Calculating After-Tax Asset Allocation Is Key to Determining Risk, Returns, and Asset Location

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Executive Summary

- This study presents a unified framework that addresses the differences in risk and returns on taxable and retirement accounts.
- It explains the logic of calculating an individual's after-tax asset allocation, where we first convert all account values to after-tax funds and then calculate the asset allocation based on these values. For example, we must first convert the pretax funds in tax-deferred accounts, such as a 401(k), into after-tax funds before calculating the after-tax asset allocation.
- The study examines how the choice of savings vehicles, such as a Roth IRA, tax-deferred account, or taxable account, affects the portions of principal effectively owned by, return received by, and risk borne by the individual investor.
- A dollar in a tax-deferred account is like $(1 - t_n)$ dollar in a Roth IRA, where t_n is the expected tax rate in retirement. The investor effectively owns $(1 - t_n)$ of the current principal, but receives all of an asset's returns and bears all of an asset's risk.
- This study explains how an investor's stock management strategy affects the after-tax risk and returns on stocks held in taxable accounts.
- It demonstrates that, in a mean-variance optimization, a bond held in a retirement account is effectively a different asset than a bond held in a taxable account. The same statement usually applies to stocks.
- The study also examines the implications of this unified framework for the asset location decision. Except for extreme cases, individuals should locate bonds in retirement accounts and stocks—especially passively managed stocks—in taxable accounts, while attaining their target asset allocation.

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This study presents a unified framework that addresses taxation issues for individual investors. It has implications for (1) how an individual should calculate his or her asset allocation, (2) how an asset's after-tax risk and returns vary across savings vehicles, and (3) the asset location decision. It uses a simplified framework with two assets (stocks and bonds) and three savings vehicles (a taxable account, a Roth individual retirement account, and a tax-deferred account like a 401(k)). In addition to qualified retirement accounts and taxable accounts, Brunel (2001 and 2004) included vehicles such as private exchange funds, family partnerships, various types of trusts, and variable life insurance. But this study uses the simplified framework so the key points can be made as simply as possible.

This study advocates the after-tax asset allocation framework that was developed by Reichenstein (1998, 2001b) and Reichenstein and Jennings (2003), and used by Dammon, Spatt, and Zhang (2004), Jennings and Reichenstein (2004), and Reichenstein (2001a) in asset location studies. It suggests that individuals should calculate their after-tax asset allocation, where the after-tax asset allocation first converts all asset values to after-tax values, and then calculate their current asset allocation based on these after-tax values.

This study shows that an asset's after-tax risk and after-tax returns vary with the savings vehicle. Thus a bond held in a taxable account has a different after-tax risk and after-tax return than the same bond held in a Roth IRA or a tax-deferred account like a 401(k); they are essentially different assets from the individual's perspective.

Additionally, this study discusses the investment implications of this framework for the asset location issue, where asset location refers to the preference to locate stocks in taxable accounts and bonds in retirement accounts or vice versa. It demonstrates that, except for extreme cases, there is an optimal asset location. In general, individuals should locate bonds in retirement accounts and stocks—especially passively managed stocks—in taxable accounts, while attaining their target asset allocation.

The paper first explains the rationale for calculating an after-tax asset allocation and presents an example. It then shows how the choice of savings vehicles affects the percentages of principal effectively owned by, return received by, and risk borne by individual investors. In

addition, it explains how an investor's stock management style will affect the after-tax risk and returns on stocks held in taxable accounts. The paper also presents mean variance optimizations that jointly determine an individual investor's optimal asset allocation and asset location.

Rationale for After-Tax Asset Allocation

Tara is single, age 50, and wants to save for retirement. She is in the 25 percent ordinary income tax bracket today and expects to remain in this bracket during retirement. Table 1 presents her situation. This year she saves $1,000 of pretax funds in a 401(k) and $750 of after-tax funds in a Roth IRA. The $1,000 contribution to the 401(k) reduces this year's income by $1,000, which reduces taxes by $250. The $1,000 pretax contribution can be separated into $250 of tax savings and $750 of Tara's after-tax funds. The $750 contribution to the Roth IRA consists of Tara's after-tax funds. Both the pretax and after-tax contributions reduce this year's spending by $750.

Table 1: Tara's Savings in 401(k) and Roth IRA

Savings Vehicle	Original Investment	Retirement Wealth
401(k)	$1,000 Pretax $ 250 Tax Savings $ 750 After-Tax	$2,000 Pretax $ 500 Tax Savings $ 1,500 After-Tax
Roth IRA	$ 750 After-Tax	$ 1,500 After-Tax

The individual is in the 25 percent tax bracket in the contribution year and withdrawal year in retirement.

Tara invests both accounts in the same mutual fund. It could be a stock fund, bond fund, or any other type of fund. Let's assume it is a bond fund. Sixteen years pass and the account values have doubled to $2,000 in the 401(k) and $1,500 in the Roth IRA. Tara is now in retirement and wants to spend the funds. She withdraws $2,000 of pretax funds from the 401(k), pays $500 in taxes, and has $1,500 of after-tax funds to buy goods and services. She withdraws $1,500 from the Roth IRA and can also buy $1,500 of goods and services. In summary, both the $1,000 contribution of pretax funds to the 401(k) and the $750 contribution of after-tax funds to the Roth IRA reduced this year's spending by $750 and they both finance the purchase of $1,500 of goods and services when withdrawn in retirement.

Now, let's change the example. In retirement, Tara moves the $2,000 in 401(k) funds to a stock fund, while leaving the $1,500 in bonds in the Roth IRA. If these are her only assets at retirement, what is her asset allocation?

According to the traditional approach to calculating asset allocation, Tara has $1,500 in bonds and $2,000 in stocks for a 43 percent bonds/57 percent stocks asset allocation. But the traditional approach fails to distinguish pretax funds from after-tax funds. It compares apples to oranges. We advocate the calculation of an after-tax asset allocation. To make this calculation, we first convert all account values to after-tax funds and then calculate the asset allocation in the usual fashion. The after-tax asset allocation compares after-tax dollars to after-tax dollars. In Tara's case, her asset allocation should be considered $1,500 of after-tax funds in bonds and $1,500 of after-tax funds in stocks—in other words, a 50 percent bonds/50 percent stocks asset allocation. Based on current market values, they both represent the same purchasing power so they should be considered equivalent.

Let's return to the Table 1 assumptions, except assume that today she invests $1,000 of pretax funds in a 401(k) in stocks and $750 of after-tax funds in a Roth IRA in bonds. If these are her only two assets, what is her asset allocation today?

Assuming the pretax funds in the 401(k) will be withdrawn during retirement, she should convert the pretax funds to after-tax values by multiplying by $(1 - t_n)$, where t_n is the expected tax rate during retirement. Notice that the applicable tax rate is t_n, and not the current tax rate. Today's $1,000 of pretax funds in the 401(k) is equivalent to $750 of after-tax funds in a Roth IRA because, if invested in the same

asset, they will buy the same amount of goods and services. Consequently, they should be viewed as equivalent today. Conceptually, Tara owns 75 percent or $(1 - t_n)$ of the principal in the 401(k) and the government "owns" the remaining 25 percent or t_n of principal.

Therefore, Tara's after-tax asset allocation today contains $750 after taxes in stocks and $750 after taxes in bonds for a 50 percent bonds/50 percent stocks mix.

Let us again change the assumptions. Assume Tara is in the 25 percent tax bracket today but expects to be in the 15 percent bracket during retirement. Today, she invests $1,000 of pretax funds in a 401(k) in stocks and $750 of after-tax funds in a Roth IRA in bonds. If these are her only two assets, what is her asset allocation today?

She should convert the $1,000 of pretax funds in the 401(k) to $850 of after-tax funds, and she should use this value to calculate her asset allocation. Her after-tax asset allocation contains $850 after taxes in stocks and $750 after taxes in bonds. Since the retirement tax rate will be 15 percent, the $1,000 in the 401(k) will buy the same amount of goods and services as $850 in a Roth IRA. So, they should be considered equivalent today. Even though the $1,000 only reduced this year's spending by $750, when calculating her asset allocation the $1,000 in the 401(k) should be considered $850, or $1,000 $(1 - t_n)$ after taxes. Under this scenario, her asset allocation mix would be roughly 47 percent bonds and 53 percent stocks.

Choosing a Savings Vehicle

These examples help answer two separate types of questions. The first concerns an individual's choice of savings vehicles. Tara must decide whether she wants to save in a traditional IRA or a Roth IRA, or to save in a 401(k) or a Roth 401(k). If there is no matching contribution, a key comparison is between the tax rates in the contribution and withdrawal years. Table 1 demonstrates that when these tax rates are the same, Tara should be indifferent between saving $1,000 of pretax funds in a tax-deferred account or $750 of after-tax funds in a tax-exempt account. When the retirement tax rate is lower, it is better to save $1,000 of pretax funds in a tax-deferred account than $750 of after-tax funds in a tax-exempt account. In general, the individual should save in the tax-deferred account when the expected tax bracket in retirement is lower than the current year's tax bracket, and vice versa. This comparison also applies to the decision of whether to convert funds from a traditional IRA to a Roth IRA. In general, someone should convert a traditional IRA to a Roth IRA when the current year's tax bracket is lower than the expected tax bracket in retirement. Although the comparison between tax brackets in the current year and withdrawal year is usually the key comparison, for a more thorough analysis of the choice of savings vehicles see Waltenberger, Rothermich, and Reichenstein (2006).

The second question concerns the method of calculating an individual's asset allocation. Assuming funds in tax-deferred accounts (for example, 401(k), SEP-IRA, Keogh) will eventually be withdrawn during retirement, these pretax balances should be converted to after-tax funds by multiplying by $(1 - t_n)$, where t_n is the expected tax rate during retirement. Then the asset allocation should be based on the accounts' after-tax values.

To calculate Tara's after-tax asset allocation, we must estimate t_n, the retirement tax rate. She might say she has no idea what her tax bracket will be during retirement. Moreover, her tax bracket may vary across years. Admittedly, the calculation of an after-tax asset allocation requires an estimate of t_n. But to understand why the after-tax asset allocation is preferable despite the uncertainty of t_n, let's return to the original example in Table 1.

She has $1,000 of pretax funds in a 401(k) and $750 of after-tax funds in a Roth IRA, and she expects to be in the 25 percent tax bracket during retirement. The traditional approach says she has $1,000 in the 401(k) and $750 in the Roth IRA, while the after-tax approach says she has $750 of after-tax funds in both the 401(k) and Roth IRA. The seeming advantage of the traditional approach is that it is based on certain values, while the after-tax approach requires an estimate of t_n. But the reality is that we are certain that withdrawals from the 401(k) will be subject to ordinary income taxes. The only uncertainty is the tax rate. Since the traditional approach fails to distinguish between pretax and after-tax funds, it says she has 33 percent more funds in the tax-deferred account; therefore, it implicitly assumes her retirement tax bracket will be zero. Although Tara may not know what her retirement tax bracket will be, it should be easy for her to improve upon the traditional approach's implicit estimate of zero. When calculating an individual's asset allocation, it is better to estimate t_n and calculate an asset allocation that is approximately correct than to calculate one that is precisely wrong.

Taxable Accounts

So far, we have discussed funds in tax-deferred accounts and Roth IRAs. We now expand the discussion to include taxable accounts. Suppose Tara has assets held in a taxable account that has embedded, but unrealized, capital gains or losses. If an embedded capital gain or loss is eventually realized, then it would be appropriate to reduce the asset's market value for the tax liability of the embedded gain or increase the market value for the tax savings from the embedded loss.

Suppose Tara has a stock with a market value of $20,000, cost basis of $12,000, and she is in the 15 percent capital gain tax bracket and 25 percent ordinary income tax bracket. The example assumes the appreciated asset is a stock but it could be any capital asset. If she sells the stock today as a short-term gain, then taxes would be $2,000 on the $8,000 capital gain and the after-tax value would be $18,000. If she sells the stock today as a long-term gain, then taxes would be $1,200 and the after-tax value would be $18,800.

If Tara will sell the stock within a few years and pay taxes at 15 percent, then the $18,800 after-tax valuation is a reasonable estimate of its after-tax value since there is little benefit to deferring taxes for a few years. If she sells the stock decades hence, then Poterba (1998) concludes that the effective tax rate might be half of t_c, or about 7.5 percent. Finally, the capital gains could become tax exempt under two scenarios: if she (1) awaits the step-up in basis at death or (2) uses the appreciated asset to finance a charitable donation. In these scenarios, the stock's after-tax value would be the same as the market value. In short, the "right" way to handle the tax consequences of the unrealized gain depends on how quickly, if ever, Tara will realize the gain. A financial advisor can add value to Tara's accounts by helping her understand the tax consequences of her actions.

Suppose Tara owns a stock with a market value of $20,000 and cost basis of $25,000. If she realizes the loss today, it would be used to offset capital gains and to reduce ordinary taxable income up to $3,000 a year. If it she uses this year to offset $5,000 of long-term capital gains, the tax savings would be $750 and the asset's after-tax value would be $20,750. If she uses it this year to offset $2,000 of long-term gains and $3,000 of ordinary income, the tax savings would be $300 from the capital gain offset and $750 from the income reduction. The after-tax value would be $21,050.

To repeat, in order to calculate the after-tax asset allocation, we must first convert all asset values to after-tax values. To convert tax-deferred accounts' pretax values to after-tax values, we need an estimate of t_n. To convert taxable accounts' market values to after-tax values, we need estimates of how quickly capital gains and losses will be realized. Once all values have been converted to after-tax values, the asset allocation is calculated in the usual way.

The bottom line is that the asset allocation decision is an important decision. Therefore, it is important that we accurately measure an individual's asset allocation. We believe the after-tax approach is a better approach than the traditional approach to calculate an individual's asset allocation because it compares after-tax dollars to after-tax dollars.

An Example

Table 2 presents an individual's portfolio. He is in the 30 percent ordinary income tax bracket and 15 percent capital gains tax bracket, and expects to remain in these brackets during retirement. He has $600,000 of bonds in tax-deferred accounts, $100,000 in stocks in a Roth IRA, and $300,000 in stocks in taxable accounts. The latter have a cost basis of $260,000. Being an active investor, he will realize the gains within a few years.

Table 2: Calculation of an Individual's After-Tax Asset Allocation

Asset Class	Market Values	After-Tax Values	Savings Vehicle
Bonds	$600,000	$420,000	Tax-Deferred Accounts
Stocks	$100,000	$100,000	Roth IRA
Stocks	$300,000	$294,000	Taxable Account
Total	**$1,000,000**	**$814,000**	

- The individual is in the 30 percent ordinary income tax bracket and 15 percent long-term capital gain tax bracket and expects to remain in these brackets.
- Cost basis of stocks in taxable account is $260,000.
- After-tax asset allocation is 51.6 percent bonds/48.4 percent stocks, while the traditional approach says the allocation is 60 percent bonds/40 percent stocks.

To calculate his after-tax asset allocation, we must first convert all accounts to after-tax values. The $600,000 in the tax-deferred account is worth $420,000 after taxes, $600,000 (1 – .3). The stocks held in the taxable account are worth approximately $294,000 after taxes—$300,000 less $6,000 in taxes on the $40,000 of unrealized gains. The after-tax asset allocation contains $420,000 in bonds and $394,000 in stocks for a 51.6 percent bonds/48.4 percent stock asset allocation.

In contrast, when calculated using the traditional approach, his portfolio contains $600,000 in bonds and $400,000 in stocks for a 60/40 bond/stock allocation. Because the traditional approach fails to distinguish between pretax and after-tax funds, it tends to exaggerate the allocation to the dominant asset held in tax-deferred accounts. In this example, it overstates the bond allocation by 8.4 percent.

From my experience, the largest adjustment is usually the conversion of pretax funds in tax-deferred accounts to after-tax values, while there is usually relatively little difference between taxable assets' market and after-tax values. In this example, there was an $180,000 adjustment to tax-deferred accounts and only a $6,000 adjustment to taxable accounts. The largest adjustment was the need to convert the tax-deferred account's pretax funds to after-tax values.

Principal, Risk, and Returns Across Savings Vehicles

This section shows how the choice of savings vehicles affects the percent of principal effectively owned by, the percent of return received by, and the percent of risk borne by individual investors. Table 3 considers two asset classes—bonds and stocks—and three savings vehicles—Roth IRA, tax-deferred account, and taxable account.

Table 3: Principal Owned, Returns Received, and Risk Borne by Individual Investors in Roth IRA, Tax-Deferred Account, and Taxable Account

	Principal	Returns	Risk
Roth IRA, Bonds, and Stocks	100%	100%	100%
TDA, Bonds, and Stocks	$(1 - t_n)$	100%	100%
Taxable Account			
Bonds	100%	$(1 - t)$	$(1 - t)$
Stocks, Trader	100%	$(1 - t)$	$(1 - t)$
Stocks, Active Investor	100%	$(1 - t_c)$	$(1 - t_c)$
Stocks, Exempt Investor	100%	100%	100%

- The ordinary income tax rate is t in years before withdrawal and t_n in the withdrawal year. The tax rate on long-term capital gains and qualified dividends is t_c in all years.
- TDA denotes tax-deferred account such as 401(k)s, 403(b)s, Keoghs, and SEP-IRAs.

Source: Reichenstein (2007).

For each savings vehicle, the investor begins with a $1 market value and we calculate its current and future after-tax values. The annual pretax return is r, the investment horizon is n years, the ordinary income tax rate is t in years before withdrawal and t_n in the withdrawal year, and the tax rate on long-term capital gains and qualified dividends is t_c in all years.

The Roth IRA begins with $1 of after-tax funds. For bonds and stocks, its after-tax value grows from $1 today to $(1 + r)^n$ dollars n years hence. This investor owns all principal, receives all returns, and bears all risk.

The tax-deferred account begins with $1 of pretax funds. For bonds and stocks, its after-tax value grows from $(1 - tn)$ dollar today to $(1 + r)^n (1 - t_n)$ dollars n years hence. The investor effectively owns $(1 - t_n)$ of principal, but receives all returns and bears all risk. The tax-deferred account is like a trust, where the government is a silent partner that owns t_n of the trust and thus t_n of the current principal.[1] This supports the conclusion from the after-tax asset allocation section that $1 of pretax funds in a tax-deferred account can be viewed as $(1 - t_n)$ dollar of after-tax funds in a Roth IRA.[2]

We assume the taxable account begins with $1 of after-tax funds, that is, the asset's cost basis equals its market value. For bonds, the after-tax value grows from $1 today to $(1 + r(1 - t))^n$ dollars n years hence. The after-tax value grows at $r(1 - t)$. The investor owns all principal, but receives $(1 - t)$ of returns and bears $(1 - t)$ of risk.

To demonstrate the risk and returns sharing, assume bonds have a 4 percent expected return with a standard deviation of 6 percent. The ordinary income tax rate is 25 percent. For a three-year period, pretax returns are –2 percent, 4 percent, and 10 percent—that is, the 4 percent mean return and one standard deviation below and above the mean. The standard deviation of these returns is 6 percent. Assuming the 2 percent loss is used to offset that year's taxable income or short-term gains, the after-tax returns are –1.5 percent, 3 percent, and 7.5 percent. The mean after-tax return is 3 percent or 4 percent (1 – .25), while the standard deviation is 4.5 percent or 6 percent (1 – 0.25). In this case, the investor receives 75 percent of returns and bears 75 percent of the risk. If the 2 percent loss is used to offset that year's long-term gains, then the after-tax returns would be –1.7 percent, 3 percent, and 7.5 percent, and the investor would receive approximately 75 percent of returns and bear approximately 75 percent of risk. Although only approximate, Table 3 assumes that the investor with bonds held in a taxable account receives $(1 - t)$ of pretax returns and bears $(1 - t)$ of pretax risk.

For stocks held in taxable accounts, there is a separate model for each stock management style. We model three styles here. The pretax return is the sum of capital gain, g, and qualifying dividend yield, d—that is, $r = g + d$.

The Trader

The trader realizes all gains within one year and pays taxes at the ordinary income tax rate. His after-tax value grows from $1 today to $(1 + g(1 - t) + d(1 - t_c))^n$ dollars n years hence. Assume capital gains average 6 percent and dividend yield averages 2 percent for the long horizon associated with most retirement accounts. In this case, the trader owns all principal, but receives 78 percent or [{6%(.75) + 2%(.85)}/8%] of returns and bears about 78 percent of risk. Although only approximate, Table 3 assumes the trader receives $(1 - t)$ of returns and bears $(1 - t)$ of risk.

The Active Investor

The active investor realizes all gains in one year and one day and pays taxes at t_c on capital gains and qualifying dividends. The after-tax value grows from $1 today to $(1 + r(1 - t_c))^n$ dollars n years hence. This investor owns all principal, but receives $(1 - t_c)$ of returns and bears $(1 - t_c)$ of risk.

To demonstrate the risk and returns sharing, assume stocks have an 8 percent expected return with a standard deviation of 15 percent. The dividend and capital gain tax rates are 15 percent. For a three-year period, pretax stock returns are –7 percent, 8 percent, and 23 percent—that is, the 8 percent mean return and one standard deviation below and above the mean. The standard deviation of these returns is 15 percent. Assuming the 7 percent loss is used to offset long-term gains, the active investor's after-tax returns are –5.95 percent, 6.8 percent, and 19.55 percent. In this case, the mean after-tax return is 6.8 percent, while the after-tax standard deviation is 12.75 percent. So, the investor receives 85 percent of returns and bears 85 percent of risk. If the 7 percent loss is used to offset this year's taxable income or short-term gains, the active investor receives approximately 85 percent of returns and bears approximately 85 percent of risk. Although only approximate, Table 3 assumes the active investor receives $(1 - t_c)$ of returns and bears $(1 - t_c)$ of risk.

The Exempt Investor

The exempt investor never realizes gains and never pays taxes on the gains, but he pays taxes each year on dividends. Eventually, the appreciated stock is either donated to charity or sold after receiving the step-up in basis. If donated to a qualifying charity, the individual can deduct the stock's market value and the charity can sell the stock without incurring taxes. At the death of the individual, the stock's cost basis increases to the market value at death, so the beneficiary can sell it without incurring capital gain taxes. The after-tax value grows from $1 today to $(1 + g + d(1 - t_c))^n$ dollars n years hence. This investor owns all principal. For most stocks, he receives almost all returns, and bears all risk. For example, if the dividend yield is 2 percent and capital gains average 6 percent, the investor receives 96 percent (or 7.7%/8%) of returns and bears almost all risk.[3]

Table 3 summarizes this section. In a Roth IRA, the investor owns all principal, receives all returns, and bears all risk. In a tax-deferred account, he owns $(1 - tn)$ of principal, but receives all returns and bears all risk. For bonds held in a taxable account, the investor owns all principal but receives $(1 - t)$ of returns and bears $(1 - t)$ of risk. For stocks held in taxable accounts, the investor owns all principal, but the portion of returns received by, and risk borne by, the individual varies with the management style. For the trader, the portion is approximately $(1 - t)$, for the active investor it is approximately $(1 - t_c)$, and for the exempt investor it is approximately 100 percent.

After-Tax Mean Variance Optimization

This section illustrates that the risk- and return-sharing have important implications for an individual's asset location decision. (Brunel (2001), using multiple asset locations, also emphasizes that an asset's location affects its after-tax risk and after-tax return.) Each individual must make an asset allocation decision and an asset location decision. Asset allocation in this study's two-asset-class world refers to the allocation of funds between stocks and bonds. Asset location refers to the decision to locate stocks in taxable accounts and bonds in retirement accounts or vice versa, while attaining the target asset allocation.

Most financial planners use the ideas of Nobel laureate Harry Markowitz. Some planners produce objective estimates of expected returns, standard deviations, and correlation coefficients, and insert them into an optimizer to estimate an optimal portfolio. Other planners apply Markowitz's key ideas, but subjectively estimate an optimal portfolio. This section uses an optimizer because of its objectivity. It objectively shows that, except for extreme cases, individual investors should locate bonds in retirement accounts and stocks in taxable accounts, while attaining their target asset allocation.

This section presents after-tax optimizations for the active investor and then generalizes the results across investors with other stock management styles. Table 4 presents the optimization for the active investor. Her portfolio contains $1 million after taxes, including $550,000 of after-tax funds in a taxable account and $450,000 of after-tax funds in retirement accounts, where retirement accounts include Roth IRAs and tax-deferred accounts.[4] The cost basis and market values are the same for assets held in the taxable account.

Table 4: After-Tax Mean Variance Optimization for Active Investor

	After-Tax Values	Optimal Weights	After-Tax Expected Returns	After-Tax Standard Deviation
1. Stocks in Retirement Accounts	$97,000	9.7%	8.0%	15%
2. Bonds in Retirement Accounts	$353,000	35.3%	4.0%	6%
3. Stocks in Taxable Accounts	$550,000	55%	6.8%	12.75%
4. Bonds in Taxable Accounts	0	0%	3.0%	4.5%
	$1,000,000			

- Maximize Utility = $ER - SD^2/RT$, where ER is the portfolio after-tax expected returns, SD is the portfolio after-tax standard deviation, and RT, the investor's risk tolerance, set at 56.25.
- Constraints: $Sr, Br, St, Bt \geq 0$; $Sr + Br = .45$; and $Sr + Br + St + Bt = 1.0$, where Sr denotes the weight of stocks in retirement accounts. Br, St, and Bt denote the weights of bonds in retirement accounts, stocks in taxable accounts, and bonds in taxable accounts.
- The correlation coefficient between stock and bond returns is 0.1.
- The active investor in the 25 percent ordinary income tax bracket and 15 percent tax bracket for capital gains and dividends. Capital gains are realized after one year and one day, and are taxed at 15 percent.
- Optimizations were performed in Excel.

She allocates funds among four "assets"—stocks in retirement accounts, bonds in retirement accounts, stocks in taxable accounts, and bonds in taxable accounts. Pretax expected returns and pretax standard deviations are 4 percent and 6 percent on bonds and 8 percent and 15 percent on stocks.[5] Tax rates are 25 percent on ordinary income and 15 percent on long-term capital gains and dividends. When held in retirement accounts, the investor receives all returns and bears all risk. Thus, her after-tax returns and risk are the same as the pretax values. When held in taxable accounts, the bond investor's after-tax return and after-tax risk are 3 percent and 4.5 percent, while the corresponding values are 6.8 percent and 12.75 percent for stocks held in taxable accounts by this active investor. Notice that bonds and stocks are effectively different assets when held in retirement accounts and taxable accounts since they provide this individual investor with different after-tax risks and returns.

The correlation coefficient between stocks and bonds is set at 0.1. This active investor maximizes utility. Following Sharpe (1990), the utility function is $U = ER - SD^2/RT$, where ER denotes expected return, SD denotes standard deviation, and RT is the level of risk tolerance. U, the level of utility, is also the certainty equivalent return, meaning it is the risk-free return that would provide the same level of utility as the portfolio. The usual portfolio constraints apply. There is no short trading and the sum of the four "asset" weights is 1.0. In addition, the sum of stocks in retirement accounts and bonds in retirement accounts is 45 percent, $450,000 after taxes of the $1 million after-tax portfolio. The risk tolerance is set at 56.25.

The optimal portfolio contains $97,000 of after-tax funds in stocks held in retirement accounts, $353,000 of after-tax funds in bonds held in

retirement accounts, and $550,000 in stocks held in taxable accounts. The optimal asset allocation is 35.3 percent bonds and 64.7 percent stocks, and the optimal location is to hold bonds primarily in retirement accounts and stocks in taxable accounts. In the optimization, the asset allocation and asset location decisions are determined jointly.

Asset Allocation Takes Precedence over Asset Location

Table 5 presents the optimal asset allocations and locations for different levels of risk tolerance. It illustrates two points. First, the optimal asset allocation varies with the level of risk tolerance. Second, it demonstrates that the asset allocation target takes precedence over the asset location preference. For example, at a risk tolerance level of 44, she holds only bonds in retirement accounts and only stocks in taxable accounts, and this allows her to attain her target asset allocation. But at lower levels of risk tolerance, the active investor holds only bonds in retirement accounts but bonds and stocks in taxable accounts to attain her target asset allocation. At higher levels or risk tolerance, she holds bonds and stocks in retirement accounts and only stocks in taxable accounts to attain her target asset allocation. But she should not hold bond and stocks in both retirement accounts and taxable accounts. (Later, I will discuss an important exception.)

Table 5: Asset Location and Asset Allocation by Risk Tolerance

Asset Location					Asset Allocation	
RT	*Sr*	*Br*	*St*	*Bt*	Stocks	Bonds
20	0%	45.0%	31.9%	23.1%	31.9%	68.1%
30	0%	45.0%	43.0%	12.0%	43.0%	57.0%
44	0%	45.0%	55.0%	0%	55.0%	45.0%
56.25	9.7%	35.3%	55.0%	0%	64.7%	35.3%
70	21.1%	23.9%	55.0%	0%	76.1%	23.9%
80	29.3%	15.7%	55.0%	0%	84.3%	15.7%

RT denotes the investor's risk tolerance. *Sr* denotes the weight of stocks in retirement accounts. *Br*, *St*, and *Bt* denote the weights of bonds in retirement accounts, stocks in taxable accounts, and bonds in taxable accounts. Stocks and Bonds denote the overall asset allocation. $Sr + Br = 0.45$ restricts retirement account assets to 45 percent of total after-tax funds, where retirement accounts include the Roth IRA and tax-deferred accounts such as a 401(k).

Table 6 summarizes other optimizations for the active investor with a risk tolerance of 56.25. Portfolio 1 is the optimal portfolio in Table 4. Portfolio 2 contains the same asset allocation as optimal Portfolio 1, but with the opposite asset location. Portfolio 2 provides a 0.13 percent lower certainty-equivalent return. If the active investor insists on locating stocks in retirement accounts, then Portfolio 3 is the optimal portfolio.[6] Thus, the wrong asset location decision costs the active investor at least 0.13 percent in lost utility.

Table 6: Asset Allocation, Asset Location, and Utility

Active Investor Portfolio	Sr	Br	St	Bt	Portfolio			
					Stocks	Utility	ER	SD
1	9.7%	35.3%	55.0%	0% 64	.7%	4.51%	5.93%	8.94%
2	45.0%	0%	19.7%	35.3%	64.7%	4.38%	6.00%	9.55%
3	45.0%	0%	19.0%	36.0%	64.0%	4.38%	5.97%	9.47%

The investor maximizes utility: $U = ER - SD^2/RT$, where ER is portfolio expected returns, SD is portfolio standard deviation, and RT is the investor's risk tolerance, set at 56.25. Sr denotes the weight of stocks in retirement accounts. Br, St, and Bt denote the weights of bonds in retirement accounts, stocks in taxable accounts, and bonds in taxable accounts. $Sr + Br = 0.45$ restricts retirement account assets to 45 percent of total after-tax funds. Retirement accounts include the Roth IRA and tax-deferred accounts such as a 401(k). Stocks have pretax expected return of 8 percent, and bonds have a pretax expected return of 4 percent. Pretax standard deviations are 15 percent for stocks and 6 percent for bonds. The correlation coefficient between stocks and bonds is 0.1. The ordinary income tax rate is 25 percent and long-term capital gain and dividend tax rates are 15 percent.

Table 7 presents an intuitive explanation for why, except for extreme cases, individual investors should locate stocks in taxable accounts and bonds in retirement accounts, while attaining the target asset allocation. The left column shows the two asset location strategies. The first strategy holds bonds in retirement accounts and stocks in taxable accounts, while the second strategy does the opposite. Because the effective tax rate is zero on assets held in retirement accounts, the key question for the active investor is whether it is better to let the government "own" 15 percent of stock returns and risk or 25 percent of bond returns and risk when held in taxable accounts. The logical answer is that it is better to let the government "own" 15 percent of stock returns and risk. For this active investor, the advantage of this asset location strategy reflects the spread (25% – 15%) between the ordinary income tax rate, and the effective tax rate on stocks held in taxable accounts.

Table 7: Optimal Asset Location for the Active Investor

Asset Location	Effective Tax Rates
1. Stocks in Taxable Accounts Bonds in Retirement Accounts	15% Tax Rate 0% Tax Rate
2. Bonds in Taxable Accounts Stocks in Retirement Accounts	25% Tax Rate 0% Tax Rate

Source: Reichenstein (2007)

Asset Location More Important for Certain Investors

We now generalize the results across stock management styles. For the exempt investor, this spread is (25% – 0%) or 25 percent for capital gains, and (25% – 15%) or 10 percent for dividends. Thus, the asset location decision is more important to this investor than to the active investor. For the trader, the spread is (25% – 25%) or zero for capital gains, and 10 percent for dividends. So, the asset location decision does not matter for a trader who holds only non-dividend paying stocks or for any trader if dividends are again taxed as ordinary income.[7] Except for these extreme examples, all investors should have a preference to locate bonds in retirement accounts, and stocks in taxable accounts.[8]

Finally, consider a passive investor who buys and holds stocks in a taxable account, but at the end of the investment horizon sells the stocks and pays capital gains taxes at 15 percent. As his investment horizon lengthens, the effective tax rate on stocks decreases. It follows that the longer the horizon, the greater the utility gain from locating stocks in taxable accounts. Generalizing, the asset location decision should be most important to taxpayers in high ordinary income tax brackets who passively manage stocks in taxable accounts. Since most financial planners' clients have above average wealth, the asset location decision should be relatively important to them.

There is an exception to the asset location advice to hold bonds in retirement accounts and stocks in taxable accounts, while attaining the target asset allocation. To serve their purpose, liquidity reserves must be held in taxable accounts. This study implies that one implicit cost of holding liquidity reserves in taxable accounts is a reduction of the potential asset location benefit.

Separately, let us generalize the asset location implications across other asset classes. The best assets to hold in retirement accounts are those that produce income that is subject to ordinary income tax rates. These include bonds, real estate investment trusts, and most hedge funds. The best assets to hold in taxable accounts are those that produce returns that are subject to low effective tax rates. These include common stocks, (especially stocks that the investor will passively hold) and passively managed stock funds such as most index funds, exchange-traded funds, and tax-managed funds. Non-income producing real estate is another desirable asset to hold in taxable accounts, since tax payments on the land could be included in itemized deductions.

Conclusions

This study points out flaws in the traditional approach to calculating an individual's asset allocation. The traditional approach fails to distinguish between pretax funds and after-tax funds. Tax-deferred accounts contain pretax funds, Roth IRAs contain after-tax funds, and taxable accounts usually contain primarily after-tax funds. The traditional approach thus compares apples to oranges. This study advocates calculating an after-tax asset allocation, where we first convert assets' market values to after-tax values and then base the asset allocation on these after-tax values. Consequently, the after-tax asset allocation compares apples to apples.

Separately, this study performs portfolio optimizations that use the after-tax asset allocation framework, which recognizes that an asset's location affects both its after-tax returns and after-tax risk. Once we adopt this framework, and assume that capital gains or dividends are taxed at lower rates than ordinary income, there is an optimal asset location: locate bonds in retirement accounts and stocks in taxable accounts, while attaining the target asset allocation. An exception to this rule is that liquidity reserves must be held in taxable accounts.

The importance of the asset location decision increases with the spread between the ordinary income tax rate and the effective tax rate on stocks held in taxable accounts. Thus, asset location should be most important to individuals in high tax brackets who attain a high degree of tax efficiency by passively managing stocks in their taxable accounts. Consequently, the asset location decision is not only important in its own right, but also important in that it highlights the importance of managing stocks tax efficiently.

Endnotes

1. I thank Jeffrey Horvitz for this analogy.
2. Horan (2006) examines withdrawal strategies in retirement from tax-deferred accounts and Roth IRAs. He, too, emphasizes that a dollar in a tax-deferred account is like (1 – *tn*) dollar in a Roth IRA. In a progressive tax rate system, he advocates a strategy of withdrawing funds from tax-deferred accounts to use "low" marginal brackets and then withdrawing additional funds from a Roth IRA. His strategy follows directly from the idea that the government "owns" *tn* of the tax-deferred account's principal, so the individual should withdraw funds from the these accounts whenever tn is low. Separately, Spitzer and Singh (2006) report the "surprising" and "counter-intuitive" conclusion that in the presence of a flat tax rate "it does not matter in which order withdrawals are taken from a tax-deferred or tax-exempt account, all else being equal." That is, retirees should be indifferent between withdrawing funds from a Roth IRA and then a traditional IRA or a traditional IRA and then a Roth IRA. This conclusion follows directly from the ideas that $1 in a tax-deferred account is like (1 – *tn*) dollar in a Roth and the investor owns (1 – *tn*) of the tax-deferred account's principal, but receives all returns and bears all risk.
3. If the dividend yield is constant, then the volatility in annual return is due entirely to the capital gain. In this case, the volatility of after-tax returns is due entirely to the capital gain portion of return, and the exempt investor bears all risk. Even if the dividend yield varies, it should be clear that the exempt investor bears almost all risk.
4. Since tn is 25 percent, the $450,000 of after-tax funds in retirement accounts could be $450,000 in a Roth IRA, $600,000 of pretax funds (that is, $450,000 of after-tax funds) in tax-deferred accounts, or some combination of the two.
5. This framework implicitly assumes that the expected pretax returns on bonds and stocks are the same whether they are held in taxable or retirement accounts. That is, it assumes the investment options in retirement accounts are as desirable as the options in taxable accounts.

6. This is the conditional optimal portfolio based on 1 percent increments to the assets' weights. Thus, Portfolio 3 has a higher utility than portfolios containing 18 percent or 20 percent in stocks held in taxable accounts and 37 percent or 35 percent in bonds held in taxable accounts.
7. Qualified dividends are currently scheduled to be taxed as ordinary income after 2010.
8. This asset location argument holds for all utility functions. For example, Dammon, Spatt, and Zhang (2004) and Reichenstein (2001a) used three different utility functions. But this asset location argument holds as long as any part of stock returns is taxed at a rate below the ordinary income tax rate.

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