of how much of a portfolio to allocate to different types of securities, is one of the fundamental issues in financial economics. For taxable individual investors, the proliferation of tax-deferred opportunities for retirement saving, such as Individual Retirement Accounts, 401(k) plans, Keogh plans, and 403(b) plans, has added a new dimension to the traditional asset allocation problem. A taxable investor needs to make choices not just about the amount to hold in various types of assets, but also about where to hold these assets. If there are two asset classes, broadly defined as riskless and risky assets, the asset allocation problem facing a tax-exempt investor involves a one-dimensional decision: choosing the fraction of the portfolio to allocate to the risky asset. A taxable investor with a tax-deferred retirement saving account, however, faces a more complex problem, since he must decide how much of the risky asset to hold in his tax-deferred account, and how much to hold in his taxable account. Shoven (1999), Shoven and Sialm (2000), and Dammon, Spatt, and Zhang (2000) label the problem of deciding where to hold a given asset as the asset location decision.

How the decision to hold a given asset in a taxable or tax-deferred account affects an investor's long-term wealth accumulation depends on the tax treatment of the asset in question, as well as on the menu of other assets that are available. Given the set of assets that an investor wishes to hold, long-run wealth accumulation will generally be maximized by placing the most heavily taxed assets in the tax-deferred account (TDA), while holding the less heavily taxed assets in a taxable account. We refer to the latter as a conventional savings account (CSA).

The asset location problem is a practical question in applied financial economics, and it confronts many households as they save for retirement and other objectives. Yet much of the “conventional wisdom” on asset location for individual investors derives from research on a related problem confronting corporations. Nearly two decades ago, Black (1980) and Tepper (1981) studied the problem of asset allocation for a corporation that could choose to hold assets in the company’s defined benefit pension plan, or on the company’s taxable corporate account. These studies explored

the impact of corporate asset location problems with respect to taxable bonds and corporate equities. Taxable bonds were assumed to generate heavily-taxed interest income, and corporate equities were assumed to generate lightly-taxed returns because capital gains are not taxed until they are realized. These studies concluded that because bonds are taxed more heavily than stocks, a firm could maximize its shareholders' after-tax cash flow by placing bonds in the pension account and stocks in the taxable corporate account. The pension account, in this setting, is the equivalent of the individual investor's tax-deferred account. Something like this analysis underlies the suggestion, made by many financial advisors, that individual investors should hold taxable bonds in their tax-deferred account before holding them in their taxable account.

This common analysis neglects two important aspects of the investment decisions that face most taxable investors. First, heavily-taxed corporate or government bonds are not the only way for taxable investors to participate in the market for fixed-income securities. Taxable investors could also choose to hold tax-exempt bonds. Over the last four decades, the average yield on long-term tax-exempt bonds has exceeded the after-tax yield for individual investors in the highest marginal tax brackets. Including the opportunity to hold tax-exempt bonds in the portfolio selection problem can therefore offer taxable investors the potential to hold fixed-income securities for which the “implicit tax rate” is lower than the statutory tax rate on taxable bonds.

The second shortcoming of the standard asset location analysis is that it assumes that investments in corporate stock are lightly taxed. In practice, many taxable investors hold equities through equity mutual funds. Many equity funds, particularly actively managed funds, are managed in a fashion that imposes substantial tax burdens on taxable individual investors. Dickson and Shoven (1995), Dickson, Shoven, and Sialm (2000), Bergstresser and Poterba (2000), Arnott, Berkin, and Ye (2000), and others have computed before-tax and after-tax returns for equity mutual funds in the United States. These studies suggest that because such funds often realize capital gains more

quickly than a tax-deferral strategy might dictate, the effective tax rate on equity investments through mutual funds is often substantially greater than the tax rate on a buy-and-hold equity portfolio.

Both of these omissions from the standard analysis of asset location work to overstate the tax burden on bonds relative to that on stocks. In this paper, we investigate whether these two factors are important enough to reverse the conventional wisdom offered by financial advisors. We study whether investors would, historically, have accumulated more after-tax wealth by holding equity mutual funds in their tax-deferred account, and municipal bonds on taxable account, than by holding taxable bonds in their tax-deferred account and equity mutual funds on taxable account.

This paper uses the historical performance of actual mutual funds to explore the asset location problem. Our earlier work on asset location was either theoretical (Shoven and Sialm (2000)) or used hypothetical or simulated mutual funds (Shoven (1999) and Shoven and Sialm (1998)). While using historical data provides information on how following alternative investment strategies would have fared in past decades, it is possible that the future performance of equity mutual funds, particularly with respect to their tax efficiency, may vary from their past outcomes.

We consider a stylized investor who made equal annual contributions to a tax-deferred account (TDA) and a conventional saving account (CSA) over the period 1962-1998. We assume that this investor rebalanced his portfolio each year to hold half of his total assets in equities, and half in fixed income investments. We assume that all equity investments are carried out through one of a set of equity mutual funds for which we collect returns information, and that fixed-income investments can be made in tax-exempt as well as taxable bonds.

Our empirical analysis computes the investor's after-tax wealth at the end of 1998 under two different assumptions about the investor's asset location strategy. The first strategy specifies that equity, held through one of the equity mutual funds in our data set, will be given a priority location in the tax-deferred account. Under this rule, if the total market value of the assets in the TDA is less than half of the combined market value of the assets in the TDA and the CSA, the investor holds only

an equity mutual fund in his tax-deferred account. If the total amount that the investor could hold in the TDA were more than half of the combined value of the TDA and the CSA, then some of the TDA, as well as all of the CSA, would be held in fixed income instruments. This would involve holding taxable bonds in the TDA, and tax-exempt bonds in the CSA.

The second asset location rule reverses this priority and holds that fixed income assets should be held in the TDA before any such assets are held in a taxable format. In this case, if the total value of the TDA assets were less than half of the combined value of the TDA and the CSA, the investor would hold only taxable bonds in his TDA.

The paper is divided into five sections. Section one describes the data on equity mutual fund returns and bond returns that underlie our calculations. We collect data on the annual returns on twelve large equity mutual funds that have been continuously traded over the 1962-1998 period. Our calculations use the actual returns on these funds to evaluate the two asset location rules. This section also describes our assumptions about the marginal tax rates facing the hypothetical taxable investors whose wealth accumulation we analyze.

The second section presents our core findings on the amount of wealth that investors would have accumulated if they had followed two different asset location strategies over the 1962-1998 period. For virtually all of the actively managed mutual funds in our data set, an investor would have had more end-of-period wealth if he had allocated his mutual fund shares to his tax-deferred account before holding any equities in his conventional saving account. The differences in end-of period wealth between the two asset location strategies are substantial for all of the actively-managed funds in our data sample. These differences are much smaller when consider equity index funds. Our findings, which stand in contrast to much "convention wisdom," are due both to our recognition of the opportunity to hold tax-exempt bonds as well as taxable bonds, and to the higher tax burden on corporate stock that follows from holding equities funds rather than directly.

In section three, we explore the sensitivity of our findings to the particular pattern of equity and bond returns that have characterized the last four decades. We evaluate the robustness of our findings by drawing sequences of thirty-seven returns (with replacement) from the empirical distribution of returns on each mutual fund. Our results suggest that while the recent history of returns has been particularly favorable to the asset location strategy that gives priority to equities in the tax-deferred account, in most cases this strategy generates more after-tax wealth than the “fixed income in the TDA” strategy.

The analysis in the first three sections considers an investor whose universe of portfolio options consists of a corporate bond mutual fund, a tax-exempt bond fund, and equity mutual funds. In section four, we expand this universe to allow for inflation-indexed bonds such as the Treasury Inflation Protected Securities that have been available in the United States since 1997. We consider two ways that investors might hold inflation-indexed bonds: by purchasing TIPS directly, and by holding inflation-indexed Series I savings bonds. We show that if inflation-indexed bonds with a four percent real return had been available throughout the 1962-1998 period, then holding equity mutual funds in the TDA and inflation-indexed savings bonds in the CSA would have given investors a higher expected utility than holding equity mutual funds in their TDA and tax-exempt nominal bonds in their CSA. Finally, section five concludes with a summary of our findings.

### 1. Data on Asset Returns and Investor Tax Rates

Our analysis of the economic effects of different asset location choices relies on data from 1962-1998. We consider the returns to twelve actively managed equity mutual funds that were available to investors for the entire 37-year period. Table 1 summarizes the total asset values of the twelve funds in our dataset. The equity funds are sorted according to their total valuation in December 1961 and 1968 as listed by Johnson's Charts (1962, 1969). The first five funds ('Top-5-Funds') were the five largest equity funds at the end of December 1961. Selection and survivorship

bias is important because funds with above-average past performance tend to be larger and are less likely to be discontinued, as discussed in Carhart (1997). Results using these five largest funds are not subject to these biases, whereas results using the other funds might be.

We also collected data for the ten largest equity funds on December 31, 1968, according to Johnson's Charts (1969). We augmented this data sample with information on two other funds, Fidelity Magellan and Vanguard Windsor. Our whole sample represents 29.2 percent of the total value of mutual funds in 1961 and 33.6 percent in 1968. The sample becomes less representative in more recent years, as a result of both increase in the total number of mutual funds and a sharp increase in inflows to equity mutual funds during the 1980s and 1990s. As these inflows were distributed across the funds in existence in those decades, many of which were new entrants that were not available in the 1960s, the share of assets in these "old" equity funds declined. In 1998, data from the Investment Company Institute (2000) suggest that our twelve actively managed mutual funds held only 2.2 percent of the assets invested in mutual funds.

The data on the pretax returns and post-tax returns of the equity funds for the years prior to 1992 are taken from Dickson and Shoven (1995). Their dataset is updated using the Standard & Poor's Dividend Records (1993-1999) and the Moody's Dividend Records (1993-1999) for the distributions (dividends, short-, medium-, and long-term capital gains) and Interactive Data (part of Financial Times Information) for the net asset values of the funds. The annual total return is defined as the percentage change in the value at the end of the current year of one mutual fund share purchased at the end of the previous year. The returns are adjusted for splits as necessary. We assume that the distributions are re-invested in the mutual funds on the 'ex-date'.

To model the taxable and tax-exempt fixed income investment options available to our hypothetical investor, we use the Vanguard Long-Term Bond Fund and the Vanguard Long-Term Municipal Bond Fund. The annual distributions and net asset values of the two bond funds are taken from Morningstar. Both bond funds pay monthly dividends and we assume monthly compounding



when computing their annual returns. In addition to the twelve actively-managed funds that we consider, we have also constructed a time series of returns that we view as corresponding to a passively managed S&P 500 index fund. When they are available, we use the returns on the Vanguard Index 500 Fund for the index fund returns.

Unfortunately, data for the two bond funds and the index fund are only available after the mid-1970s. To indicate the type of returns that investors in such funds would have earned if such funds had been available during the first decade and a half of our sample period, we construct "synthetic funds." The returns on the synthetic bond funds are calculated from the year-end yields to maturity of long term corporate bonds (Moody's Aaa-rated bonds) and of long-term tax-exempt bonds (with an average rating of A1) as reported in the Statistical Release of the Federal Reserve. The synthetic bond funds are assumed to hold the bonds for one year. The interest income of the funds paid at the end of the year equals the yield to maturity at the issue date minus expenses of 50 basis points. Each year, we calculate the capital gain or loss for each bond fund by calculating the capital gain or loss on 20-year par bonds that were newly-issued at the beginning of the year.<sup>1</sup>

Positive capital gains in the synthetic mutual funds are distributed to the shareholders annually and capital losses are carried forward. To check whether the characteristics of the synthetic funds are similar to those of the actual funds, we computed returns on the synthetic funds for the period when we also had returns on the actual equity index fund and on the two bond funds, and we compared their performance. This is the period 1979-1998. The income and capital gains distributions of the synthetic bond funds correspond closely to the distributions of the actual bond funds for this period. The synthetic funds have 100 percent turnover each year, whereas the

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<sup>1</sup> The capital gain (*CG*) of the synthetic bond fund between time  $t$  and time  $t+1$  is computed as the difference between the price of a 19-year bond at time  $t+1$ ,  $p_{t+1}^{19}$ , and the price of a 20-year bond at time  $t$ ,  $p_t^{20}$ . By convention, bonds are issued at par, so  $p_t^{20} = 1$ . We define the yield to maturity of a 20-year bond at time  $t$ , and a 19-year bond at time  $t+1$ , as  $y_t^{20}$  and  $y_{t+1}^{19}$ , respectively. We assume that yields at all maturities are equal, so that  $y_{t+1}^{19} = y_{t+1}^{20}$ . In this case,

$$CG_{t+1} = p_{t+1}^{19} / p_t^{20} - 1 = (y_t^{20} / y_{t+1}^{19}) * [(1 - (1 + y_{t+1}^{19})^{-19}) + (1 + y_{t+1}^{19})^{-19}] - 1.$$

The interest return at time  $t+1$  of the synthetic bond fund is set equal to the coupon rate at time  $t$ ,  $y_t^{20}$ .

corporate and the municipal bond funds have average turnovers of 81.5 and 85.0 percent, respectively. The average expenses for the actual corporate bond fund were 0.49 percent, and those for the actual municipal bond fund were 0.31 percent.

The synthetic bond funds have slightly higher mean returns (0.21 percent for the corporate bond fund and 0.43 percent for the municipal bond fund), and considerably higher standard deviations (3.14 percent for the corporate bond fund and 2.53 percent for the municipal bond fund) than the actual bond funds. The correlation coefficients between the returns of the actual and synthetic funds are 0.94 for the corporate bond fund and .99 for the municipal bond fund.

We create a synthetic index fund corresponding to the Vanguard 500 Index Fund using the return data of the large stock index of Ibbotson Associates (2000). The synthetic fund distributes the dividends net of expenses, with expenses set to 25 basis points. The fund's turnover rate of 5 percent results in short- and long-term capital gains distributions, which are distributed if they are positive and carried forward if they are negative. The actual index fund and the synthetic index fund yield very similar returns during the period from 1979-1998. The average return on the synthetic index fund is slightly higher (by 0.10 percent per year) than that on the actual index fund, and the standard deviation of the synthetic index fund return is 0.05 percent higher than that of the actual index fund return. The correlation between the returns on the actual and the synthetic index funds is 0.9997.

When we consider investor performance over the 1962-1998 period, we splice together the returns on our synthetic bond and index funds for the early part of our sample, with the actual returns on these funds in the later part of the sample. We label these "spliced funds."

We translate the before-tax returns on the various mutual funds in our sample into after-tax returns using two sets of marginal tax rates. We develop time series of tax rates for hypothetical high- and medium-tax individuals. We assume that the high-tax individual has taxable income that is ten times the median adjusted gross income (AGI), less the standard deduction for a married couple with three exemptions, in each year. The medium-tax individual has taxable income equal to three

times this quantity. Median AGI is taken from the Statistics of Income of the Internal Revenue Service. The tax rates between 1962 and 1992 are taken from Dickson and Shoven (1995); we updated these using tax forms for the years 1993 to 1998. We assume that our medium-tax investor has an income roughly three times the median AGI because stock and bond investors, particularly those with the asset location problem we study, have much higher incomes than average households do. We use data on the short- and long-term capital gain distributions of the equity mutual funds in our sample, as well as on their dividend distributions, to compute after-tax returns. We also consider "medium term" capital gain distributions for the applicable years, 1997 and 1998.

Table 2 presents summary statistics on returns for the mutual funds in our sample. The twelve actively managed equity funds have an average nominal return of 12.68 percent over the 1962-1998 period, and an average standard deviation of the annual returns of 17.07 percent. The rate of consumer price inflation has a mean of 4.74 percent and a standard deviation of 3.17 percent (Ibbotson Associates (2000)). The nominal return on the corporate bond fund averages 7.44, which translates to an average real return of 2.73 percent.

The mean nominal returns and the standard deviations of the funds differ considerably during this period. The Van Kampen Enterprise Fund has the highest average nominal return (16.89 percent) and the highest standard deviation (28.77 percent). The IDS Stock Fund has the lowest average return (10.74 percent) and the Affiliated Fund has the lowest standard deviation (14.10 percent). The 'Top-5-Funds' have a considerably lower mean return than the remaining seven funds (11.66 percent vs. 13.41 percent), possibly because of survivorship bias.

Table 2 describes the composition of returns received by investors, with particular attention to the division between dividends, realized capital gains, and unrealized gains. The twelve funds distributed on average 72.57 percent of their total return annually either as dividends or capital gains,

and 30.44 percent of the total average returns were either dividends or short-term capital gains.<sup>2</sup> Capital gains that are not distributed are deferred until the investor sells the mutual fund shares. The most successful fund (Van Kampen Enterprise Fund) distributed only 43.81 percent of its total returns, whereas the relatively poorly performing United Accumulative Fund distributed 88.45 percent of its total return. The 'Top-5-Funds' tend to impose somewhat higher tax burdens on their investors than the other funds since they distribute a larger portion of their total returns and since a slightly larger portion of their distributions do not qualify as long-term capital gains.

The passively managed "spliced" index fund has an average nominal return of 12.78 percent and a standard deviation of 15.91 percent. The average return on the index fund is similar to that for our whole sample of equity funds, and it is considerably higher than the return on the bias-free 'Top-5-Funds'. The passively managed index fund exhibits a smaller difference between pre-tax and post-tax returns than the actively managed equity funds. Only 39.21 percent of its total nominal returns were distributed on average to shareholders, and only a small portion of those distributions resulted from the distribution of realized capital gains.

The "spliced" corporate bond fund has a mean nominal return of 7.44 percent and a standard deviation of 8.27 percent, while the "spliced" tax-exempt municipal bond fund has a lower mean nominal return (5.87 percent) and a higher standard deviation (11.16 percent). The average implied tax rate of the municipal bond fund, defined as  $1 - E(r_M)/E(r_B)$  where  $E(r_M)$  and  $E(r_B)$  are the expected nominal returns of municipal bonds and corporate bonds, respectively, is 21.10 percent. Both bond funds distribute a very large proportion of their total returns as interest income.

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<sup>2</sup> The data sources do not always distinguish between short- and long-term capital gains. We assume that capital gains are long-term if the sources do not indicate the term of the gains. This results in an overstatement of the actual tax-efficiency of the mutual funds.

## 2. Asset Location and Investor Returns: Historical Evidence

In this section we present asset location results for the period 1962-98 for the twelve actively managed equity mutual funds as well as the three spliced funds. The investor is assumed to have made identical contributions (in constant dollars) each year to a tax-deferred pension account (TDA) and to a conventional taxable savings account (CSA). We use 1998 as our price level benchmark, so the actual 1998 contributions were 50 cents to each account, whereas the earlier contributions were less in nominal dollars. The total real investment over the 37-year period was \$37 at 1998 prices.

We assume that half of each annual investment placed in the TDA and half in the CSA, and that the investor wants half of his or her total portfolio in stocks and half in bonds.<sup>3</sup> We assume that the initial 1962 investments are half to stocks and half to bonds. Thereafter, the investor annually adjusts the portfolio to maintain a 50 percent proportion in stocks and 50 percent in bonds. The necessary rebalancing is first accomplished by adjusting the composition of new investments. If necessary, assets are sold and bought in order to bring about the desired 50-50 stock-bond balance. At the end of the year, the investor is taxed on the taxable mutual fund distributions and the realized capital gains from selling fund shares in the taxable account. Realized losses are carried forward and subtracted from future capital gains. At the end of our sample period, the investor liquidates all assets and pays the necessary capital gains taxes as well as the ordinary income taxes on withdrawals from the TDA. The dollar figures shown in our tables thus represent retirement accumulations after the payment of all taxes.

We evaluate two possible asset location strategies. Strategy one gives the equity mutual fund priority for placement inside the TDA. The corporate bond fund would be held in the TDA only if

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<sup>3</sup> When we compute the stock proportions we do not adjust the value of assets held in the two different accounts to reflect deferred taxes. There are at least two issues in this regard. First, the investor only owns  $(1-t)$  of the assets invested in the tax-deferred account, because the government will tax withdrawals from a tax-deferred account at the rate  $t$ . Second, the realized returns of assets in the CSA are taxed annually; this reduces their accumulation. Whether one invested in the TDA is more valuable than one dollar invested in a CSA depends on the investment horizon. One dollar invested in a CSA is more valuable at sufficiently short investment horizons and one dollar invested in a TDA is more valuable at sufficiently long horizons.

there is room after all of the equity is in the TDA. Municipal bonds have a preferred location in the CSA. Strategy two gives the corporate bond fund priority for placement inside the TDA. The equity mutual fund is given priority for placement in the CSA. If it is necessary to hold bonds in the CSA to maintain the desired 50-50 asset allocation, then the investor would hold the municipal bond fund.

Table 3 shows our basic asset location results. Strategy 1 works out better for all twelve of the actively managed equity mutual funds for the high-income, high-tax investor and for eleven of the twelve funds for the medium-income, medium-tax investor. The additional wealth accumulated by following strategy 1 (giving equities preference for placement in the TDA) can be quite large. For the twelve actively managed funds as a whole the average gain of strategy 1 over strategy 2 is 8.9 percent for high-tax retirement accumulators. For the five largest funds in 1961, the gain of strategy 1 over strategy 2 averages 7.7 percent. For someone who contributed \$10,000 (\$1998) per year to both the CSA and the TDA in each year between 1962 and 1998, the 7.7 percent differential would translate to additional wealth of more than \$140,000 in 1998.

The equity mutual fund that gains the most from strategy 1 is the Vanguard Windsor fund. Its before-tax performance was better than average over the 1962-98 period, while it imposed a higher than average tax burden on its investors. With Vanguard Windsor, strategy 1 results in more than 17 percent more retirement wealth than strategy 2. The actively managed fund for which the advantage of strategy 1 is the smallest is the Fundamental Investors Fund. Its before-tax performance was worse than average and its investor tax burden was better than average. For high-income investors using Fundamental Investors in a 50-50 stocks-bonds asset allocation plan, strategy 1 offers an advantage of less than 1 percent. For the medium-income investor using Fundamental Investors, strategy 2 actually works better than strategy 1, although the difference is extremely small. For the eleven other funds, strategy 1 yields between 1 and 17 percent more after-tax wealth than strategy 2 at the end of the sample period.

Interestingly, when we consider the S&P 500 Index Fund, strategy two yields the highest terminal wealth. This involves giving the equity fund locational preference in the CSA and corporate bonds locational preference in the TDA. The Index Fund had slightly better before-tax returns than the average actively managed fund, almost all due to the lower expenses of the index fund, and imposes much lower tax burdens on its investors. In this case the advantage of strategy 2 is considerable. A high-tax investor holding an S&P 500 fund in the TDA and municipal bonds in the CSA would have ended up with 1.7 percent less retirement wealth than a similar investor who put corporate bonds in the TDA and held the index fund in the CSA.

Table 3 suggests that over the 1962-1998 period, 50-50 stock-bond investors who had access to tax-deferred accounts, and who favored actively managed equity mutual funds for their equity investments, achieved higher after-tax wealth by following strategy 1 than by following strategy 2. Strategy 1 implies that the equity fund should be first in line for placement in the tax-deferred pension account. On the other hand, those who used index funds for their equity positions, or other tax-efficient equity mutual funds, attained higher end-of-period net worth by following strategy 2. This is the strategy that gives the corporate bond fund priority for placement in the TDA, while the equity index fund is held in the CSA.<sup>4</sup>

It is interesting to note that the index fund runs a very close second against the twelve actively managed funds under strategy 2, but a much more distant fifth if all equity funds are located according to strategy 1. (The index fund also came in fifth place in the gross-of-tax average return rankings of Table 2.) All this means is that it is very hard for an actively managed fund to generate more end-of-period wealth than an index fund over 37 years in a fully taxable environment. It is much easier in the tax-deferred and tax-neutral TDA environment.

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<sup>4</sup> While we have modeled people who choose a particular equity mutual fund and stick with it, many investors periodically switch funds. Such switching generates taxable capital gains in a CSA, which raises the relative wealth accumulation from strategy 1 relative to strategy 2.

One reason that strategy 1 yielded higher end-of-period wealth than strategy 2 for most actively managed equity funds during our sample period is that equities have experienced higher rates of return than bonds, and thus would have generated higher tax bills in a taxable environment. This is related to the well-documented equity premium puzzle described by Mehra and Prescott (1985). One could ask whether strategy 1 would still generate higher end-of-period wealth if the average return advantage of equities were lower. Table 4 answers this question for our high-tax, high-income investor. Each successive column presents results that are based on a 100 basis point reduction of realized fund returns, relative to those in the previous column. All fund distributions (dividends and capital gains) are reduced proportionally. Each additional 100 basis point reduction lowers the average advantage of strategy 1 over strategy 2, but by decreasing amounts. Even an unrealistically high reduction of 500 basis points (i.e. eliminating the premium of equity funds over corporate bonds) would leave strategy 1 generating higher end-of-period wealth than strategy 2 for nine of the twelve actively managed funds. The results in Table 4 suggest that the relative wealth accumulation from strategies 1 and 2 would be attenuated, but slowly, if the average return to stocks was lower than that in the 38-year period that we study.

The results in Table 4 are driven both by the fact that capital gain distributions on actively managed equity funds raise their effective tax burden, and by the fact that the implicit tax rate on tax-exempt bonds has been below the statutory marginal tax rate throughout our sample. Table 5 helps to indicate the relative importance of these two factors. In Table 5, the investors do not take advantage of municipal bonds. Instead, they invest in a single equity mutual fund and a corporate bond fund. The only location decision is between giving the equity fund preference in the TDA with the corporate bond fund having locational preference in the CSA (strategy 1) or vice versa (strategy 2). Without the use of municipal bonds, strategy 1 generates higher end-of-period wealth for only three of the twelve actively managed mutual funds for the high-income investor. For the other equity mutual funds, strategy 2 (i.e. conventional wisdom) produces more retirement wealth, often quite a



bit more. The average gain of strategy 2 for the twelve actively managed funds is 3.8 percent. Strategy 1 yields more attractive relative wealth values (Table 5) for the medium-income, medium-tax investor, producing more retirement wealth for six of the twelve actively managed equity funds. In fact, even without allowing municipal bonds, the average retirement wealth from following strategy 1 is slightly greater than that from following strategy 2 for the medium-tax investor.

Our interpretation of the results of Tables 3 and 5 is that the average actively managed mutual fund produces a higher effective tax rate for its high-income taxable holders than the implicit tax rate on municipal bonds. Hence, most of the actively managed funds would have gained more from being in the TDA environment than would corporate bonds, given the availability of tax-exempt bonds for investments in the CSA. The only equity mutual fund that would have generated a significantly lower effective tax rate than the implicit tax rate on municipal bonds was the passively managed index fund. The reason that the presence of municipal bonds in the analysis is less important for the medium-income investors is obvious. For them, the effective tax rate on the equity funds is lower (due to lower tax rates on ordinary income and capital gains) but the implicit tax rate on municipal bonds is the same. Tables 3 and 5 underscore the fact that the "conventional wisdom" that it is best to give preference to corporate bonds for placement in the TDA is based on analysis that does not consider the availability of municipal bonds.

One caution about our comparison of taxable and tax-exempt bond yields, and our calculation of implicit tax rates from these yields, should be noted. Investors in taxable and tax-exempt bonds may face somewhat different risks, and the yield differential between the yields on these bonds may reflect both tax considerations and the pricing of these risks. One particularly important risk, noted in Poterba (1989), is that of tax reform. Investors in tax-exempt bonds hold assets that could experience substantial valuation changes if the current income tax treatment of taxable and tax-exempt bonds were to change. Quantifying the price that investors demand for bearing this risk, and modifying the implicit tax rate accordingly, is very difficult.

Table 6 is also presented to help interpret the main results of Table 3. In Table 6, we apply the 1998 tax law, rather than the contemporaneous tax laws, to the 1962-98 returns generated by the CSA assets. Figure 1 shows the evolution of marginal tax rates for our high-tax and medium-tax investors between 1962 and 1998. The tax rate on ordinary income was lower in 1998 than it was through most of the 1962-98 period. The 1998 tax rate on realized long-term capital gains was near its 1962-98 average. Table 6 shows that the after-tax wealth from strategy 1, relative to strategy 2, would have been much lower if the 1998 tax law had been applied throughout the 1962-98 period, particularly for the high-income investors. Nonetheless, strategy 1 would have still yielded a higher end-of-period wealth for eight of the twelve actively managed mutual funds. The counterfactual tax assumption of Table 6 affects the results less for the medium-income investor, with strategy 1 still generating more retirement wealth for ten of the twelve actively managed mutual funds.

Table 6 does not describe what actually would have happened if the 1998 tax code had prevailed over the entire 37-year period. We have not adjusted the implicit tax rate on municipal bonds even though it would have presumably dropped in the presence of lower marginal tax rates on the wealthy. Similarly, we have not adjusted the before-tax rates of return of any of the assets even though a significant tax change would presumably have substantial general equilibrium effects.

### 3. Asset Location and Investor Returns: Simulation Evidence

The foregoing asset location results show the performance of different strategies using historic data over the period from 1962-1998. This time-period was in many respects unrepresentative; equity returns were relatively high, the rate of inflation was high and very volatile, and marginal tax rates changed considerably. To determine whether our results are robust, we run some bootstrap simulations. Each simulation proceeds in two steps: we first randomly select one mutual fund from our sample, and we then draw a random sequence of years with replacement. For each year selected, we draw the selected fund's return, as well as the returns of two bond funds, the

inflation rate, and the tax rate. We compute the wealth levels of investors making constant real annual contributions to the CSA and TDA for 37 years, just as described above. All the simulations are repeated 10,000 times.<sup>5</sup>

Figure 2 shows the probability distributions of the real wealth levels at retirement of strategies 1 and 2 for a high-tax individual choosing from the set of the five largest mutual funds in December 1961. Strategy 1 outperforms strategy 2 at all probability levels except for the four lowest simulations out of 10,000. This means that the probability of reaching a particular wealth level or higher is almost always higher using strategy 1. Even if we focus on the lower tail of the wealth distribution in Figure 3, we can hardly discern the intersection of the two cumulative distribution functions. Table 7 summarizes a few points of the probability distribution. The real wealth level of strategy 1 exceeds the one of strategy 2 by 3.7 percent at the first percentile, by 6.1 percent at the median, and by 16.4 percent at the 99<sup>th</sup> percentile. The portfolio selection of this investor is quite risky. There is a more than 20 percent probability that the real wealth level accumulated at retirement does not exceed the 37 real dollars invested and there is a more than 20 percent probability that retirement wealth under strategy 1 exceeds twice the total real investments (74 real dollars).

The median wealth level at retirement with strategy 1 equals \$51.81. This is considerably lower than the \$86.46 from Table 3 that was computed using the actual history as opposed to the simulated returns. A realization of \$86.46 would be an outcome at the 87<sup>th</sup> percentile in our bootstrap simulations. The main reason for this discrepancy is the ordering of the returns between 1962-1998. The ordering of the identical returns has a substantial effect on the wealth levels at retirement for investors making contributions over many years to their savings accounts. The arithmetic average of the real returns of the S&P 500 Index was 2.2 percent during 1962-1979 and 13.9 percent during 1980-1998. The computations that used actual historical returns had the low

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<sup>5</sup> Our bootstrap results are generated from the actual 1962-1998 set of data. It is possible, of course, that future returns will be generated from less or more favorable distributions.

returns in the first half of our investment horizon (when the accumulated contributions were relatively small) and the high returns in the second half (when the accumulated contributions were large). These back-loaded returns generate higher wealth levels at retirement compared to a more equal distribution of returns which occurs in the bootstrap simulations.<sup>6</sup>

If we let history run backwards (i.e., the 1998 returns occur first, the 1997 second, and the 1962 returns last), then we accumulate a real wealth level of \$32.70 under strategy 1, which corresponds to the 15<sup>th</sup> percentile of the bootstrap distribution. This is because the low returns then occur when the investor has a large accumulated asset balance.

Table 7 also summarizes the distribution for investors who randomly choose funds from the whole set of twelve actively managed equity funds and who choose the "spliced" index fund. Strategy 1 outperforms strategy 2 at all indicated points of the cumulative distribution for the actively managed equity funds. The probability distribution function for the whole sample usually lies to the right of the one for the 'Top-5-Funds', because the five largest funds did not perform as well as the other seven funds. Strategy 2 outperforms strategy 1 for the index fund. Figure 4 shows that the distributions of the two investment strategies are quite close if an investor holds a passively managed index fund; this underscores our earlier point that asset location is less important in this case than in the case of actively managed funds.

To facilitate the comparison between the different cases we summarize the whole probability distribution of the 10,000 simulations by computing the certainty equivalent wealth level of an individual with a Constant-Relative-Risk-Aversion (CRRA) utility function. The expected utility of real wealth  $EU=E[U(W)]$  of the investor is defined as:

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<sup>6</sup> The ordering of the returns  $r_t$  is irrelevant if investors make only a single investment to an account. In this case the final wealth level is simply the product of the return relatives  $W_0=\prod_{i=0}^T(1+r_i)$ . The ordering has a significant effect on accumulated wealth levels for investors making multiple contributions to an account. We can think of the portfolio with multiple contributions as the sum of a sequence of single-contribution portfolios with decreasing maturities  $\sum_{t=0}^T [W_t]=\sum_{t=0}^T [\prod_{i=t}^T(1+r_i)]$ . The returns during the last years affect most of these single-contribution portfolios, whereas the returns during the first years only affect a few of these single-contribution portfolios.

$$(1) \quad EU = E[U(W)] = n^{-1} \sum_i [W_i^{1-\alpha} / (1-\alpha)].$$

Simulations are indexed by  $i$ , the real wealth level is  $W_i$ , and we denote the risk-aversion coefficient by  $\alpha$  and the total number of bootstrap simulations by  $n$ . The certainty equivalent wealth level is the certain wealth level that makes an individual indifferent to the outcome of the random 10,000 simulations. We assume that income from assets accumulated in the CSA and the TDA is the only source of income during retirement. The certainty equivalent is given by:

$$(2) \quad CE(EU) = U^{-1}(EU) = [(1-\alpha)EU]^{1/(1-\alpha)}.$$

Table 8 summarizes the certainty equivalents for five levels of risk-aversion. The values with a risk-aversion of  $\alpha=0$  equal the expected wealth levels. Most economists think that coefficients of relative risk-aversion between 1 (log-utility) and 5 are plausible. The average real wealth level at retirement for investments in the five largest mutual funds using strategy 1 equals \$58.09. Investing in all the twelve mutual funds and in the index fund results in considerably higher average wealth levels. All the certainty equivalents for the actively managed equity funds are larger in strategy 1 than in strategy 2. Using strategy 1 instead of strategy 2 results in a 5.2 percent higher certainty equivalent for an individual with a risk-aversion of 3 investing in the top-5 funds. However, strategy 2 outperforms strategy 1 for intermediate levels of risk-aversion if investors hold the index fund. The index fund has a higher certainty equivalent than the actively managed funds. These results confirm the deterministic results above.

Figure 5 shows the relationship between the real wealth levels of the two location strategies using exactly the same simulation results as in Figures 2 and 3. The 45-degree line represents the cases where the wealth levels are identical for the two strategies. There are 7,116 points (out of 10,000) below the 45-degree line and 2,884 points above. Thus, strategy 1 outperforms strategy 2 roughly 71.2 percent of the time. The distribution of the relative wealth levels of the two strategies is summarized in the third row of Table 8. Strategy 1 outperforms strategy 2 in 64.0 percent of the

simulations if investors choose between all twelve funds and in 48.5 percent of the cases with the index fund.

The previous results analyzed the optimal asset location choice for an asset allocation of 50 percent stocks and 50 percent bonds. This ‘rule-of-thumb’-allocation is not necessarily optimal. Moreover, the optimal stock proportion for an investor might depend on his location strategy, since the two strategies have different effective stock exposures. To derive the effects of different asset allocations, we perform bootstrap simulations for eleven different target stock proportions (0.0, 0.1, 0.2, ... 1.0) and compute the corresponding certainty equivalents of the two location strategies. Figure 6 plots the results for a high-tax individual with a risk-aversion of 3 investing in the ‘Top-5-Funds’. The certainty equivalent is exactly identical with pure asset allocations, i.e., when the investor holds either only bonds or only stocks. In these two cases asset location is irrelevant, because the investor holds the same assets in the two locations.

We find that the certainty equivalent of strategy 1 is always higher than that of strategy 2 for interior stock proportions. The certainty equivalent is maximized at a stock proportion of between 80 and 100 percent with strategy 1 and 100 percent with strategy 2. At stock proportions this high, the effect of optimal asset location is smaller than when the stock proportion is 50 percent.

Asset location is more important if investors have a risk-aversion of 5, as shown in Figure 7. Asset location increases the certainty equivalent by 4.9 percent (the maximal certainty equivalent wealth level with strategy 1 is 37.21 and with strategy 2 is 35.46). A 100 percent stock portfolio has a higher certainty equivalent than a 100 percent bond portfolio for both levels of risk-aversion. Table 9 summarizes the certainty equivalents of the two location strategies if the return of equity funds is decreased by 2.5 percentage points. The fund distributions (dividends, short-, medium-, and long-term capital gains) are adjusted proportionally. The certainty equivalent is maximized at a stock proportion of between 40 and 60 percent with strategy 1 and between 10 and 30 percent with strategy

2 (with  $\alpha=3$ ). The benefit of asset location in this case equals 4.8 percent (35.96 for strategy 1 vs. 34.32 for strategy 2).

#### 4. Asset Location with Inflation-Protected Bonds

The high optimal stock proportion and the relatively low benefit of asset location that we found in the last section might result from our non-representative data-sample. Average equity returns were relatively high, and inflation was unexpectedly high and volatile during our sample period. Both factors decrease the certainty equivalent utility level associated with holding nominal bonds. This section shows that for plausible parameter values, investors demand substantially larger amounts of bonds if bonds are protected against inflation uncertainty and if they offer the real returns that are currently available on indexed bonds in the United States.

The corporate and municipal bond funds in the asset allocation and asset location analysis of the previous sections are exposed to at least three risks that can be reduced with recently introduced government securities. These risks are (1) default risk of individual issues, (2) inflation risk and (3) reinvestment risk. Reinvestment risk results from the fact that the bond or bond fund investor cannot be sure of the terms on which future interest payments can be reinvested. The inflation risk results from the fact that corporate and municipal bonds are nominal contracts. While investing in high-grade securities can control default risk, corporate and municipal borrowers are usually considered riskier than the U.S. federal government.

Since 1997, the U.S. government has issued securities -- inflation indexed bonds -- that essentially eliminate all of the risks just described. There are two forms of inflation-indexed bonds. The first are Treasury Inflation Protected Securities (TIPS). These are U.S. government bonds with fixed maturities (so far 5, 10, and 30 year bonds have been issued), with real interest payments, and with the principal amount adjusted to reflect CPI inflation. Both the interest payment and the adjustment

in the principal amount are fully taxable if TIPS are held in conventional savings accounts, but these considerations are not relevant in a TDA. TIPS essentially eliminate the default and inflation risks of corporate and municipal bonds, but they still are subject to reinvestment risk.<sup>7</sup> The real return on TIPS is currently near 4.0 percent.

The other U.S. government inflation indexed security is the Series I savings bond. The I Bonds are savings bonds issued in denominations from \$50 to \$10,000. Like all savings bonds, I bonds are zero-coupon instruments with taxation deferred until redemption. Like all federal notes, bills and bonds, the interest on I bonds is exempt from state and local income taxation. I bonds are non-transferable and non-marketable, but are redeemable at par at any time. There is a forfeiture of 3 months interest if the bonds are redeemed in less than 5 years. Interest is compounded monthly and accrues for up to 30 years. Investors are limited to purchasing \$30,000 of Series I savings bonds per year. They have one other unusual feature which they share with Series EE savings bonds. The interest realized upon redemption can be exempt from taxation if it is used for college tuition expenses. This tax-free redemption possibility is available to households with adjusted gross income less than roughly \$80,000. After that, the tax-free possibility is phased out until it is completely eliminated for AGIs above roughly \$110,000.

The features of various forms of bonds are listed in Table 10. The primary advantage of Series I Savings Bonds for retirement accumulators using bonds in a CSA is their tax deferred nature. The combination of zero-coupons (and therefore no reinvestment risk) and redeemability at par at any time up to 30 years are also advantages. It should be noted that neither TIPS nor I bonds are completely inflation protected when they are held in a CSA environment. That is because the taxable interest increases with inflation and therefore the after-tax real return is lower at higher rates of inflation. In a TDA, either TIPS or I bonds offer a true inflation-indexed real return. Currently I

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<sup>7</sup> Investors also may bear some risk associated with prospective redefinition of the Consumer Price Index, or with measurement error in this price index.



bonds yield 40 basis points less than TIPS. Given this modest interest rate discount, I bonds (with their tax deferred feature) would result in more long-term wealth accumulation than TIPS for investors holding bonds in a CSA, while TIPS could generate greater long-term wealth accumulation in a TDA. Holding I bonds in a TDA would render the tax deferral feature of these bonds worthless.

We repeat the asset location computations with the historic returns used above by replacing the municipal bonds in the taxable CSA with Series I bonds and the corporate bonds in the TDA by TIPS.<sup>8</sup> We assume a real return of 3.6 percent for I bonds and a 4 percent real return for TIPS, which corresponds closely to the current real yields. We should be careful when we compare the results in the earlier sections with the results of this section. The previous sections used the actual real returns of bonds, whereas this section uses hypothetical real returns for inflation-protected bonds, and holds this return at its current level for the entire sample period. (Corporate bonds had a real return of only 2.73 percent between 1962-1998, while the simulations that we report here assume that indexed bonds offer a four percent real return.)

Table 11 summarizes our findings when we use historic returns on equity mutual funds, and allow investors to hold inflation-protected bonds with their current yields. Strategy 1 (giving equities preference for placement in the TDA and I-bonds preference for placement in the CSA) yields higher end-of-sample wealth than strategy 2 for 9 of the 12 actively managed equity funds for a high-tax individual and for all funds for a medium-tax individual. Strategy 1 outperforms strategy 2 on average by 5.25 percent for a high-tax and by 6.08 percent for a medium-tax individual. Those gains are similar to the ones in Table 3 with nominal bonds. With inflation-protected bonds, strategy 1 is relatively more beneficial for medium-tax individuals than for high-tax individuals. The taxation advantage of I-bonds over stocks is greater for medium-tax investors than it is for high-tax investors.

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<sup>8</sup> I-series bonds are currently only available with a maximum maturity of 30 years. Our computations assume that the tax on those bonds can be deferred until retirement. The benefits of holding I-series bonds would decrease if the taxation of the bond returns could only be deferred for 30 years.

Strategy 2 is again superior for the index fund. The accumulated wealth levels in Tables 3 and 11 are quite similar.

Table 12 reports the average wealth levels at retirement of different sets of mutual funds for different real yields of the inflation-protected bonds. The average wealth levels decrease significantly as the real yield decreases. However, strategy 1 still outperforms strategy 2 for all cases using actively managed mutual funds. The relative advantage of strategy 1 increases slightly as the real yield of the bonds falls, because sheltering bonds in the tax-deferred account is less beneficial if bonds pay a lower yield. Holding the passively managed index fund in the CSA continues to generate higher after-tax wealth at the end of the period than other allocations using this fund.

The most significant benefit of TIPS and I bonds is their inflation-protection. To quantify this benefit we perform bootstrap simulations with those two real securities. The bootstrap simulations follow the same method that we used in the last section, although the real yields on the inflation protected bonds are not affected by our randomization algorithm since we assume that these yields are fixed. Figure 8 depicts the wealth distribution at retirement for a high-tax individual investing in the largest five funds during a period of 37 years and using location strategy 1. The figure shows the cumulative distribution functions for an environment with the historic nominal municipal and corporate bonds, and with the hypothetical real bonds (I-Bonds). The distribution function for the nominal bonds is exactly identical to the one in Figure 2. Introducing inflation-protected bonds increases the outcomes at the lower tail significantly and does not affect the outcomes at the upper tail much. Comparing Panel 2 of Table 7 with the same panel in Table 13 shows that the wealth level increases under strategy 1 by 34.4 percent at the 1<sup>st</sup> percentile and by 23.9 percent at the 10<sup>th</sup> percentile. It is almost identical at the 90<sup>th</sup> percentile, and decreases by 11.8 percent at the 99<sup>th</sup> percentile.

Tables 8 and 14 show that the certainty equivalent of an investor with a risk-aversion of 3 investing in the top-5-funds increases by 19.4 percent from 43.30 (with nominal bonds) to 51.69

(with real bonds). In particular, risk-averse investors value inflation-protection because they put a much higher weight on the lower tail of the probability distribution.

Figure 9 plots the probability distributions of the two location strategies for a high-tax individual investing in one of the ‘Top-5-Funds’. The two functions are quite close at low wealth levels and strategy 1 dominates strategy 2 at higher wealth levels. Table 13 shows that strategy 1 usually dominates strategy 2 for the actively managed mutual funds but not for the passively managed index fund. The certainty equivalents from Table 14 indicate that strategy 1 is preferable to strategy 2 at all listed levels of risk-aversion for the actively managed mutual funds. Strategy 2 dominates strategy 1 for the index fund unless individuals are extremely risk-averse. By simply comparing Panel 3 with the other two panels, we once again see that using the index fund has a higher certainty equivalent outcome than a randomly selected actively managed fund.

We conclude this section by analyzing the importance of asset location if investors use inflation-indexed bonds and follow different heuristic allocation rules. Figures 10 and 11 show the certainty equivalents of the two strategies at different stock proportions. With a risk-aversion of 3, the certainty equivalent is maximized at stock proportions between 40 and 60 percent with strategy 1 and 50 and 70 percent stocks with strategy 2. The benefit of asset location in this case equals 1.5 percent (51.51 for strategy 1 vs. 50.75 for strategy 2). Introducing inflation-protected bonds increases the attractiveness of holding fixed-income securities. The stock proportion with the maximum certainty equivalent decreases significantly at a risk-aversion of 5. The gain of using strategy 1 instead of 2 equals 3.3 percent (47.38 for strategy 1 vs. 45.86 for strategy 2).

## 5. Conclusion

The findings in this paper suggest that asset location decisions are very important for retirement accumulators who hold assets in both tax-deferred pension accounts and in taxable accounts. We compiled the actual 37-year performance of twelve actively managed equity mutual

funds along with the results of a passively managed index fund and two (corporate and municipal) bond funds.

We have come to two rather robust conclusions regarding the after-tax wealth that high-income and medium-income investors would have accumulated over the 1962-1998 period, if they had invested in both stocks and bonds and held assets in both pension and taxable accounts. First, if an investor chose to use an actively managed equity mutual fund for stock investments, then after-tax wealth was maximized by holding as much of the equity mutual fund as possible in the pension account. Such an investor would hold corporate bonds in the pension account only if there is room for them, while holding municipal bonds in taxable accounts. Second, we find that an investor who used a passively managed equity index fund for stock investments would have accumulated wealth most quickly by first locating corporate bonds in the pension account, and by holding the index fund in the outside taxable environment. Our findings suggest that the tax burden that equity mutual funds, particularly actively managed funds, impose on their investors, and the availability of both municipal bonds and inflation-protected Treasury securities as alternatives to corporate bonds, need to be factored into the asset location policy.

The effect of following different asset location strategies, in terms of retirement wealth, can be quite substantial. The improvement in the average or certainty equivalent outcome can be as high as 9 percent. With particular actively managed funds, the ex-post gain can be as high as 17 percent.

The explanation of our findings is fairly transparent. At least historically, most actively managed equity funds imposed a higher effective tax rate on their shareholders than the implicit tax on municipal bonds. Therefore, the typical actively managed fund gains more from being in a tax-deferred pension environment than a corporate bond gains from being held in the TDA, as an alternative to a tax-exempt bond held in a taxable setting. The story is just opposite with index funds, although it appears the stakes from optimal location are lower in this case. Passively managed

index funds impose low enough tax burdens on their investors that they gain less from the pension environment than the premium of corporate bond yields over municipal bond yields.

Even though our purpose was not to enter the debate between actively-managed and passively managed equity funds, our simulations do shed light on the relative advantage of the two fund types for someone saving consistently over 37 years. The bootstrap simulations that we performed indicate that a risk averse retirement accumulator would likely fare better with an index fund, and an asset location strategy that held this fund in a taxable setting, than with a randomly chosen actively managed fund, held in the tax-deferred account.

One important issue that arises in using our history-based results to predict the future concerns the extent to which actively managed funds will recognize the tax consequences that managerial decisions impose on taxable investors. If actively managed funds are more tax aware in the future, and the recent emergence of tax-managed funds and other financial products that are designed to reduce investor tax burdens suggests that they might be, then our findings may be attenuated.

While most of our analysis was done for someone following a rule-of-thumb 50-50 stocks-bonds asset allocation, we did look at the outcome for different allocations in our bootstrap simulations. Not surprisingly, an investor's optimal asset allocation is a function of his risk aversion. Still, given the well-known equity premium puzzle and the fact that even our bootstrap results were based on the realized returns from 1962-98, mildly risk averse retirement investors would have achieved their highest certainty equivalent outcomes by allocating substantially more than 50 percent of their portfolio to stocks. Whether such results would also hold if the start of the investment period was the current day, given changes in the equity premium, is not clear.

We also looked at using the relatively new inflation-protected Treasury bonds as part of a retirement accumulation portfolio. These bonds come in two types: Treasury Inflation Protected Securities (TIPS) and Series I Savings Bonds. TIPS are bonds with a real coupon rate and an

inflation-adjusted principal amount. Both the coupon and the principal adjustment are taxable income. Series I bonds, on the other hand, are zero-coupon inflation protected bonds with taxation deferred until sale. Given these features, the inflation-linked securities pose their own location question. Is it better to give stocks priority in a pension account and hold I bonds outside, or give TIPS preference in a pension environment and hold stocks outside? Our results suggest that the solution depends on the type of equity mutual fund that the investor holds. If index bonds had been available for the last four decades, and their yields had been similar to those on current index bonds, then investors would have generated more wealth by holding actively managed funds in a pension account (with I bonds outside) than by following other strategies with such actively managed funds. Investors who wished to hold index funds, however, would have accumulated more wealth by holding such funds outside their retirement accounts, with TIPS in their pension accounts.

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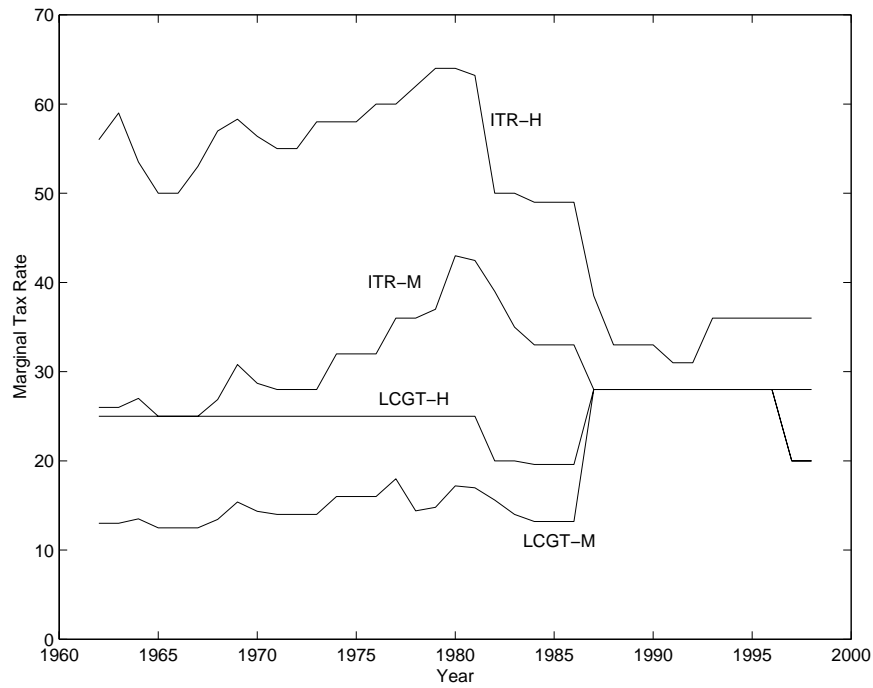
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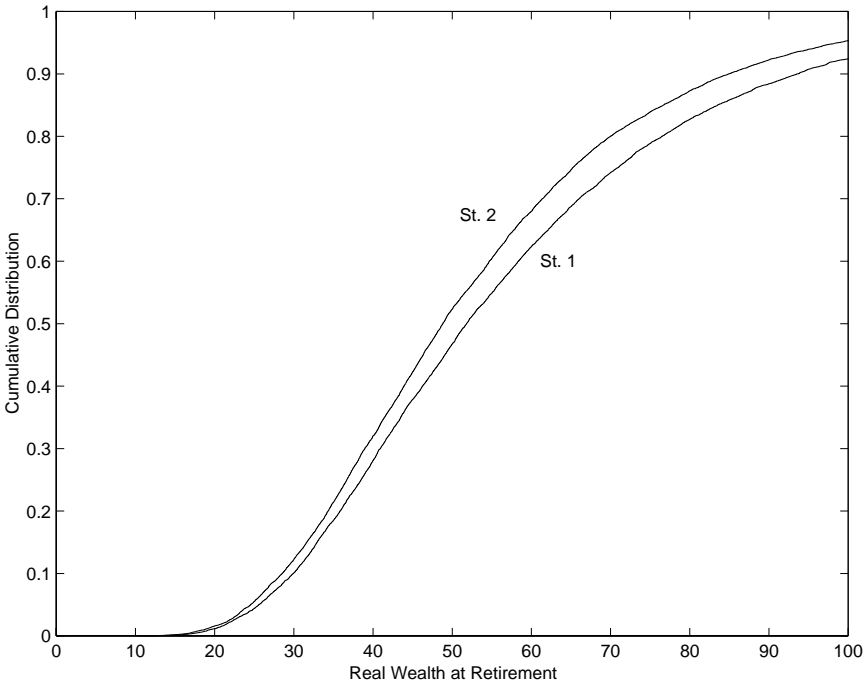


**Figure 1: Marginal Tax Rates**

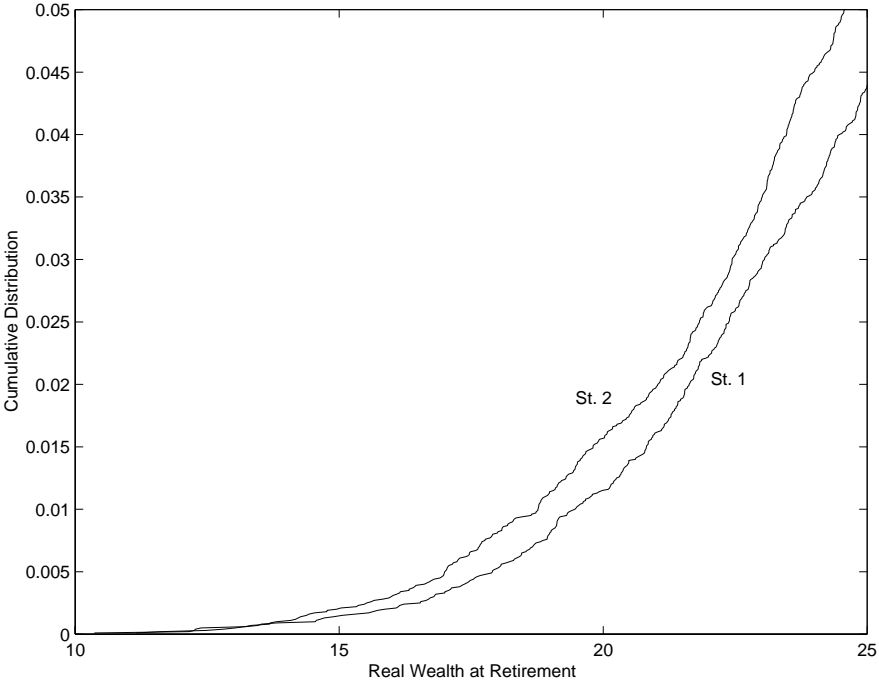
The time-series of the marginal tax rates of income (ITR) and long-term capital gains (LCGT) for high- (H) and medium- (M) income individuals are depicted. Taxable income for a medium- (high-) income individual is computed as three (ten) times the median adjusted gross income (AGI) and subtracting the standard deduction for married couples and three exemptions. Median AGI is taken from the Statistics of Income of the Internal Revenue Service. The values between 1962 and 1992 are taken from Dickson and Shoven (1993).



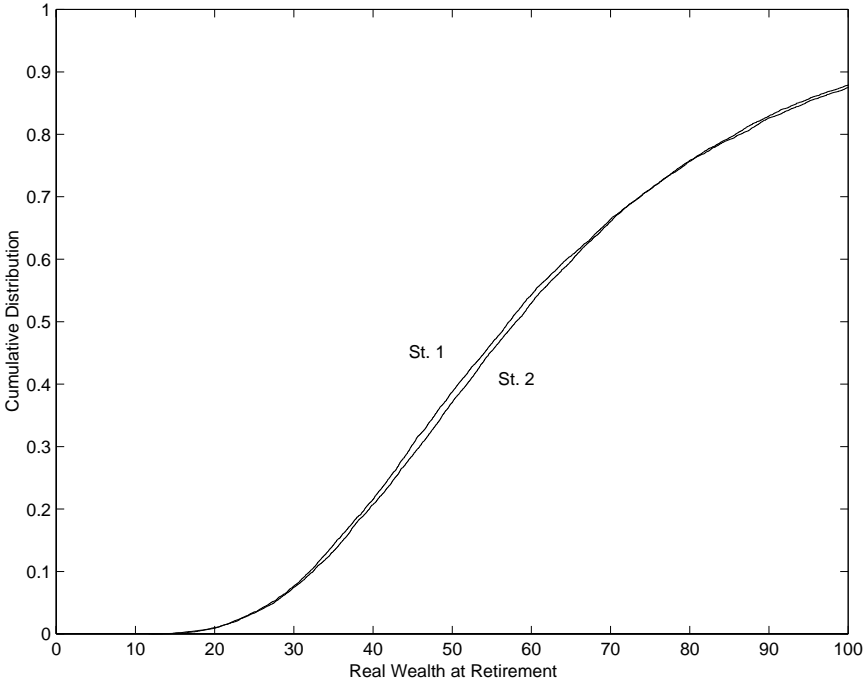
**Figure 2: Wealth Distribution of the Two Location Strategies with Bootstrap-Simulations (Top 5 Funds)**



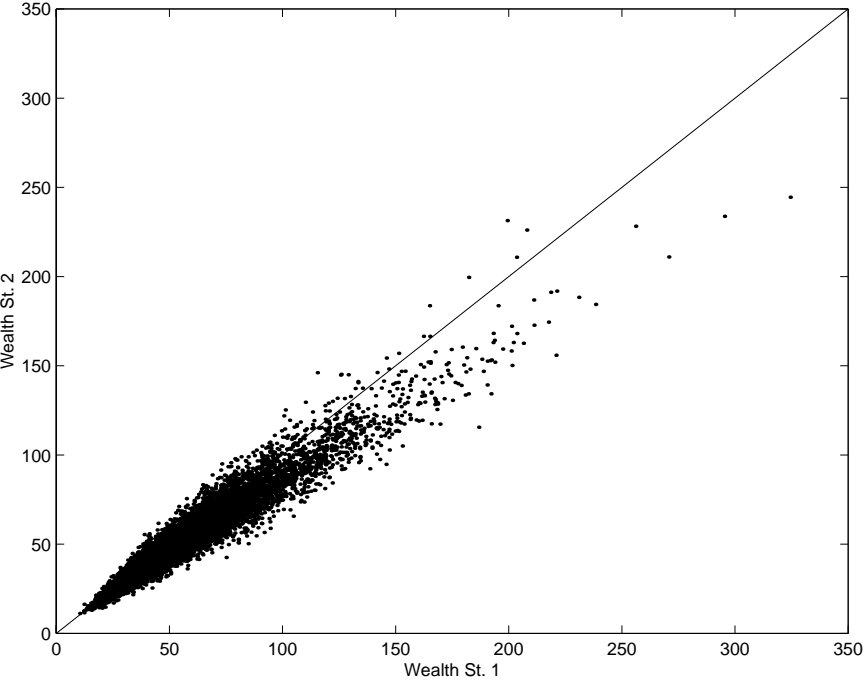
**Figure 3: Lower Tail of the Wealth Distribution with Bootstrap-Simulations (Top 5 Funds)**



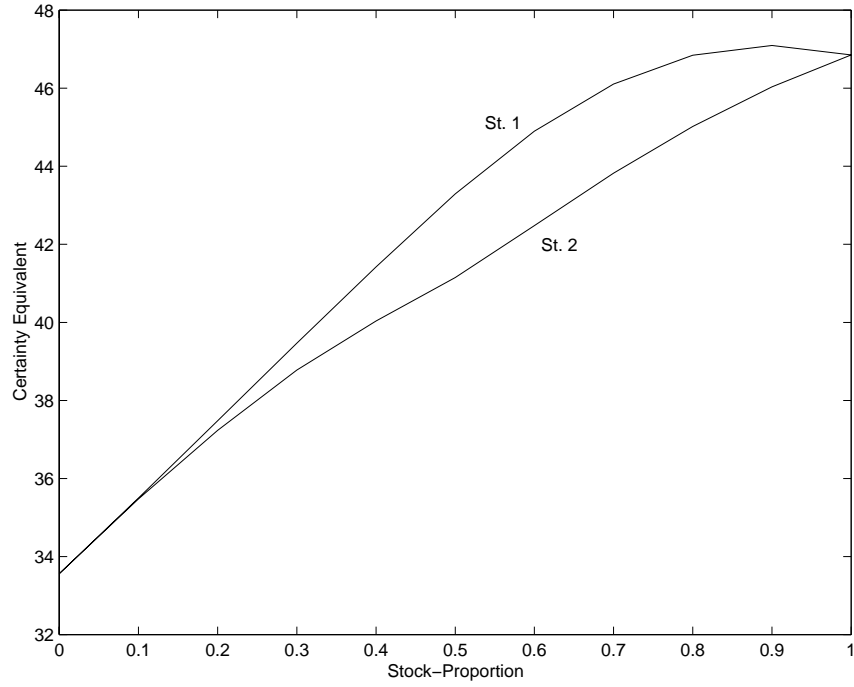
**Figure 4: Wealth Distribution with Bootstrap-Simulations (Index Fund)**



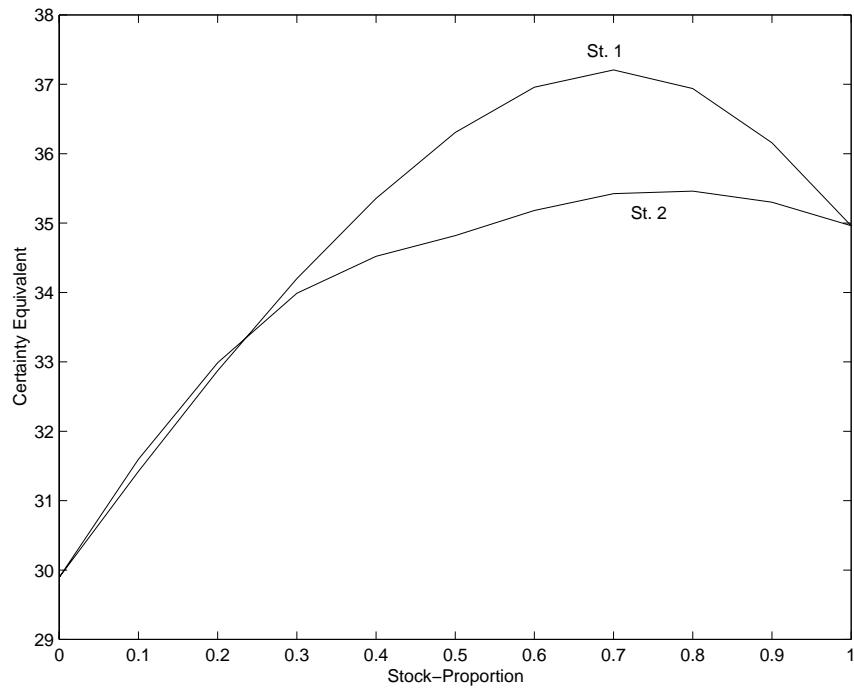
**Figure 5: Relationship between the Wealth Levels of the Two Location-Strategies (Top 5 Funds)**



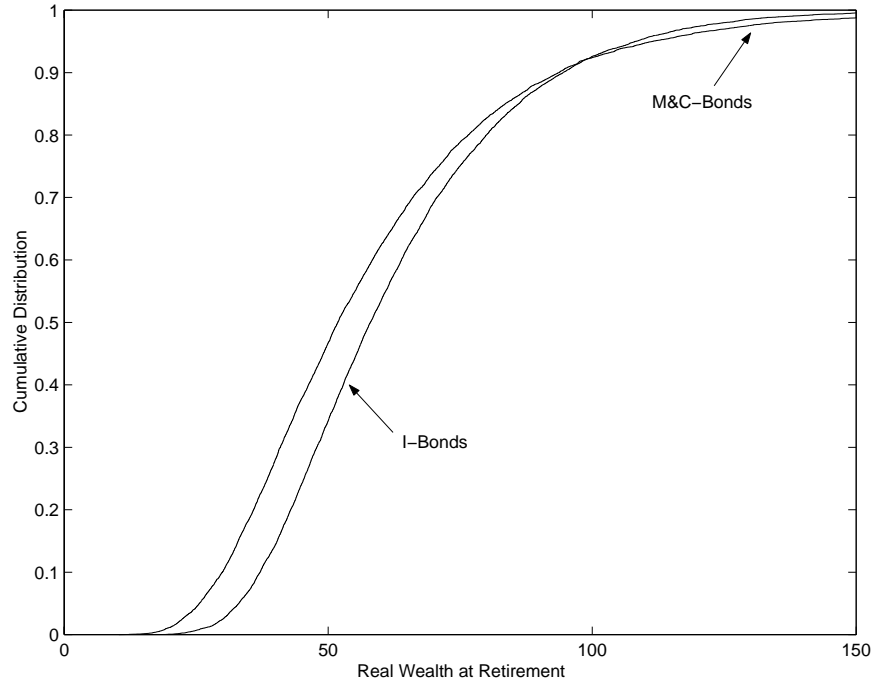
**Figure 6: Certainty Equivalents of Different Asset Allocations (CRRA=3)**  
The data of the following figures are from Table 12.



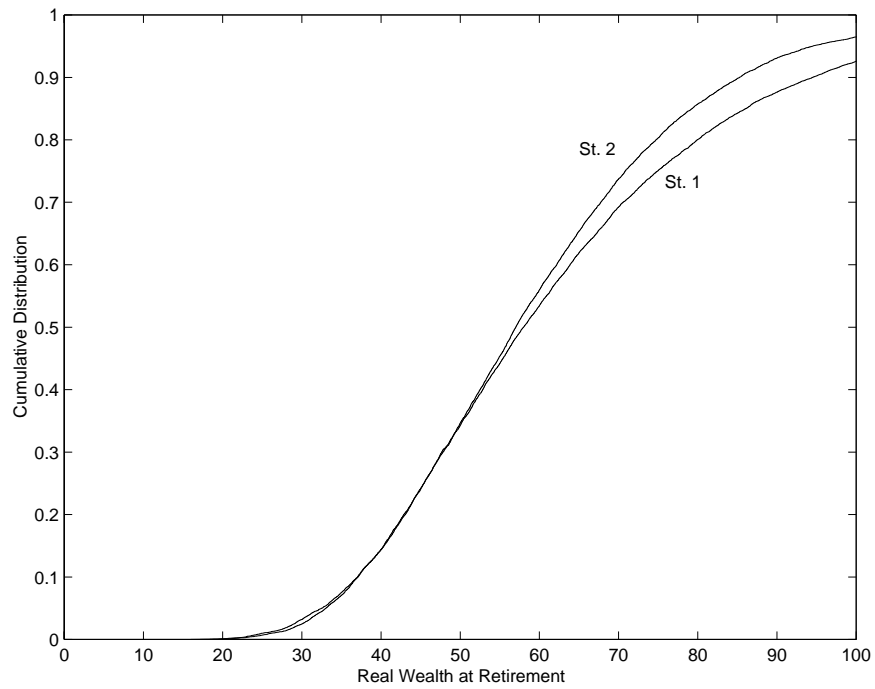
**Figure 7: Certainty Equivalents of Different Asset Allocations (CRRA=5)**



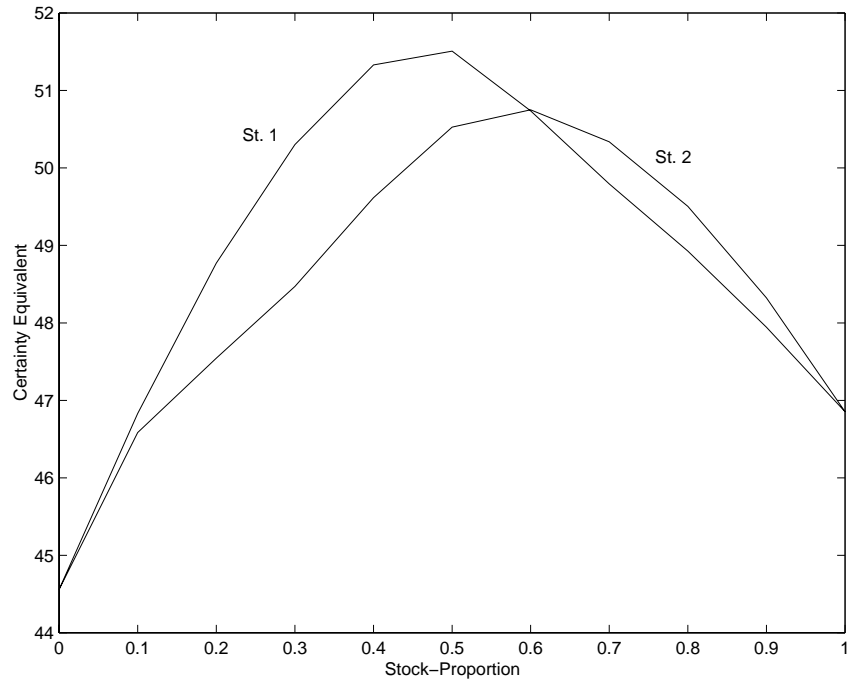
**Figure 8: Wealth Distribution of Inflation Protected Bonds compared to Municipal and Corporate Bonds (Top 5 Funds; Strategy 1)**



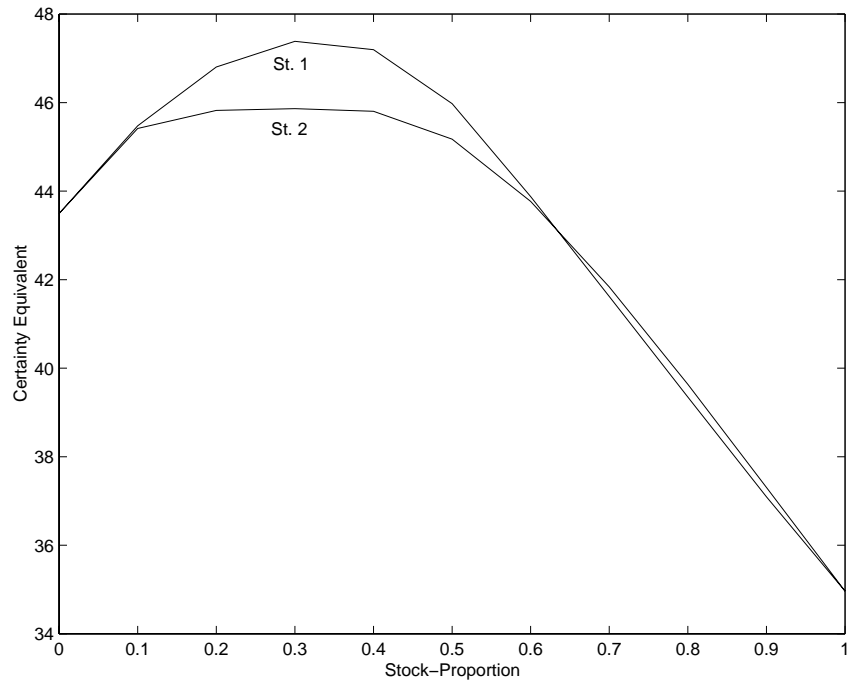
**Figure 9: Simulated Wealth Distribution with Inflation Protected Bonds (Top 5 Funds)**



**Figure 10: Certainty Equivalents of Different Asset Allocations with I-Bonds and TIPS (CRRA=3)**



**Figure 11: Certainty Equivalents of Different Asset Allocations with I-Bonds (CRRA=5)**



**Table 1: Equity Mutual Funds in Dataset**

The total asset values of the 12 equity funds in our dataset are summarized. The top 5 equity mutual funds correspond to the five largest equity funds at the end of 1961. The results of those 5 funds should not be subject to selection bias. Ten funds (all funds except Fidelity and Vanguard Windsor) were the ten largest equity funds at the end of 1968.

Name	Assets in Millions (Dec. 31, 1961)	Assets in Millions (Dec. 31, 1968)	Assets in Millions (Dec. 31, 1998)
01. MFS Mass Investors Trust	1800	2293	7142
02. IDS Stock	1025	2341	3257
03. Lord Abbett Affiliated	815	1805	8594
04. Fundamental Investors	733	1391	12,713
05. United Accumulative	601	1460	1864
06. MFS Mass Investors Growth	575	1264	3609
07. Fidelity Fund	487	898	10,563
08. Dreyfus	311	2666	2591
09. Investment Comp. of America	259	1056	48,498
10. Fidelity Trend	42	1346	1198
11. Van Kampen Enterprise	N.A.	953	2127
12. Vanguard Windsor	N.A.	225	18,188
<i>Sum of Equity Funds</i>	<i>6647</i>	<i>17,698</i>	<i>120,344</i>
<i>Sum of Top 5 Funds (in 1961)</i>	<i>4974</i>	<i>9290</i>	<i>33570</i>
Total Assets of All Mutual Funds	22,789	52,677	5,525,200
Total Number of Funds	170	240	7314

Source: Investment Company Institute, Mutual Fund Fact Book, Johnson's Charts

The Mass Investors Trust and Mass Investors Growth Funds changed their names to MFS Mass Investors Trust and Growth, respectively. Investors Stock changed to IDS Stock, Affiliated to Lord Abbett Affiliated, the Enterprise Fund to Van Kampen Enterprise, and Windsor to Vanguard Windsor. Investor's Mutual and the Wellington Fund were both larger than United Accumulative in 1961. Those two funds are not included in our dataset because they were balanced funds and held a significant portion of bonds. We excluded the Investors Mutual and the Investors Stock Fund because they were balanced mutual funds in 1968. Moreover we excluded the ISI Trust Fund, because this fund did not issue shares in 1968, but rather 10 year participating agreements.

**Table 2: Summary Statistics of Mutual Funds (1962-1998)**

This table reports the annual mean nominal returns, the standard deviations of the annual returns, and the distribution characteristics of the funds. Dividend-, ST-CG-, and LT-CG-Dist. are the returns that are distributed to shareholders as dividends, short-term, and long-term capital gains. The last two columns show the total proportions of the average returns that are distributed to shareholders as short-term distributions and as short- and long-term distributions. Unfortunately it is not possible to get long-run data on the S&P 500 Index Fund, taxable corporate, and tax-exempt municipal bond funds. Actual data are available for the Vanguard 500 Index fund after 1977 and for the Vanguard Long-Term Corporate Bond Fund and the Vanguard Long-Term Municipal Bond Fund after 1978. The synthetic funds use market data to replicate the payoffs of those funds before 1977 and 1978 and the data from the actual funds afterwards. CPI is the Consumer Price Index.

Fund	Average Return	Standard Deviation	Dividend Dist.	ST-CG Dist.	LT-CG Dist.	Total ST Prop. Dist.	Total Prop. Dist.
<b>Panel 1: Actively-Managed Equity Funds</b>							
01. Mass Inv Trust	0.1193	0.1522	0.0338	0.0010	0.0686	0.2919	0.8668
02. IDS Stock	0.1074	0.1492	0.0339	0.0031	0.0524	0.3447	0.8325
03. LA Affiliated	0.1271	0.1410	0.0450	0.0011	0.0586	0.3623	0.8239
04. Fund Investors	0.1190	0.1585	0.0322	0.0015	0.0437	0.2827	0.6497
05. United Acc	0.1102	0.1500	0.0311	0.0171	0.0493	0.4372	0.8845
06. Mass Inv Growth	0.1253	0.1947	0.0151	0.0068	0.0724	0.1746	0.7524
07. Fidelity Fund	0.1352	0.1518	0.0379	0.0204	0.0430	0.4308	0.7490
08. Dreyfus	0.1126	0.1415	0.0308	0.0136	0.0482	0.3948	0.8225
09. Inv Co of America	0.1404	0.1471	0.0344	0.0002	0.0477	0.2466	0.5864
10. Fidelity Trend	0.1174	0.1974	0.0164	0.0073	0.0377	0.2022	0.5232
11. VK Enterprise	0.1689	0.2877	0.0161	0.0101	0.0477	0.1556	0.4381
12. Vanguard Windsor	0.1386	0.1773	0.0390	0.0066	0.0623	0.3294	0.7791
<i>All Equity Funds:</i>							
<i>Mean</i>	<i>0.1268</i>	<i>0.1707</i>	<i>0.0305</i>	<i>0.0074</i>	<i>0.0526</i>	<i>0.3044</i>	<i>0.7257</i>
<i>Sdt.Dev.</i>	<i>0.0171</i>	<i>0.0416</i>	<i>0.0096</i>	<i>0.0067</i>	<i>0.0107</i>	<i>0.0957</i>	<i>0.1441</i>
<i>Top 5 Funds:</i>							
<i>Mean</i>	<i>0.1166</i>	<i>0.1502</i>	<i>0.0352</i>	<i>0.0047</i>	<i>0.0545</i>	<i>0.3438</i>	<i>0.8115</i>
<i>Std.Dev.</i>	<i>0.0079</i>	<i>0.0063</i>	<i>0.0056</i>	<i>0.007</i>	<i>0.0096</i>	<i>0.0622</i>	<i>0.0937</i>
<b>Panel 2: Synthetic Funds</b>							
S&P Index	0.1278	0.1591	0.0361	0.0006	0.0134	0.2876	0.3921
Corporate Bonds	0.0744	0.0827	0.0810	0.0005	0.0033	1.0953	1.1398
Municipal Bonds	0.0587	0.1116	0.0611	0.0008	0.0059	1.0541	1.1540
<b>Panel 3: Consumer Price Inflation</b>							
CPI	0.0474	0.0317					



**Table 3: Asset Location Results**

The real wealth levels at retirement are reported for an individual making annual real contributions of \$0.50 to both a tax-deferred account (TDA) and a conventional taxable savings account (CSA) during a period of 37 years (i.e., from 1962-1998). The investor annually adjusts the portfolio to maintain a 50% proportion of stock funds (the remaining 50% are allocated to either taxable corporate bonds or tax-exempt municipal bonds). Strategy 1 gives preference to stocks in the TDA and municipal bonds in the CSA and strategy 2 gives preference to corporate bonds in the TDA and stocks in the CSA.

Fund	High-Tax Individual			Medium-Tax Individual		
	Wealth at Retirement Strategy 1	Wealth at Retirement Strategy 2	Relative Wealth	Wealth at Retirement Strategy 1	Wealth at Retirement Strategy 2	Relative Wealth
<b>Panel 1: Actively-Managed Mutual Funds</b>						
01. Mass Inv Trust	90.4858	84.5924	1.0697	98.2054	93.2989	1.0526
02. IDS Stock	79.9051	74.9416	1.0662	86.2972	83.1471	1.0379
03. LA Affiliated	91.7548	81.2025	1.1300	99.6138	91.9285	1.0836
04. Fund Investors	89.0174	88.2579	1.0086	96.5688	96.8411	0.9972
05. United Acc	81.1143	73.0705	1.1101	87.6777	82.9069	1.0575
06. Mass Inv Growth	92.7034	89.5975	1.0347	100.7160	98.0175	1.0275
07. Fidelity Fund	100.6765	88.3097	1.1400	109.6649	100.8574	1.0873
08. Dreyfus	74.1819	64.5583	1.1491	79.8313	73.7282	1.0828
09. Inv Co of America	101.0258	96.0821	1.0515	110.0527	106.3918	1.0344
10. Fidelity Trend	71.2063	69.3972	1.0261	76.4907	76.0517	1.0058
11. VK Enterprise	109.2348	98.8491	1.1051	119.3080	108.8624	1.0960
12. Vanguard Windsor	102.2023	87.2119	1.1719	111.3714	100.1544	1.1120
<i>All Funds:</i>						
<i>Mean</i>	<i>90.2924</i>	<i>83.0059</i>	<i>1.0886</i>	<i>97.9832</i>	<i>92.6822</i>	<i>1.0562</i>
<i>Sdt. Dev.</i>	<i>11.8677</i>	<i>10.5910</i>	<i>0.0532</i>	<i>13.3569</i>	<i>11.4472</i>	<i>0.0367</i>
<i>Top 5 Funds:</i>						
<i>Mean</i>	<i>86.4555</i>	<i>80.4130</i>	<i>1.0769</i>	<i>93.6726</i>	<i>89.6245</i>	<i>1.0458</i>
<i>Std.Dev.</i>	<i>5.5300</i>	<i>6.3930</i>	<i>0.0468</i>	<i>6.2163</i>	<i>6.2843</i>	<i>0.0318</i>
<b>Panel 2: Index Fund</b>						
S&P 500	96.2835	97.9101	0.9834	104.7186	106.9057	0.9795

**Table 4: Sensitivity Analysis with Lower Equity Premia**

This table reports the relative wealth levels of the two location strategies for a high-tax individual if the return of the equity funds is decreased. The distributions of the equity funds are adjusted proportionally. The first column corresponds exactly to the third column in Table 34.

Fund	Reduction in Equity Premium (in basis points)					
	0	100	200	300	400	500
<b>Panel 1: Actively-Managed Mutual Funds</b>						
01. Mass Inv Trust	1.0697	1.0478	1.0309	1.0180	1.0084	1.0003
02. IDS Stock	1.0662	1.0478	1.0341	1.0245	1.0172	1.0098
03. LA Affiliated	1.1300	1.1019	1.0784	1.0589	1.0429	1.0303
04. Fund Investors	1.0086	0.9935	0.9839	0.9784	0.9749	0.9736
05. United Acc	1.1101	1.0894	1.0739	1.0628	1.0548	1.0502
06. Mass Inv Growth	1.0347	1.0173	1.0036	0.9942	0.9887	0.9844
07. Fidelity Fund	1.1400	1.1131	1.0910	1.0718	1.0561	1.0449
08. Dreyfus	1.1491	1.1265	1.1083	1.0930	1.0809	1.0719
09. Inv Co of America	1.0515	1.0332	1.0168	1.0020	0.9919	0.9853
10. Fidelity Trend	1.0261	1.0190	1.0144	1.0133	1.0158	1.0196
11. VK Enterprise	1.1051	1.0910	1.0762	1.0650	1.0547	1.0449
12. Vanguard Windsor	1.1719	1.1468	1.1249	1.1059	1.0891	1.0743
<i>All Funds:</i>						
<i>Mean</i>	<i>1.0886</i>	<i>1.0690</i>	<i>1.0530</i>	<i>1.0406</i>	<i>1.0313</i>	<i>1.0241</i>
<i>Sdt. Dev.</i>	<i>0.0532</i>	<i>0.0489</i>	<i>0.0449</i>	<i>0.0409</i>	<i>0.0371</i>	<i>0.0341</i>
<i>Top 5 Funds:</i>						
<i>Mean</i>	<i>1.0769</i>	<i>1.0561</i>	<i>1.0402</i>	<i>1.0285</i>	<i>1.0196</i>	<i>1.0129</i>
<i>Std.Dev.</i>	<i>0.0468</i>	<i>0.0426</i>	<i>0.0384</i>	<i>0.0344</i>	<i>0.0313</i>	<i>0.0292</i>
<b>Panel 2: Index Fund</b>						
S&P 500	0.9834	0.9657	0.9518	0.9460	0.9453	0.9459

**Table 5: Asset Location without Municipal Bonds**

The results in this table differ from those of Table 4 by not allowing individuals to invest in municipal bonds. Corporate bonds are held both in the TDA and the CSA.

Fund	High-Tax Individual			Medium-Tax Individual		
	Wealth at Retirement	Wealth at Retirement	Relative Wealth	Wealth at Retirement	Wealth at Retirement	Relative Wealth
	Strategy 1	Strategy 2		Strategy 1	Strategy 2	
<b>Panel 1: Actively-Managed Mutual Funds</b>						
01. Mass Inv Trust	79.0440	84.5377	0.9350	92.6440	93.4867	0.9910
02. IDS Stock	69.7116	74.8922	0.9308	81.4623	83.2522	0.9785
03. LA Affiliated	80.9927	81.2064	0.9974	94.8480	91.7465	1.0338
04. Fund Investors	78.1370	88.1686	0.8862	91.6162	96.6772	0.9477
05. United Acc	70.9861	73.0683	0.9715	83.0637	82.8706	1.0023
06. Mass Inv Growth	80.8671	89.5412	0.9031	94.8016	98.2042	0.9654
07. Fidelity Fund	88.8766	88.2622	1.0070	104.2811	100.8833	1.0337
08. Dreyfus	64.8481	64.4723	1.0058	75.5259	73.7095	1.0246
09. Inv Co of America	89.6167	94.6776	0.9465	105.0719	105.5809	0.9952
10. Fidelity Trend	62.0459	69.2520	0.8959	72.1519	76.2139	0.9467
11. VK Enterprise	96.1787	96.3957	0.9977	112.5495	108.0128	1.0420
12. Vanguard Windsor	91.2918	85.3673	1.0694	107.0528	98.6307	1.0854
<i>All Funds:</i>						
<i>Mean</i>	79.3830	82.4868	0.9622	92.9224	92.4390	1.0039
<i>Sdt. Dev.</i>	10.8758	10.0801	0.0553	12.9092	11.1505	0.0417
<i>Top 5 Funds:</i>						
<i>Mean</i>	75.7743	80.3746	0.9442	88.7268	89.6066	0.9907
<i>Std.Dev.</i>	5.0791	6.3680	0.0424	6.0416	6.2326	0.0316
<b>Panel 2: Index Fund</b>						
S&P 500	84.4770	97.7745	0.8640	99.1517	106.9545	0.9270

**Table 6: Asset Location Results with Taxes From 1998**

The results in this table differ from those in Table 3 by using the tax rates from 1998 instead of the historical taxes from 1962-1998.

Fund	High-Tax Individual			Medium-Tax Individual		
	Wealth at Retirement Strategy 1	Wealth at Retirement Strategy 2	Relative Wealth	Wealth at Retirement Strategy 1	Wealth at Retirement Strategy 2	Relative Wealth
<b>Panel 1: Actively-Managed Mutual Funds</b>						
01. Mass Inv Trust	90.7760	90.2446	1.0059	98.4475	96.2464	1.0229
02. IDS Stock	80.1833	79.1980	1.0124	86.5160	85.2941	1.0143
03. LA Affiliated	92.0125	87.5961	1.0504	99.8378	94.6059	1.0553
04. Fund Investors	89.3218	93.1754	0.9586	96.8020	99.3281	0.9746
05. United Acc	81.4055	76.6583	1.0619	87.8904	84.2434	1.0433
06. Mass Inv Growth	93.0159	94.4896	0.9844	100.9655	100.0218	1.0094
07. Fidelity Fund	100.9601	93.8106	1.0762	109.9091	102.6798	1.0704
08. Dreyfus	74.4101	68.7419	1.0825	80.0269	75.4790	1.0603
09. Inv Co of America	101.2926	101.6271	0.9967	110.2785	108.2290	1.0189
10. Fidelity Trend	71.4467	72.4033	0.9868	76.6832	77.6906	0.9870
11. VK Enterprise	109.5192	104.9340	1.0437	119.5342	111.3054	1.0739
12. Vanguard Windsor	102.4566	94.7291	1.0816	111.5841	102.8196	1.0852
<i>All Funds:</i>						
<i>Mean</i>	<i>90.5667</i>	<i>88.1340</i>	<i>1.0284</i>	<i>98.2063</i>	<i>94.8286</i>	<i>1.0346</i>
<i>Sdt. Dev.</i>	<i>11.8769</i>	<i>11.4639</i>	<i>0.0428</i>	<i>13.3677</i>	<i>11.6654</i>	<i>0.0355</i>
<i>Top 5 Funds:</i>						
<i>Mean</i>	<i>86.7398</i>	<i>85.3745</i>	<i>1.0179</i>	<i>93.8988</i>	<i>91.9436</i>	<i>1.0221</i>
<i>Std.Dev.</i>	<i>5.5272</i>	<i>7.1349</i>	<i>0.0409</i>	<i>6.2249</i>	<i>6.7757</i>	<i>0.0311</i>
<b>Panel 2: Index Fund</b>						
S&P 500	96.5664	101.8646	0.9480	104.9666	108.4305	0.9681

**Table 7: Wealth Distribution with Bootstrap-Simulations**

The probability distributions of the real wealth levels of a high-income individual are shown for the two location strategies. Individuals randomly choose one equity fund and contribute as described in Table 3. The returns of the assets are bootstrapped 10,000 times.

	Cumulative Distribution						
	0.001	0.010	0.100	0.500	0.900	0.990	0.999
<b>Panel 1: All Actively-Managed Funds</b>							
Wealth St. 1	14.8044	20.3122	31.1615	55.8679	107.5278	195.7065	343.7075
Wealth St. 2	13.8089	19.6549	30.1254	53.6524	100.9961	186.5739	312.9260
Rel. Wealth	0.6862	0.7798	0.8849	1.0498	1.2278	1.3967	1.5771
<b>Panel 2: Top 5 Actively Managed Funds</b>							
Wealth St. 1	14.5485	19.4649	29.9401	51.8138	93.7262	155.0837	211.1432
Wealth St. 2	13.8089	18.7639	28.5500	48.8170	84.9819	133.2406	188.4167
Rel. Wealth	0.7615	0.8196	0.9195	1.0687	1.2370	1.4110	1.5785
<b>Panel 3: Index Fund</b>							
Wealth St. 1	14.9761	20.2389	32.0098	57.1830	106.9206	182.0619	264.0713
Wealth St. 2	14.8227	19.9510	32.4400	58.0469	105.2569	173.6970	259.5210
Rel. Wealth	0.7056	0.7623	0.8538	0.9948	1.1519	1.2984	1.4596

**Table 8: Certainty Equivalents of Bootstrap Results**

This table records the certainty equivalents of the bootstrap simulations of the two location strategies for a high-tax individual with a constant-relative-risk-aversion (CRRA) utility function. The wealth resulting from the investment in the two accounts is the only income source at retirement. The returns are bootstrapped 10,000 times.

	Coefficient of Relative Risk Aversion				
	0	1	3	5	10
<b>Panel 1: All Actively-Managed Funds</b>					
CE 1	64.8632	57.2014	45.9605	38.0211	26.1126
CE 2	61.6389	54.6711	44.2343	36.6687	25.4596
RCE	1.0523	1.0463	1.0390	1.0369	1.0256
<b>Panel 2: Top 5 Actively Managed Funds</b>					
CE 1	58.0949	52.4623	43.2998	36.3093	24.9024
CE 2	53.7767	49.1125	41.1565	34.8242	24.7283
RCE	1.0803	1.0682	1.0521	1.0426	1.0070
<b>Panel 3: Index Fund</b>					
CE 1	64.8912	57.9265	46.7991	38.5672	26.6319
CE 2	64.8629	58.2668	47.2308	38.6553	26.4379
RCE	1.0011	0.9942	0.9909	0.9977	1.0073

**Table 9: Different Asset Allocations with Lower Equity Premium**

This table summarizes the certainty equivalents of the two allocation strategies at different stock-proportions. The return of the equity funds is assumed to be 2.5 percent lower than observed in the period from 1962-1998. The fund distributions are adjusted proportionally. Investors randomly choose in which fund they want to invest at the beginning of the investment horizon out of the set of the top 5 funds in 1961. The returns are bootstrapped 10,000 times.

Stock Share	CRRA=0		CRRA=1		CRRA=3		CRRA=5		CRRA=10	
	CE 1	CE 2	CE 1	CE 2	CE 1	CE 2	CE 1	CE 2	CE 1	CE 2
0.0	40.77	40.77	38.09	38.09	33.56	33.56	29.90	29.90	23.04	23.04
0.1	41.86	41.16	39.04	38.55	34.27	34.07	30.41	30.40	23.10	23.38
0.2	43.01	41.60	39.99	38.93	34.89	34.32	30.76	30.51	22.98	23.26
0.3	44.21	42.09	40.93	39.23	35.39	34.27	30.93	30.17	22.71	22.69
0.4	45.48	42.63	41.84	39.45	35.76	33.96	30.93	29.49	22.31	21.82
0.5	46.74	43.45	42.67	39.84	35.96	33.71	30.75	28.85	21.86	21.03
0.6	47.77	44.69	43.23	40.52	35.86	33.59	30.30	28.29	21.28	20.24
0.7	48.54	46.08	43.46	41.23	35.39	33.39	29.46	27.64	20.53	19.42
0.8	49.24	47.54	43.49	41.90	34.57	33.08	28.28	26.90	19.51	18.60
0.9	50.00	49.08	43.39	42.52	33.48	32.67	26.85	26.10	18.31	17.78
1.0	50.71	50.71	43.09	43.09	32.16	32.16	25.26	25.26	17.00	17.00

**Table 10: Features of Various Types of Fixed Income Securities**

	Corporate Bonds	Municipal Bonds	TIPS	Series I Bonds
Inflation Protection	No	No	Yes	Yes
Call Option	Callable	Callable	Non-Callable	Non-Callable
Coupon or Zero	Coupon and Zeros	Coupon and Zeros	Coupon	Zeros
Marketability	Market Traded	Market Traded	Market Traded	Nontransferable; Redeemable at Par
Maturity	Fixed	Fixed	Fixed	Flexible (up to 30 years)
Taxation	Federal, state and local taxation	Can be exempt from all taxation	Federal taxation only; Exempt from state and local tax	Tax Deferred; Exempt from state and local tax
Accumulation Limit	None	None	None	\$30,000 per year
Special Features	None	None	None	Tax free if used for college tuition for qualifying households

**Table 11: Hypothetical Asset Location Results with Inflation Protected Bonds**

This table modifies Table 3 by replacing the municipal bonds in the CSA with I-Series Bonds and the corporate bonds in the TDA with Treasury Inflation Protected Securities (TIPS). The real annual return is 3.6 percent for I-Series Bonds and 4 percent for TIPS. All the taxes of the total return of the I-Series bonds held in the CSA are deferred until the funds are withdrawn at the end of the time horizon.

Fund	High-Tax Individual			Medium-Tax Individual		
	Wealth at Retirement Strategy 1	Wealth at Retirement Strategy 2	Relative Wealth	Wealth at Retirement Strategy 1	Wealth at Retirement Strategy 2	Relative Wealth
<b>Panel 1: Actively-Managed Mutual Funds</b>						
01. Mass Inv Trust	89.6037	86.7561	1.0328	101.1282	95.9583	1.0539
02. IDS Stock	78.2631	76.9939	1.0165	88.2293	85.3751	1.0334
03. LA Affiliated	92.9673	85.4574	1.0879	104.3493	96.1557	1.0852
04. Fund Investors	89.4239	90.6786	0.9862	100.8496	99.2489	1.0161
05. United Acc	80.4847	75.6684	1.0637	90.5612	85.4828	1.0594
06. Mass Inv Growth	92.4454	92.6112	0.9982	104.2209	101.6240	1.0256
07. Fidelity Fund	103.2007	93.6165	1.1024	115.9608	106.3918	1.0899
08. Dreyfus	73.1994	67.0356	1.0919	81.8424	76.1910	1.0742
09. Inv Co of America	105.1687	100.9120	1.0422	117.8542	111.2868	1.0590
10. Fidelity Trend	69.8900	70.8936	0.9858	78.3139	78.2535	1.0008
11. VK Enterprise	112.679	104.6431	1.0768	126.2963	114.9897	1.0983
12. Vanguard Windsor	106.4217	92.8488	1.1462	119.4487	105.4107	1.1332
<i>All Funds:</i>						
<i>Mean</i>	<i>91.1456</i>	<i>86.5096</i>	<i>1.0525</i>	<i>102.4212</i>	<i>96.3640</i>	<i>1.0608</i>
<i>Sdt. Dev.</i>	<i>13.8264</i>	<i>11.7315</i>	<i>0.0508</i>	<i>15.4898</i>	<i>12.6574</i>	<i>0.0380</i>
<i>Top 5 Funds:</i>						
<i>Mean</i>	<i>86.1485</i>	<i>83.1109</i>	<i>1.0374</i>	<i>97.0235</i>	<i>92.4441</i>	<i>1.0496</i>
<i>Std.Dev.</i>	<i>6.3918</i>	<i>6.4975</i>	<i>0.0398</i>	<i>7.1459</i>	<i>6.5357</i>	<i>0.0263</i>
<b>Panel 2: Index Fund</b>						
S&P 500	96.8499	101.6809	0.9525	109.2796	110.9679	0.9848



**Table 12: Asset Location Results with Different Real Returns of Inflation Protected Bonds**

This Table reports the average wealth levels of the two location strategies if the real return of the bonds is changed. RT denotes the real return of TIPS and RI denotes the real return of I-Series bonds. The results in the base case are given in Table 11.

Fund Group	High-Tax Individual			Medium-Tax Individual		
	Wealth at Retirement Strategy 1	Wealth at Retirement Strategy 2	Relative Wealth	Wealth at Retirement Strategy 1	Wealth at Retirement Strategy 2	Relative Wealth
<b>Panel 1: RI=2.1% RT=2.5%</b>						
All Actively-Managed Funds	79.0403	73.8402	1.0692	88.2481	81.8614	1.0761
Top 5 Actively-Managed Funds	75.0760	71.3334	1.0533	83.9602	78.7036	1.0668
Index Fund	84.2899	86.5201	0.9742	94.4560	93.7057	1.0080
<b>Panel 2: RI=2.6% RT=3.0%</b>						
All Actively-Managed Funds	82.8836	77.7974	1.0642	92.7212	86.3687	1.0715
Top 5 Actively-Managed Funds	78.6034	75.0442	1.0482	88.0837	82.9857	1.0615
Index Fund	88.3044	91.2787	0.9674	99.1439	99.0023	1.0014
<b>Panel 3: RI=3.1% RT=3.5%</b>						
All Actively-Managed Funds	86.9047	82.0058	1.0586	97.4337	91.2003	1.0663
Top 5 Actively-Managed Funds	82.2612	78.9708	1.0425	92.4160	87.5642	1.0555
Index Fund	92.4968	96.3384	0.9601	104.0895	104.8471	0.9928
<b>Panel 4: RI=3.6% RT=4.0%</b>						
All Actively-Managed Funds	91.1456	86.5096	1.0525	102.4212	96.3640	1.0608
Top 5 Actively-Managed Funds	86.1485	83.1109	1.0374	97.0235	92.4441	1.0496
Index Fund	96.8499	101.6809	0.9525	109.2796	110.9679	0.9848
<b>Panel 5: RI=4.1% RT=4.5%</b>						
All Actively-Managed Funds	95.6119	91.2637	1.0466	107.6634	101.9183	1.0543
Top 5 Actively-Managed Funds	90.2608	87.4783	1.0326	101.8732	97.6190	1.0437
Index Fund	101.4267	107.3669	0.9447	114.7539	117.4366	0.9772

**Table 13: Wealth Distribution with Inflation Protected Bonds**

The probability distribution of the real wealth levels of a high-income individual is shown for the two location strategies. Individuals randomly choose one equity fund initially and contribute as described in Table 3. The returns of the assets are bootstrapped 10,000 times. The annual real return of I-Bonds is 3.6 percent and of TIPS is 4 percent.

	Cumulative Distribution						
	0.001	0.010	0.100	0.500	0.900	0.990	0.999
<b>Panel 1: All Actively-Managed Funds</b>							
Wealth St. 1	20.5430	27.2640	38.3147	63.0074	111.2781	198.7997	377.0282
Wealth St. 2	20.1458	26.6302	38.4669	62.0482	101.2919	182.2546	323.2021
Rel. Wealth	0.7421	0.8070	0.9001	1.0182	1.2018	1.3524	1.4442
<b>Panel 2: Top 5 Actively Managed Funds</b>							
Wealth St. 1	20.8138	26.1524	37.1028	57.9973	94.4987	136.8665	173.7991
Wealth St. 2	19.9240	25.0612	37.0389	57.0135	85.2567	115.5888	138.1924
Rel. Wealth	0.7996	0.8439	0.9224	1.0256	1.1938	1.3115	1.3914
<b>Panel 3: Index Fund</b>							
Wealth St. 1	22.9346	28.4083	40.2910	65.0681	108.2462	158.0215	208.1282
Wealth St. 2	21.6726	28.0136	42.0884	67.1756	103.1580	145.1305	178.6733
Rel. Wealth	0.7462	0.7825	0.8615	0.9747	1.1561	1.2507	1.3071

**Table 14: Certainty Equivalents with Inflation Protected Bonds**

This table records the certainty equivalents of the bootstrap simulations of the two location strategies for a high-tax individual with a constant-relative-risk-aversion (CRRA) utility function.

	Coefficient of Relative Risk Aversion				
	0	1	3	5	10
<b>Panel 1: All Actively-Managed Funds</b>					
CE 1	70.9309	64.4064	54.8677	47.9746	36.8050
CE 2	67.8844	62.5837	54.1751	47.3957	35.7635
RCE	1.0356	1.0291	1.0128	1.0122	1.0291
<b>Panel 2: Top 5 Actively Managed Funds</b>					
CE 1	62.6172	58.6236	51.6904	46.0271	35.9685
CE 2	59.5421	56.5198	50.6367	45.1334	34.5574
RCE	1.0516	1.0372	1.0208	1.0198	1.0408
<b>Panel 3: Index Fund</b>					
CE 1	70.5206	65.5687	57.0357	50.2531	39.0446
CE 2	70.6237	66.4989	58.5553	51.2626	38.3528
RCE	0.9920	0.9860	0.9740	0.9803	1.0180