Asset Location in Tax-Deferred and Conventional Savings Accounts*

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Abstract

The optimal allocation of assets among different asset classes has received considerable attention in financial theory and practice. On the other hand, investors have not been given much guidance about which assets should be located in tax-deferred and which in taxable accounts. This paper analyzes the taxation of returns of stocks, taxable corporate bonds, and tax-exempt municipal bonds held in both types of accounts. We derive optimal asset allocations (which assets to hold) and asset locations (in which accounts to hold them) for a risk-averse investor saving for retirement. We show that locating assets optimally can significantly improve the risk-adjusted performance of retirement saving.

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1 Introduction

Saving for retirement is one of the biggest financial challenges facing households. Investors must decide how much to save, what to invest in, and which assets to locate either in tax-deferred retirement accounts or in conventional taxable savings accounts. This paper addresses two main parts of the overall problem: which assets to hold, and where to hold them. It does not deal with the choice of how much to save. The U.S. tax system influences the size and the composition of retirement savings by giving individuals the option of saving in tax-qualified retirement vehicles (e.g., IRA, Roth-IRA, 401(k) accounts), and by exempting the interest payments of certain assets (e.g., municipal bonds) from taxable income. Taking into account these institutional features, this paper derives optimal portfolio choices for a risk-averse individual saving for retirement.

The optimal *allocation* between different asset classes such as stocks and bonds has received much attention in financial theory and practice since the seminal paper of Markowitz (1952). More recently several papers analyzed the effect of personal taxes on optimal asset allocation. Auerbach and King (1983) explore the portfolio behavior of investors differing with respect to their tax rates in a general equilibrium model. Balcer and Judd (1987) examine the impact of capital income taxation on savings and the demand for corporate financial instruments under certainty. They show that the effective taxation depends on the investment horizon. Dybvig and Ross (1986) demonstrate that the taxation of asset returns can create clientele effects and derive the impact on asset pricing.

The aspect of this general topic which has been under-studied is the asset *location* choice—i.e. the choice of holding assets in tax-deferred or in taxable environments. Tepper and Affleck (1974), Black (1980), and Tepper (1981) show that companies should hold bonds as opposed to equities in their *defined-benefit* pension plans to take full advantage of the preferred tax treatment of bonds. Black (1980) demonstrates that if a firm wants to take advantage of the differing tax treatment of bonds without altering the level of its contributions to the pension plan, it can perform an arbitrage by selling stocks and then buying bonds with the proceeds in the pension fund while issuing debt and buying back its own shares in the firm.

Our paper discusses the optimal asset location in *defined-contribution* tax qualified accounts. Due to limitations on how much households can contribute to tax-qualified accounts, they may want or be forced to accumulate funds both inside and outside a tax-qualified environment. We show that it can be optimal for households to hold stocks and not bonds in the

tax-deferred environment if they have the choice to invest in tax-exempt municipal bonds.

This subject was introduced in Shoven (1999) and Shoven and Sialm (1998). These two papers compare the simulated distributions of wealth levels at retirement for different heuristic portfolio locations and allocations. This paper computes the optimal asset location and allocation choices for risk-averse individuals and shows that optimal asset location can increase the financial resources at retirement significantly. Wang and Judd (1998) solve a dynamic savings allocation problem with tax-deferred and taxable accounts using an interpolation method that preserves the shape of the value function. Our paper captures more completely important features of the U.S. tax code. In particular, we include tax-exempt municipal bonds in our analysis and we allow stock portfolios to differ in their tax-efficiency. Dammon, Spatt, and Zhang (2001) derive optimal dynamic asset locations and allocations and show that taxable bonds should have a preferred location in the tax-deferred account and stocks in the taxable account. Our paper shows that it can be optimal to locate equity in the tax-deferred account if investors can invest in tax-exempt bonds and if the stock portfolio is sufficiently tax-inefficient. Poterba, Shoven, and Sialm (2000) use data on actual returns on taxable bonds, tax-exempt bonds, and a sample of equity mutual funds over the 1962-1998 period to discuss the results of different asset location strategies for retirement savers. The empirical analysis confirms the theoretical results derived in our paper. Huang (2000) uses replication arguments in a multiple-period model to show that an investor prefers taxable bonds to stocks in a tax-deferred account. Our optimal asset locations are consistent with her result if investors can only hold taxable bonds and stocks. We show that the optimal asset location of stocks can switch from the taxable account to the tax-deferred account if investors can hold tax-exempt bonds.

The actual behavior of individuals investing in tax-qualified accounts and taxable accounts is discussed by Bodie and Crane (1997) and Poterba and Samwick (1997). Poterba and Samwick analyze the relationship between age, birth cohorts, and portfolio structure for households using the Federal Reserve Board's Survey of Consumer Finances. They find that the composition of portfolios differ across birth cohorts. Bodie and Crane describe the asset allocation behavior of participants of TIAA-CREF, an organization that manages self-directed retirement funds for the staff of some 6,000 universities, secondary schools, and other nonprofit organizations. They find that most households in the survey have significant amounts of money in both tax-deferred and in conventional accounts. The survey respondents tend to invest in taxable bonds and stocks in both environments. The

respondents do not appear to take advantage of the potential benefits of optimal asset location.

There are three main results in this paper. First, assets held in taxable savings accounts face very high effective taxes over long time horizons. The availability of tax-deferred accounts and tax-exempt assets benefits individuals significantly. Different stock mutual funds face very different tax burdens because the proportion of total returns distributed as taxable capital gains differs considerably between funds. Second, the preferred asset location is determined primarily by the tax rates facing the asset returns. We show that assets with high tax rates should be located in the tax-deferred environment. In particular, taxable bonds should be held in the tax-deferred environment, whereas tax-exempt municipal bonds should be held in the taxable environment. Stocks can be located in either environment depending on the tax-efficiency of the stock portfolios. Third, an optimal asset location significantly improves the risk-adjusted performance of retirement saving. By simply adopting an optimal location strategy an individual enhances the resources enjoyed in retirement by several percentage points.

The paper is organized as follows. Section 2 derives optimal asset locations in a simple setting. Section 3 formulates the optimization problem of the investor. Section 4 derives the after-tax rates of return of different asset classes under the present U.S. tax system and discusses the effective taxation of assets in the different environments. Section 5 analyzes how asset characteristics and taxation influence the optimal asset location and allocation if investors can invest in stocks, taxable bonds, and tax-exempt municipal bonds. We take into account that the government taxes nominal returns instead of real returns (i.e., inflation tax). Section 6 computes the gains of optimal asset location and compares them to the gains of tax-deferred savings and tax-exempt assets. The final section summarizes the major results of the paper.

2 Asset Location Arbitrage in a Simple Setting

We begin our analysis with a generalization of the arbitrage argument of Black (1980). The following example applies for investors holding assets in tax-deferred and in taxable accounts. It introduces tax-exempt bonds as an additional investment choice besides taxable bonds and stocks. The exposition of this simple example follows Poterba, Shoven, and Sialm (2000). The following transactions hold for a tax-*deferred* account (such as a regular IRA, 401(k) account). A similar arbitrage exists also for assets in a tax-

preferred account (such as a ROTH-IRA). We derive four asset location results.

Suppose that an investor can hold taxable bonds (B), tax-exempt municipal bonds (M), and stocks (S) in a taxable conventional savings account (CSA) or in a tax-deferred account (TDA). The investor cannot short-sell these assets. The pretax gross returns of the three asset classes are R_B, R_M, and R_S, where the bond returns are non-stochastic and satisfy $1 < R_M < R_B$. The effective tax rate of stocks is assumed to be lower than the effective tax rate of taxable bonds: $\tau_S \leq \tau_B$. Bond returns are taxed at the ordinary income tax rate, whereas a portion of the stock returns are taxed at the lower capital gains tax rate which results in a lower effective tax rate on stock returns. The implicit municipal bond tax rate equals[1]:

$$\tau_M = 1 - \frac{R_M - 1}{R_B - 1}. \tag{1}$$

We assume that the tax rates do not change over time. Initial contributions to a TDA can be deducted from taxable income and withdrawals from the TDA during retirement are taxed at the ordinary income tax rate, which equals τ_B. The after-tax return of a taxable asset in a CSA equals $R_i^{CSA} = 1 + (1 - \tau_i)(R_i - 1)$ for $i \in (B, S)$.

Result 1 *Taxable bonds dominate tax-exempt bonds in the TDA.*

The first result follows from the fact that the taxable bond has a higher before-tax return than the tax-exempt bond and that both assets are risk-free. The optimal location of tax-exempt bonds is never in the tax-deferred account.

Result 2 *Tax-exempt bonds dominate taxable bonds in the CSA if* $\tau_M < \tau_B$.

The second result shows that investors with relatively high tax rates on bond returns should hold tax-exempt assets in the CSA instead of taxable assets in their taxable account. This result holds because the two assets are risk-free. If municipal bonds are more risky than taxable bonds, then it is not certain that investors with $\tau_M < \tau_B$ would prefer municipal bonds in their CSA.

[1]The difference between the yields on long-term municipal bonds and the yields on corresponding taxable bonds is surprisingly small. The average implicit tax rate on long-term municipal bonds has been approximately 25 percent during the last 30 years; this is considerably lower than the maximum statutory marginal personal income tax rate (Shoven 1999).

In equilibrium, the implicit tax rate of municipal bonds can be lower than the tax rate of taxable bonds for some individuals because of clientele effects. The demand for municipal bonds by the investors in the highest tax bracket is not sufficient to cover the whole supply. In this case, the marginal investor in municipal bonds is in an intermediate tax bracket. Different risk characteristics of municipal and taxable bonds might also explain the relatively low implicit tax rate on municipal bonds. Imperfectly correlated returns between taxable and tax-exempt bonds are discussed in Section 5.

To analyze the optimal location of stocks between the two accounts, suppose that an investor with $\tau_M < \tau_B$ holds tax-exempt bonds in the CSA, taxable bonds in the TDA, and stocks in the CSA. The following argument provides conditions under which it will be optimal to switch the stock exposure from the TDA to the CSA.

Consider increasing the proportion of stocks held in the TDA by $\epsilon > 0$ and reducing the holdings of taxable bonds in the TDA by ϵ. At the same time, decrease the holdings of stocks in the CSA by $\epsilon(1-\tau_B)/(1-\tau_S)$ and increase the holdings of tax-exempt bonds in the CSA by $\epsilon(1-\tau_B)/(1-\tau_S)$. This transaction involves no net investment in total financial assets, and it leaves the investor with the same amount of exposure to risky equity as the initial portfolio.

Before the portfolio shift, the value of the stock component of the total portfolio is:

$$W_S = I\left[\omega_S^{TDA}(1-\tau_B)R_S + \omega_S^{CSA}\left(1+(1-\tau_S)(R_S-1)\right)\right], \qquad (2)$$

where the proportion ω_i^j of the initial wealth I is invested in asset i in the account j. The withdrawals from the TDA are taxed at the ordinary income tax rate, which equals the tax rate of bond returns.[2]

The riskless component of the initial portfolio equals:

$$W_B + W_M = I\left[\omega_B^{TDA}(1-\tau_B)R_B + \omega_M^{CSA}R_M\right]. \qquad (3)$$

The total wealth before the portfolio shift equals $W = W_B + W_M + W_S$.

After the suggested portfolio shift, the values of the risky and risk-free components are:

[2]In a ROTH-IRA withdrawals from a tax-qualified account during retirment are not taxed at all and contributions are not tax-deductible either. In this case the holdings of stocks in the CSA should be decreased by $\epsilon/(1-\tau_S)$ and the holdings of tax-exempt bonds in the CSA should be increased by the same amount to perform the arbitrage.

$$
\begin{aligned}
W_S^{'} &= I\left[(\omega_S^{TDA}+\epsilon)(1-\tau_B)R_S\right] \\
&\quad +I\left[\left(\omega_S^{CSA}-\epsilon\frac{1-\tau_B}{1-\tau_S}\right)(1+(1-\tau_S)(R_S-1))\right], \\
&= W_S - I\epsilon\tau_S\frac{1-\tau_B}{1-\tau_S}, \qquad (4)
\end{aligned}
$$

and

$$
\begin{aligned}
W_B^{'}+W_M^{'} &= I\left[(\omega_B^{TDA}-\epsilon)(1-\tau_B)R_B+\left(\omega_M^{CSA}+\epsilon\frac{1-\tau_B}{1-\tau_S}\right)R_M\right], \\
&= W_B+W_M+I\epsilon(1-\tau_B)\left(\frac{R_M}{1-\tau_S}-R_B\right). \qquad (5)
\end{aligned}
$$

The total value of the portfolio after the shift equals:

$$
W^{'}=W_B^{'}+W_M^{'}+W_S^{'}=W+I\epsilon(1-\tau_B)\left[\frac{\tau_S-\tau_M}{1-\tau_S}(R_B-1)\right]. \qquad (6)
$$

The suggested portfolio shift increases the wealth level if the tax rate on stock returns τ_S is larger than the implicit tax rate on tax-exempt bond returns τ_M. This portfolio shift does not involve any risk and the investor should take advantage of this profitable arbitrage opportunity until she reaches borrowing or other constraints. If stocks are highly taxed, then they should replace the taxable bonds with stocks in the TDA and replace the stocks with tax-exempt bonds in the CSA.

Result 3 *Stocks in the TDA dominate stocks in the CSA if* $\tau_S > \tau_M$ *and* $\tau_B > \tau_M$.

If tax-exempt bonds are not available, then we can modify the arbitrage example given above by simply setting $\tau_M = \tau_B$. The total value of the portfolio after the shift equals in this case:

$$
W^{'}=W+I\epsilon(1-\tau_B)\left[\frac{\tau_S-\tau_B}{1-\tau_S}(R_B-1)\right]. \qquad (7)
$$

The portfolio shift decreases the wealth level if the tax rate on stock returns τ_S is smaller than the tax rate on bond returns τ_B, which holds by assumption.

Result 4 *Stocks in the CSA dominate stocks in the TDA if tax-exempt bonds are not available.*

Huang (2000) generalizes the conditions given above in a multiple-period setting. She does not include tax-exempt bonds in her analysis. We develop in the remainder of the paper numerical results for the case where asset returns are taxed continuously. We introduce in addition uncertain bond returns and inflation uncertainty.

3 The Model

We develop a two-period model to simplify the analysis of asset location. The investor chooses her portfolio during her working career in the first period and withdraws the savings during retirement in the second period. The investor has the choice to invest her exogenous saving of I in n risky assets, which can be located either in a tax-deferred account (TDA) or a conventional savings account (CSA). The assets are well-diversified portfolios of securities (and should be considered mutual funds of stocks or bonds). The investment horizon of the individual is $h > 1$ years, which corresponds to the length of the first period (i.e, the difference between retirement age and current age). Due to the limitations on how much individuals can contribute to a tax qualified account, they may want to accumulate funds in both locations. The maximum contribution to the TDA is $\overline{C}$.

The value of asset i follows a geometric Brownian motion with drift. After t years, the before-tax total return of the asset equals:

$$R_i(t) = \exp(\mu_i t + \sigma_i z_i(t)), \qquad z_i(t) \sim N(0,t). \tag{8}$$

The logarithm of the total return $R_i(t)$ is normally distributed and has a mean of $\mu_i t$ and a variance of $\sigma_i^2 t$. Ito's Lemma implies that R_i is an Ito process with the following stochastic differential equation:[3]

$$dR_i(t) = (\mu_i + 0.5\sigma_i^2)R_i(t)dt + \sigma_i R_i(t)dz_i(t). \tag{9}$$

The return after taxes depends on the location and is denoted by R_i^{TDA} or R_i^{CSA} if the asset is held in a tax-deferred account or in a conventional savings account. Let τ_W and τ_R denote the marginal income tax rates during the work career and at the time of retirement, respectively. If the investor saves \$1 after taxes, she can contribute $\$1/(1-\tau_W)$ to her TDA after

[3] Cf. Duffie (1996), p. 86.

taking into account the tax-deductibility of contributions to a TDA. This investment compounds at the before-tax rate of return R_i. The withdrawn benefits at the time of retirement are taxed at the future marginal income tax rate τ_R, which is assumed to be known in advance. The TDA-returns are identical to the before-tax returns if the tax rates do not change at the time of retirement (i.e, $\tau_W = \tau_R$). The after-tax return of asset i in a TDA after h years amounts to:

$$R_i^{TDA}(h) = \frac{1-\tau_R}{1-\tau_W} R_i(h). \tag{10}$$

Savings in a CSA are not deductible from taxable income, and withdrawals are not taxed. Distributed returns (dividends, interest income, and capital gains distributions) on assets held in a CSA are taxed continuously. A fixed proportion of the instantaneous return of asset i is paid either as a short-term distribution d_i^{st} or as a long-term distribution d_i^{lt}. The remainder $1 - d_i^{st} - d_i^{lt}$ is called accrued or unrealized capital gains. Short-term distributions (i.e., interest income, dividends and short-term capital gains) are taxed at the full current marginal income tax rate τ_W and long-term distributions are taxed at the lower capital gains tax rate τ_C. The after-tax distributions are reinvested in the CSA. The funds are withdrawn at the time of retirement and the investor pays long-term capital gains taxes on the remaining unrealized capital gains.

The savings in the CSA compound after taxes at the following rate:

$$\begin{aligned} dR_i^{CSA}(t) &= \left(1-\tau_i^d d_i\right) R_i^{CSA}(t) \frac{dR_i(t)}{R_i(t)} \\ &= \left(1-\tau_i^d d_i\right) R_i^{CSA}(t) \left[(\mu_i + 0.5\sigma_i^2)dt + \sigma_i dz_i(t)\right], \quad (11) \\ where: & \\ d_i &= d_i^{st} + d_i^{lt}, \\ \tau_i^d &= \frac{\tau_W d_i^{st} + \tau_C d_i^{lt}}{d_i}. \end{aligned}$$

The value of an investment in asset i in the CSA accumulates to the following value after $t < h$ years:

$$R_i^{CSA}(t) = \exp\left[(1-\tau_i^d d_i)\left(\mu_i + 0.5\sigma_i^2 \tau_i^d d_i\right) t + (1-\tau_i^d d_i)\sigma_i z_i(t)\right]. \tag{12}$$

The investor liquidates the CSA at time h. She is required to pay capital gains taxes on the difference between the value of the portfolio and its cost

basis. The cost basis changes continously by the reinvested after-tax distributions. The appreciation of asset i at time t is $R_i^{CSA}(t)dR_i(t)/R_i(t)$. The proportion d_i of this appreciation is realized by the shareholder and is taxed at the rate τ_i^d. These after-tax distributions are reinvested and increase the cost basis B_i of the asset holdings:

$$dB_i(t) = (1-\tau_i^d)d_i R_i^{CSA}(t)\frac{dR_i(t)}{R_i(t)} \tag{13}$$

The cost basis per dollar of initial investment just before the account is liquidated at time h equals:

$$\begin{aligned} B_i(h^-) &= 1 + \int_0^{h^-} (1-\tau_i^d)d_i R_i^{CSA}(t)\frac{dR_i(t)}{R_i(t)} \\ &= 1 + \frac{(1-\tau_i^d)d_i}{1-\tau_i^d d_i}\left(R_i^{CSA}(h^-) - 1\right) \end{aligned} \tag{14}$$

The value of asset i in a CSA after paying the capital-gains tax on the realized capital gains amounts to:

$$R_i^{CSA}(h) = R_i^{CSA}(h^-) - \tau_C\left(R_i^{CSA}(h^-) - B_i(h^-)\right). \tag{15}$$

We define the "effective tax rate" as the proportion of the final value of the initial investment collected by the government. The government would impose this effective tax on asset values if, instead of taxing asset distributions continuously, it deferred the collection of taxes until the end of the time horizon h. The effective tax rate of asset i in the location $j = (CSA, TDA)$ is defined as:[4]

$$\phi_i^j(h) = 1 - \frac{R_i^j(h)}{R_i(h)}. \tag{16}$$

The initial savings I can be allocated to n assets in two locations. The corresponding weights are denoted by ω_i^j. The investor is not allowed to short-sell assets. We assume for simplicity that the investor does not have any other sources of income during retirement. The nominal wealth level at retirement amounts to:

$$W(h) = I\sum_i \sum_j \omega_i^j R_i^j(h). \tag{17}$$

[4]This definition of the effective tax rate is similar to Protopapadakis (1983).

The price level at the time of retirement is $P(h)$ (where $P(0) = 1$). The utility of final real wealth is given by a power-utility function with a constant coefficient of relative risk-aversion $\alpha \geq 0$.

$$U\left(\frac{W(h)}{P(h)}\right) = \frac{1}{1-\alpha}\left(\frac{W(h)}{P(h)}\right)^{1-\alpha} \tag{18}$$

The investor maximizes the expected utility of real wealth at retirement subject to short-selling constraints and the limitation of contributions to the TDA.

$$\begin{aligned} \max_{\omega} \quad & E\left[U\left(\frac{W(h)}{P(h)}\right)\right] \\ s.t. \quad & \sum_i \sum_j \omega_i^j = 1, \\ & \omega_i^j \geq 0 \; \forall \; i, j, \\ & \frac{I}{1-\tau_W} \sum_i \omega_i^{TDA} \leq \overline{C}. \end{aligned} \tag{19}$$

Asset i is said to have a preferred location in the TDA if its optimal proportion is higher in the TDA than in the CSA (i.e., $\omega_i^{TDA} / \sum_j \omega_j^{TDA} > \omega_i^{CSA} / \sum_j \omega_j^{CSA}$) and a preferred location in the CSA if its optimal proportion is higher in the CSA than in the TDA. The asset does not have a preferred location if its optimal proportion is identical in both taxable accounts or if the investor only contributes to one of the two accounts.

The optimization problem (19) cannot be solved analytically. Instead, we determine the optimal portfolio weights numerically assuming a log-normal distribution for the returns of the assets. The expected utility is computed using a multi-dimensional Gauss-Hermite quadrature with 10 nodes.[5]

4 Distribution of Returns

Two major asset classes in financial markets are stocks and bonds. These two asset classes differ considerably in their characteristics and their rate of effective taxation. Stock returns have a higher expected return and greater variability. Bonds usually pay most of their total returns as short-term distributions (interest payments) and only a small portion of their returns in the form of capital gains and losses. Income from municipal bonds (bonds

[5] Cf. Judd (1998), p. 261-263.

issued by state and local governments in the investor's state of residence) is completely exempt from federal and state income taxation. Because of this tax-exempt feature, the interest rate on these securities is below the rate on equally safe taxable bonds.

Stocks pay a smaller portion of their total returns as short-term distributions (dividends and short-term capital gains). Capital gains and losses result from active trading by the investor or the mutual fund. Mutual funds differ considerably in their rate of asset turnover and in their proportion of total returns distributed in the form of realized capital gains. Different management styles of mutual funds impose very different tax-burdens on investors in taxable accounts as previously shown by Dickson and Shoven (1995) and Dickson, Shoven, and Sialm (2000). Individuals can influence the net distributions by trading their shares of mutual funds and thereby realizing accumulated capital gains and losses. Tax-efficient trading strategies result in lower distributions and tax-inefficient strategies in higher distributions.[6]

4.1 Historical Performance of Large Mutual Funds

Table 1 summarizes the moments of the nominal log-returns and the distribution characteristics of large mutual funds over three time periods. Each Panel shows the summary statistics of the five stock mutual funds with the highest total asset values at the beginning of the the three time periods according to different issues of Johnson (1979). The third Panel, covering the period between 1979 and 1998, shows in addition the characteristics of a taxable bond fund, a tax-exempt municipal bond fund, and a Standard & Poor's 500 index fund. Data for bond and index funds are not available over the two longer periods. The data until 1995 on the equity funds were taken from Dickson and Shoven (1995). Their dataset was updated using the dividend reports of Moody's (1999) and Standard and Poor's (1999) and Morningstar. Consumer price inflation was taken from Ibbotson (1999). The summary statistics include the mean and the standard deviation of the logarithm of the annual nominal returns of the funds, the proportions of the nominal returns which are distributed annually either as dividends, short-term capital gains, long-term capital gains, and the proportions of the

[6] Constantinides (1983), Stiglitz (1983), and Dammon and Spatt (1996) argue that optimal stock trading with personal taxes reduces the effective taxation considerably. Poterba (1987) and Auerbach, Burman, and Siegel (1998) find that avoidance of tax on realized capital gains is not prevalent and that the effective tax rate on realized capital gains is close to the statutory rate for a large proportion of investors.

Table 1: Distributions of Mutual Funds
The means and the standard deviations of the nominal log-returns and the proportions of the returns distributed to fund investors are summarized. Total returns are divided into dividend payments (Div.), short-term (ST-CG) and long-term capital gains (LT-CG), and unrealized capital gains (UR-CG). Each Panel shows the values for the five largest equity mutual funds at the beginning of the corresponding time periods. The third Panel includes as well the results for an index fund and two bond funds. All the values are in percent.

	Log-Return		Distributions			
Fund Name	Mean	Std.	Div.	ST-CG	LT-CG	UR-CG
Panel 1: 1962-1998						
Average Top 5	10.08	14.16	30.11	4.26	46.77	18.85
MFS Mass. Inv. Trust	10.32	14.18	28.33	0.86	57.49	13.32
IDS Stock	9.24	14.36	31.60	2.87	48.79	16.75
LA Affiliated	11.17	12.91	35.41	0.83	46.16	17.61
Fundamental Inv.	10.19	14.95	27.05	1.23	36.70	35.03
United Accumulative	9.49	14.41	28.17	15.55	44.73	11.55
Consumer Prices	4.59	2.97				
Panel 2: 1969-1998						
Average Top 5	10.38	14.23	30.58	7.77	50.34	11.31
Dreyfus	9.26	13.27	31.40	15.85	51.24	1.51
IDS Stock	9.99	14.70	30.83	3.21	51.15	14.81
MFS Mass. Inv. Trust	10.97	14.77	27.34	0.99	59.14	12.53
LA Affiliated	11.55	13.29	35.88	0.95	44.70	18.46
United Accumulative	10.14	15.24	27.46	17.84	45.45	9.26
Consumer Prices	5.10	3.04				
Panel 3: 1979-1998						
Average Top 5	14.70	9.82	23.50	4.74	46.89	24.86
IDS Stock	14.24	9.75	24.00	3.33	53.86	18.82
Dreyfus	12.75	9.07	24.95	17.97	50.90	6.18
LA Affiliated	15.18	9.34	28.44	1.12	44.05	26.40
Inv. Comp. of America	15.79	9.79	20.73	0.23	31.88	47.16
MFS Mass. Inv. Trust	15.54	11.14	19.40	1.08	53.77	25.75
Vanguard Index	16.04	11.31	21.03	0.38	11.14	67.45
Vanguard LT-Bonds	9.99	7.71	90.06	0.92	4.34	4.68
Vanguard LT-Munis	7.36	10.79	91.50	1.70	9.33	-2.53
Consumer Prices	4.42	3.09				

nominal returns which are not distributed (unrealized capital gains).

The moments of the log-returns indicate that real stock returns were low and variable in the 1970s and high and more stable in the 1980s and 1990s. The large mutual funds distributed most of their total returns to their shareholders. The five largest funds at the end of 1961 distributed 81.15 percent of their annual returns over the period from 1962-1998. 34.37 percent were dividend and short-term capital gains that were taxed at the marginal income tax rate and 46.77 percent were long-term capital gains that were taxed at the lower capital gains tax rate. The proportions distributed were higher in the 1970s when stock markets performed poorly and were lower in the 1980s and 1990s when they performed very well. Large stock mutual funds differ significantly in the proportion of the total returns which are distributed to their shareholders. The Dreyfus fund distributed on average 93.82 percent of its annual returns over the period from 1979-1998, whereas the Investment Company of America fund distributed only an average of 52.84 percent. Actively managed funds with high asset turnover tend to distribute more than index funds and tax-efficient funds. The Vanguard Index fund distributed on average only 32.55 percent of its annual total return over the period between 1979-1998. It is not surprising that the two bond funds distributed most of their annual nominal returns as interest payments and short-term capital gains. The ex-post implicit tax rate on long-term municipal bonds relative to long-term corporate bonds was 26.33 percent.

4.2 Base Case Assumptions

The base case of the following computations assumes that the investor has a time horizon h of 30 years. The coefficient of relative risk-aversion α is taken as 3, which can be characterized as moderate risk-aversion. The investor can at most contribute half of her savings to the TDA.[7] The base-case tax rates on short-term and long-term distributions in the CSA are taken as 40 and 20 percent, roughly corresponding to the marginal federal income tax rate and capital gains tax rate faced by a high-income taxpayer. Some results are also computed for medium-income individuals (with tax rates of 30 and 20 percent, respectively).

In the paper we discuss the effect of different stock fund distributions on asset location. We assume that the fraction of the total returns which are distributed to the shareholders either as dividends or capital gains is

[7] The contribution limit is therefore $\overline{C} = \frac{I}{2(1-t_W)}$.

Table 2: Assumptions of Returns
The table lists the annualized means, standard deviations, and correlations of the logarithms of the real asset return relatives and of the rate of inflation. All values are in percent.

	Mean	Std.Dev.	Correlation			
			S	B	M	P
Stocks (S)	7	20	100			
Taxable Bonds (B)	4	8	30	100		
Tax-Exempt Bonds (M)	2.5	8	25	95	100	
Inflation (P)	2.5	4	-20	-60	-60	100

identical to the fraction of those distributions which are taxed as short-term distributions. For example, funds with distributions of 75 percent are assumed to distribute 75 percent of their returns to the shareholders and 75 percent of those distributions are dividends and short-term capital gains. Stock mutual funds are assumed to distribute 50 percent in our base case. The returns of both taxable and tax-exempt bonds are distributed completely as short-term income.

We assume that the logarithms of the return relatives (i.e., one plus the simple returns) and the logarithm of the price level are jointly normally distributed and serially uncorrelated. Our assumptions regarding the probability distributions of real asset returns are shown in Table 2.[8] The values for stocks and inflation correspond roughly to the historical record between 1926-1998 as summarized in Ibbotson (1999). The real return of taxable bonds is set slightly higher than the current real yield on inflation-protected bonds to reflect a compensation for default and inflation risk. We perform sensitivity analyses on these assumptions to check the robustness of our results. The returns of the bonds assume an implicit tax rate of 22.08 percent for the municipal bonds, which is close to the average rate over the last thirty years.[9]

[8]The moments of the simple returns can be computed from the moments of the logarithms of the return relatives. The mean of the simple return equals $m = \exp(\mu + \sigma^2/2)$ and its variance equals $s^2 = \exp(2\mu + 2\sigma^2) - \exp(2\mu + \sigma^2)$, where Latin letters denote the moments of the simple returns and Greek letters denote the moments of the logarithms of the return relatives. The means and standard deviations of the simple real returns corresponding to the values in Table 2 are 9.42 and 22.10 percent for stocks, 4.41 and 8.37 percent for taxable bonds, and 2.86 and 8.24 percent for municipal bonds. Inflation has a mean simple return of 2.61 and a standard deviation of 4.11 percent.

[9]Note that the implicit tax rate is defined for nominal returns. The assumptions from Table 2 imply expected nominal returns of 7.02 and 5.47 percent for taxable and tax-

Table 3: After-Tax Returns
The table lists the annualized moments of the logarithms of the real return relatives of investments in a CSA and a TDA with two different tax brackets. The investment horizon equals 30 years. Stock funds are assumed to distribute 50 percent of their returns. All values are in percent.

	CSA		TDA	
	Mean	Std.Dev.	Mean	Std.Dev.
Panel 1: Medium Income Tax ($t_W = 0.3$, $t_R = 0.3$)				
Stocks	5.67	3.17	7.00	3.65
Taxable Bonds	2.09	1.17	4.00	1.46
Tax-Exempt Bonds	2.50	1.46	2.50	1.46
Panel 2: Increasing Tax ($t_W = 0.3$, $t_R = 0.4$)				
Stocks	5.67	3.17	6.49	3.65
Taxable Bonds	2.09	1.17	3.49	1.46
Tax-Exempt Bonds	2.50	1.46	1.99	1.46
Panel 3: Decreasing Tax ($t_W = 0.4$, $t_R = 0.3$)				
Stocks	5.46	3.08	7.51	3.65
Taxable Bonds	1.45	1.08	4.51	1.46
Tax-Exempt Bonds	2.50	1.46	3.01	1.46
Panel 4: High Income Tax ($t_W = 0.4$, $t_R = 0.4$)				
Stocks	5.46	3.08	7.00	3.65
Taxable Bonds	1.45	1.08	4.00	1.46
Tax-Exempt Bonds	2.50	1.46	2.50	1.46

4.3 Distribution of After-Tax Returns

The distribution of after-tax returns depends on the asset class and the tax-environment. Table 3 summarizes the annualized means and standard deviations of the logarithms of the real return relatives of the three assets considered here. Panel 1 summarizes the results for a medium-income individual who faces the same marginal income tax rate while working and in retirement. Panels 2 and 3 look at individuals with increasing and decreasing marginal income tax rates. Panel 4 reflects a high-income individual with a marginal income tax rate of 40 percent.

The mean real returns in the TDA equal the mean before-tax returns if marginal income tax rates do not change during the life-time. The annualized standard deviations over the 30-year investment horizon are smaller than the assumed annual standard deviations from Table 2 because the annualized standard deviation decreases as the investment horizon lengthens.

exempt bonds, which corresponds to a 22.08 percent implicit tax rate on municipal bonds.

The average CSA returns are lower for individuals facing high income taxes during their work-career. Irrespective of the location, stocks have a higher average return and a higher standard deviation than bonds. Savings in a TDA have a higher average return and a higher standard deviation than savings in a CSA for all assets except for tax-exempt bonds. Municipal bonds have a higher expected return than taxable bonds in the CSA for high- and medium-income individuals. Returns in a CSA are less variable than the returns in a TDA because the tax system insures against losses in a CSA. Realized capital gains increase the tax liability, while capital losses decrease it. In a TDA however, the government does not insure against losses at all.[10]

The effective wealth taxes on assets in a CSA are shown in Table 4. Imposed at the end of the time horizon as a proportion of the total asset value, effective tax rates on total asset values leave investors with the same average proceeds as the continuous tax rates. The average effective tax rate in the base case for a high-income individual is 53.00 percent for taxable bonds, 35.62 for tax-exempt bonds, and 36.06 percent for stocks.[11] In the base case, taxable bonds face a higher effective tax because they pay all their returns as short-term distributions which are taxed at the ordinary income tax rate, whereas stocks only distribute 50 percent of their returns, and half of those distributions are taxed as long-term capital gains. Municipal bonds have similar expected tax burdens as stock mutual funds with a 50 percent distribution ratio. The effective tax on stocks decreases relative to the tax on municipal bonds as the investment horizon lengthens, because the tax on the unrealized capital gains of the stock mutual funds can be deferred for a longer period while the (implicit) tax on municipal bonds can not be deferred at all. The effective tax rates can be higher than the statutory tax rates because the government taxes investment returns continuously and not just at the end of the investment horizon. The effective wealth taxes are very low at short time horizons because only a small portion of the final

[10] Our model does not capture two institutional facts. First, mutual funds are forced to distribute realized capital gains to their shareholders but are prohibited from distributing losses. Second, the tax code limits the deduction of realized capital losses from taxable income. If the capital losses are higher than the limit, then only the limit can be deducted from taxable income. However, it is possible to carry the remaining losses forward and to deduct them from future taxable income. Introducing those limitations does not change the main results of our paper significantly. Mintz and Smart (1999) show that the asymmetric treatment of capital gains and losses increases the effective tax on stocks and shifts the preferred location of stocks to the tax-deferred account.

[11] The effective tax rate of tax-exempt bonds is computed by comparing the accumulated wealth of municipal bonds with the accumulated wealth of taxable bonds before taxes.

Table 4: Effective Tax Rates in a CSA
The table reports the average effective tax rates of stock, bond, and muni funds held in a CSA at different time horizons and different distributions of the stock funds. Bond funds are assumed to distribute 100 percent of their returns. All values are in percent.

Horizon			Stocks			Bonds	Munis
Distributions	0	25	50	75	100	100	100
Panel 1: Medium Income Tax ($t_W = 0.3$)							
1	1.46	1.52	1.67	1.91	2.25	1.87	1.46
5	6.31	6.79	7.70	9.03	10.75	9.01	7.08
10	10.63	11.96	14.08	16.91	20.34	17.20	13.65
30	17.94	24.36	32.17	40.73	49.45	43.24	35.62
50	19.55	31.68	44.59	56.98	67.92	61.09	52.00
Panel 2: High Income Tax ($t_W = 0.4$)							
1	1.46	1.56	1.86	2.33	2.99	2.49	1.46
5	6.31	7.01	8.59	10.97	14.07	11.82	7.08
10	10.63	12.39	15.73	20.42	26.15	22.25	13.65
30	17.94	25.48	36.06	47.98	59.73	53.00	35.62
50	19.55	33.35	49.76	65.38	78.04	71.59	52.00

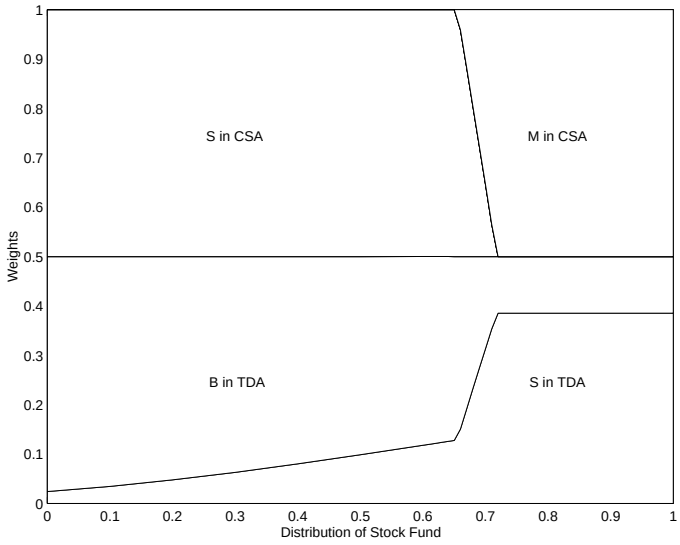
wealth level are taxable investment returns.

Medium-income individuals ($t_W = 0.3$ and $t_C = 0.2$) face an average 43.24 percent tax rate on taxable bonds, 35.62 percent on tax-exempt bonds, and 32.17 percent on stocks. The municipal bond funds face exactly the same effective tax rates for high- and medium income individuals. The effective tax rate on stocks can exceed that on bonds if stocks distribute a sufficient proportion of their returns. Choosing mutual funds with low distribution levels decreases the effective tax significantly. For example, the effective tax rate of a high-income individual with a time horizon of 30 years is 47.98 percent if the individual is invested in a tax-inefficient fund with distributions of 75 percent (typical for an actively managed mutual fund) and drops to 25.48 percent if the investor switches to a tax-efficient fund with distributions of 25 percent (typical for a passively managed mutual fund).

5 Optimal Portfolio Choice

We compute in this section the optimal portfolio choices for an investor who can invest in stock mutual funds, taxable bonds, and tax-exempt municipal

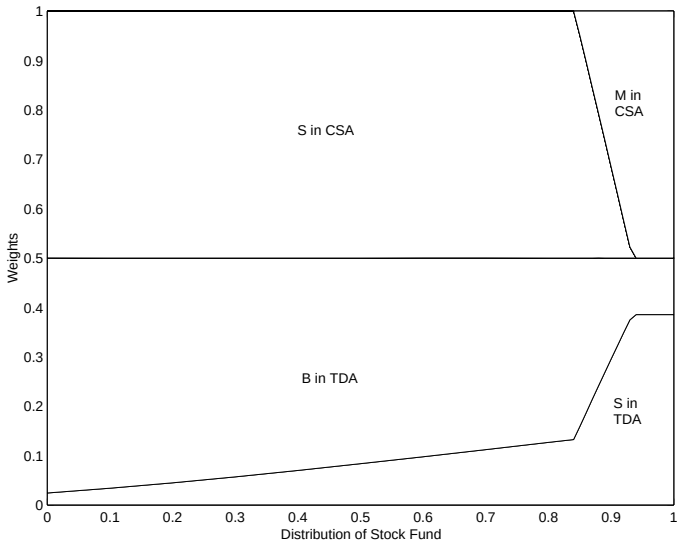
Figure 1: Optimal Portfolio Choice for a High-Income Individual
Tax-exempt bonds have always a preferred location in the CSA and taxable bonds in the TDA. Stock mutual funds should be located in the TDA if they distribute more than 68.6 percent. Municipal bonds are only held if stocks are sufficiently tax-inefficient. If the stock fund distributes 50 percent of its total returns, then it is optimal to invest 9.86 percent in stocks in the TDA, 40.14 percent in bonds in the TDA, and the remaining 50 percent in stocks in the CSA.



bonds and who can locate those assets in a tax-deferred account and in a conventional savings account. The assumptions of the computations are summarized in Table 2.

Figure 1 shows the optimal asset allocation and location for a high-income individual at different distribution levels of the mutual fund. Irrespective of the characteristics of the stock portfolio, it is always optimal to contribute the maximum amount of 50 percent to the TDA. If the stock fund distributes 50 percent of its total returns, then it is optimal to invest 9.86 percent in stocks in the TDA, 40.14 percent in bonds in the TDA, and the remaining 50 percent in stocks in the CSA. This high-income individual does not invest in municipal bonds although the implied tax on municipal bonds is only 22.08 percent. Locating stocks in the CSA and holding mostly taxable bonds in the TDA is better than holding munis in the CSA

Figure 2: Optimal Portfolio Choice for a Medium-Income Individual
Stock mutual funds should be located in the TDA if they distribute more than 88.5 percent. Municipal bonds are only held if stocks are sufficiently tax-inefficient. If the stock fund distributes 50 percent of its total returns, then it is optimal to invest 8.34 percent in stocks in the TDA, 41.66 percent in bonds in the TDA, and the remaining 50 percent in stocks in the CSA.



and locating the stocks in the TDA. Figure 1 shows that the proportion of stocks increases in the TDA and decreases in the CSA as the stock funds become more tax-inefficient. Municipal bonds always have a preferred location in the CSA and taxable bonds in the TDA. If stocks are sufficiently tax-inefficient and distribute more than 68.6 percent of their annual returns, their preferred location shifts from the CSA to the TDA. Most of the actively managed equity funds in Table 1 distributed more than 68.6 percent, and should therefore be located in the TDA. The passively managed index fund with an average distribution of 32.55 percent should be located in the CSA. Individuals will be better off if they hold stock portfolios with low distribution levels.

The asset allocation and location is similar for a medium-income individual and is depicted in Figure 2. Such investors hold 8.34 percent stocks and 41.66 percent taxable bonds in the TDA, and the CSA consists of 50 percent stocks if stocks distribute 50 percent. Medium-income individuals

hold fewer stocks than high-income individuals because the tax advantage of stocks is relatively smaller for medium-income individuals than for high-income individuals. The preferred location of stocks shifts to the TDA and municipal bonds in the CSA replace taxable bonds in the TDA if stocks distribute more than 88.5 percent. The point of asset location reversal occurs for medium-income individuals at considerably higher levels of stock distributions. The portfolio choice is not affected much for individuals expecting higher or lower marginal tax rates in the future.

Investment practitioners suggest that individuals hold municipal bonds if their marginal tax rate on ordinary income is higher than the implicit tax rate of municipal bonds. This advice is not always correct for individuals saving in both tax environments. The relevant comparison in this case is the implied tax on municipal bonds relative to the tax on stocks in the CSA, as demonstrated in the simple setting in Section 2. Individuals should put bonds in the TDA and mostly stocks in the CSA if the taxes on stocks are lower than the implied taxes on municipal bonds. This reduces the demand of investors for municipal bonds and might explain the low implicit tax rate on municipal bonds, which is often perceived to be puzzling.[12]

We have performed several computations to check the robustness of our results. Figure 3 shows the portfolio composition at different levels of risk-aversion for a high-income individual if stocks distribute 50 percent of their returns. Investors hold exclusively stock funds if their risk-aversion is lower than $\alpha = 1.4$. Asset location is irrelevant in this case unless the investors can choose between different equity funds. As their risk-aversion increases, they increase their holdings of taxable bonds in the TDA. At a risk-aversion of $\alpha = 4$, the TDA includes only taxable bonds and the CSA includes only stock funds. Municipal bonds replace some stocks in the CSA as the risk-aversion increases further. At very high levels of risk-aversion, individuals substitute taxable bonds in the CSA for the tax-exempt munis because the after-tax returns of taxable bonds are assumed to be less variable than the returns of municipal bonds.

The optimal asset location choice depends on the investment horizon. Figure 1 shows that the proportion of stocks is identical in both accounts at the critical distribution level of 68.6 percent for an investment horizon of 30 years. Stock mutual funds should have a preferred location in the TDA (CSA) if they distribute more (less) than this critical level. Figure 4 shows that the critical distribution level of stock mutual funds increases with the

[12]This explanation of the low implicit tax rate on municipal bonds is similar to Mankiw and Poterba (1996).

Figure 3: Changes in Risk Aversion
The optimal portfolio locations and allocations are depicted for a stock mutual fund that distributes 50 percent of its annual returns. The proportion invested in stocks decreases as the risk-aversion increases. Investors exchange their stock mutual funds in the TDA for taxable bonds at relatively low levels of risk-aversion and they exchange their stock mutual funds in the CSA for municipal bonds at higher levels of risk-aversion.

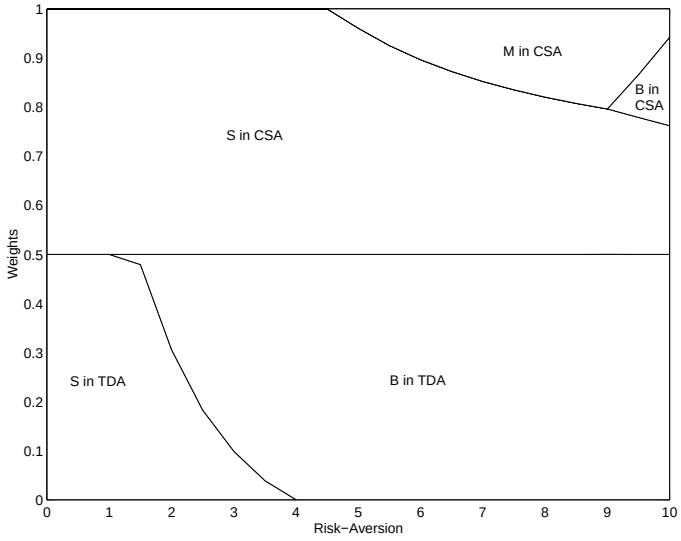


Figure 4: Critical Distribution Level at Different Investment Horizons
The critical distribution levels of stock mutual funds are depicted at different investment horizons. The proportion of stocks in the two accounts is identical at the critical distribution level. If stock mutual funds distribute more (less) than the critical distribution level, then the stock mutual funds should have a preferred location in the TDA (CSA). The effective taxation of stock mutual funds decreases as the investment horizon lengthens, because the tax on the unrealized capital gains can be deferred for a longer period. This justifies why the critical distribution level increases with the investment horizon.

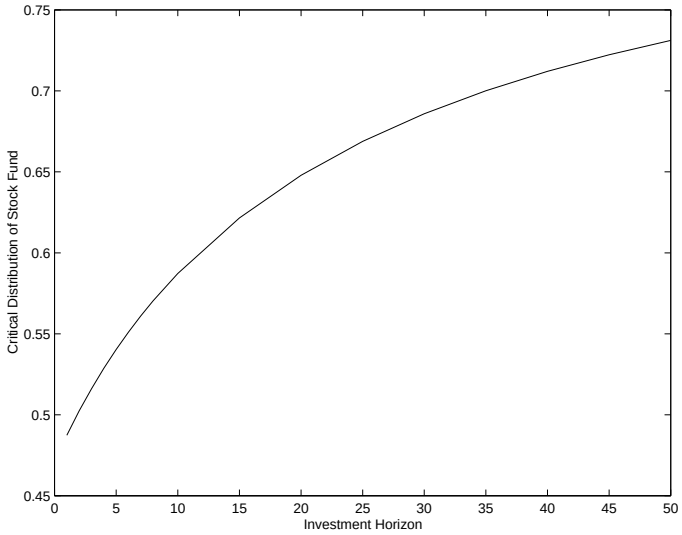
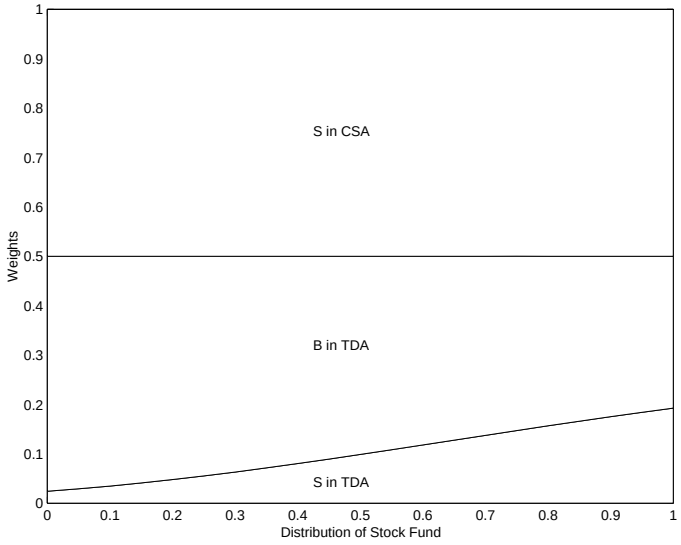


Figure 5: Optimal Portfolio Choice without Tax-Exempt Bonds
The optimal location of stocks is the taxable account irrespective of the distribution characteristics of stocks. If the stock fund distributes 50 percent of its total returns, then it is optimal to invest 9.86 percent in stocks in the TDA, 40.14 percent in bonds in the TDA, and the remaining 50 percent in stocks in the CSA.



investment horizon. The reversal of the optimal location of stocks results at higher distribution levels if investors plan to hold their assets for a longer period. This effect is justified by the relatively lower effective taxation of stock mutual funds at longer time horizons as demonstrated in Table 4. The effective taxation of stock mutual funds decreases relative to the effective taxation of municipal bonds as the investment horizon lengthens, because the tax on the unrealized capital gains of stocks can be deferred for a longer period.

If tax-exempt municipal bonds are not available, then it is optimal to locate the taxable bonds in the TDA and the equity funds in the CSA irrespective of the proportion of the stock returns which are distributed by the mutual fund. Figure 5 shows that the proportion of stocks held in the TDA increases as stock funds become less tax-efficient. If the stock fund distributes 50 percent of its total returns, then it is optimal to invest 9.86 percent in stocks in the TDA, 40.14 percent in bonds in the TDA,

and the remaining 50 percent in stocks in the CSA. This portfolio choice is exactly identical to the one in an environment with municipal bonds, because investors do not want to hold municipal bonds if stock funds are relatively tax-efficient. This result is consistent with Huang (2000) and Dammon, Spatt, and Zhang (2001), who do not add tax-exempt bonds as an additional investment option.

6 Gains from Asset Location

To determine whether asset location is economically significant, we compare the gains from asset location to the gains from the existence of a tax-deferred account. We compute the expected utility of an investor in four different environments. In the first environment investments can only be made in a taxable CSA and municipal bonds are not available (No TDA, No Munis). The second environment allows investments in a TDA, but restricts investors to hold the same relative proportions of the taxable bond and the stock in the CSA and the TDA. This environment does not allow an investor to locate the assets optimally (No Location, No Munis). The third environment does not restrict the asset location between the TDA and the CSA (Optimal Location, No Munis). The fourth environment adds tax-exempt municipal bonds as an additional asset class. This environment corresponds to the optimization problem described in Section 3. For a better comparison of the three environments we compute the certainty equivalents CE of the expected utilities.

$$CE\left(E(U)\right) = U^{-1}\left(E(U)\right) = \left(\left(1-\alpha\right)E(U)\right)^{\frac{1}{1-\alpha}}. \tag{20}$$

Panel 4 of Table 5 shows the certainty equivalent retirement wealth levels (as a proportion of initial after-tax saving) for a high-income individual facing the same tax rates during the working career and during retirement. The certainty equivalent in the environment without the possibility of investing in a TDA and without municipal bonds equals 241 percent of the initial saving I with an equity fund distributing 50 percent of its total return. The availability of a TDA increases the certainty equivalent by 27.6 percent to 308 percent of initial savings. The benefits of a TDA increase with the distributions of the stocks. Asset location improves the performance of a portfolio significantly. Optimal asset location adds an additional 6.6 percent to certainty equivalent wealth in the base case. Allowing investors to hold tax-exempt municipal bonds has no effect on the utility level because individuals should not hold munis if stocks distribute just 50 percent of their

Table 5: Certainty Equivalents
The certainty equivalents are computed in different investment environments. The environments are characterized by different restrictions facing the investors. 'No TDA, No Munis' is an environment where individuals can only invest in stocks and taxable bonds in the CSA. 'No Location, No Munis' is an environment where an investor is restricted to hold the same proportion of stocks and taxable bonds in the TDA and the CSA. 'Optimal Location, No Munis' is an environment with optimal location of the stocks and taxable bonds in the two accounts. 'With Munis' adds tax-exempt municipal bonds to the investment choices. The certainty equivalents are expressed in percent of the initial (after-tax) savings.

	Distributions of Stocks				
	0	25	50	75	100
Panel 1: Medium Income Tax ($t_W = 0.3$, $t_R = 0.3$)					
No TDA, No Munis	274	270	261	238	232
No Location, No Munis	326	323	319	314	307
Optimal Location, No Munis	349	343	334	322	309
With Munis	349	343	334	322	315
Panel 2: Increasing Tax ($t_W = 0.3$, $t_R = 0.4$)					
No TDA, No Munis	274	270	261	238	232
No Location, No Munis	299	296	292	287	280
Optimal Location, No Munis	322	316	306	295	282
With Munis	322	316	306	295	288
Panel 3: Decreasing Tax ($t_W = 0.4$, $t_R = 0.3$)					
No TDA, No Munis	258	252	241	222	195
No Location, No Munis	348	345	339	331	321
Optimal Location, No Munis	381	373	360	342	323
With Munis	381	373	360	347	347
Panel 4: High Income Tax ($t_W = 0.4$, $t_R = 0.4$)					
No TDA, No Munis	258	252	241	222	195
No Location, No Munis	317	314	308	299	289
Optimal Location, No Munis	349	341	328	311	291
With Munis	349	341	328	315	315

returns.

The gains of asset location are particularly high if the available assets differ considerably in their characteristics, that is if stocks differ from bonds by distributing considerably less than 100 percent. If the stock fund distributes 25 percent of the returns, the investor increases her certainty equivalent by 8.8 percent by optimally locating assets, or if the stock fund distributes 75 percent by 3.8 percent. The benefits of asset location are computed relative to a symmetric asset location. Other sub-optimal asset locations can reduce retirement wealth considerably more. The benefits of municipal bonds are limited and increase with the distributions of the equity fund.

Panel 1 of Table 5 shows that a medium-income individual has a slightly higher certainty equivalent than the high-income individual. The gains of a TDA and asset location are slightly lower because tax-deferral is less valuable if investors face lower taxes. Saving in tax-deferred accounts is particularly beneficial if tax rates are expected to be lower during retirement than during the working career as shown in Panel 3. Individuals can deduct their contributions from their taxable income when they face a higher tax rate and pay taxes on the withdrawn benefits when their tax rate is lower. Panel 2 shows that contributions to the TDA are beneficial even if the marginal income tax rate is expected to rise from 30 to 40 percent at retirement.

7 Conclusions

This paper derives optimal asset locations and allocations for a risk-averse investor saving for retirement. It confirms the desirability of accumulating assets in tax-deferred accounts and suggests that certain assets are best suited to either taxable or tax-deferred accounts. The most important determinant of asset location is the proportion of returns distributed as income and capital gains. The paper shows that corporate bonds and stocks with high distributions have a preferred location in the tax-deferred environment, and that tax-exempt municipal bonds and stocks with low distributions have a preferred location in conventional savings accounts. One of the key findings of this paper is that asset location choice can affect welfare in retirement by significant amounts.

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