TAXATION AND HOUSEHOLD ASSET LOCATION AND ALLOCATION: EVIDENCE FROM THE BUSH TAX ACTS

Daeyong Lee[†]

University of Washington

JOB MARKET PAPER

October 2012

ABSTRACT

By exploiting the structural tax rate changes created by the Bush-era tax acts in 2001 and 2003, this study offers a first direct investigation of how the differential taxation of financial assets affects households' asset location and allocation into taxable and tax-deferred accounts in a natural experimental framework. Because bonds are heavily taxed assets, relative to stocks, and tax treatments of financial assets in tax-deferred accounts differ from those in taxable accounts under U.S. federal tax laws, households' tax burdens vary depending on which account they use for their asset holdings. Relying on the tax arbitrage model, this study identifies optimal asset locations in taxable and tax-deferred accounts; the household should hold only assets with the heavily taxed asset (taxable bonds) in the tax-deferred account and mixed assets in a taxable account with the desired risk exposure. The empirical results, based on the Survey of Consumer Finances data, indicate that households with greater tax rate differentials between interest (bonds) and capital gains (stocks) hold significantly lower shares of bonds in taxable accounts and greater shares of bonds in tax-deferred accounts by "risk-preserving" portfolio changes. These households also hold significantly more shares of stocks in their taxable portfolio. These findings are consistent with the predictions of the tax arbitrage model, such that tax arbitrage provides profits from changing asset locations depending on the difference in tax rates between bonds and stocks, and these profits increase as the tax rate differential between bonds and stocks (i.e., the tax disadvantages of bonds relative to stocks) increases. These findings also support the idea of households' tax-motivated asset allocation decisions, based on the after-tax capital asset pricing model (CAPM).

Keywords: Tax arbitrage, Asset location, Taxable and tax-deferred accounts

JEL classification: D14, G11, H24, H31

[†] Department of Economics, University of Washington, Seattle, WA 98195-3330. E-mail: daeyong@uw.edu

* I am indebted to my advisor, Neil Bruce, for his guidance and encouragement. I am also grateful for valuable comments from Terry Shevlin, Eric Zivot, Seik Kim, and the participants of the public finance seminar at the University of Washington. I thank Daniel R. Feenberg at the NBER for helping me solve the issues with TAXSIM. I gratefully acknowledge the Henry T. Buechel Fellowship and the Grover and Creta Ensley Fellowship for financial support. All remaining errors are my own.

1. INTRODUCTION

As the number of tax-deferred savings accounts has grown, households also have come to face the need to deliberate about which savings account to use for financial asset holdings and how much to invest in each asset.[1] Incomes obtained from financial assets in tax-deferred accounts incur no tax liabilities until withdrawal; financial incomes in taxable accounts are taxed every year. Therefore, after-tax returns vary depending on where households maintain their financial assets, that is, on their asset location decisions. This article empirically investigates whether different tax treatments across different financial assets affect households' asset location decisions in taxable and tax-deferred accounts, and, if so, how households respond.

Regarding the asset location and allocation problem, Shoven (1999) outlined joint portfolio decisions, with the suggestion that holding heavily taxed bonds in tax-deferred accounts and less heavily taxed stocks in taxable accounts could minimize the tax burdens generated from the income of each asset. Thus, households should not hold highly taxed assets in taxable accounts if the desired holdings of those highly taxed assets do not exceed the capacity of tax-deferred accounts. This strict pecking order of asset holdings relies on the tax arbitrage argument, as proposed by Black (1980) and Tepper (1981) and followed by Auerbach and King (1983): If households have room to replace low-taxed assets in tax-deferred accounts with high-taxed assets held elsewhere, they make tax arbitrage profits by relocating the assets. The highest taxed asset should be always located in tax-preferred accounts before any lower taxed assets can be replaced there. Portfolio allocations thus are "tax efficient" when it is not possible to replace low-taxed assets in tax-deferred accounts with high-taxed assets held elsewhere.

[1] For example, tax-deferred assets in IRAs, self-employed plans, and employer-based defined contribution plans such as 401(k) and 403(b) amounted to almost $8.5 trillion in 2007. Also, 58.7 million households held positive amounts of financial assets in both taxable and tax-deferred accounts and decided where to locate their assets.

Several studies provide empirical evidence about households' actual asset location decisions that indicates they deviate from the suggestion of tax arbitrage arguments in practice. Bodie and Crane (1997) find that many investors maintain significant amounts of money in both taxable and tax-deferred accounts and that a large portion of them do not take advantage of the potential tax arbitrage benefits of optimal asset locations. Other studies (Barber and Odean, 2004; Bergstresser and Poterba, 2004; Poterba and Samwick, 1997, 2003) indicate that portfolio choices by U.S. households substantially deviate from tax-efficient asset locations; they keep both stocks and bonds in each account type and often maintain higher shares of stocks in their tax-deferred accounts. This discrepancy is referred to as the "asset location puzzle."

To resolve it, Amromin (2003) considers a model that includes uninsurable labor market risk and institutional rules regarding penalties on early withdrawal from tax-deferred accounts. He shows that holding taxable bonds in taxable accounts can be optimal for households with labor income shocks that thus need liquidity. Related studies (Dammon, Spatt and Zhang, 2004; Zhou, 2009) consider limitations on the set of investment options available to households, or the credit constraints of borrowing and short selling. In such settings, tax is only one of the factors that affects households' asset location decisions. Models with labor income risk or accessibility restrictions improve on the uniformly tax-efficient corner solutions of the model. That is, considerations of an early withdrawal penalty, transaction costs, or liquidity constraints in the model make it optimal for some households to hold high-taxed but riskless assets (bonds) in taxable accounts.

Although many past studies investigate which determinants affect household asset location decisions and how, a substantial gap remains between the theoretical model and the empirical findings. The preceding empirical studies performed extensive Monte Carlo simulations and

calibrations to gain an idea of how each possible factor affects households' asset location decisions, or else undertook cross-tabulations to describe the patterns of households' asset locations in recent years. No extant literature offers any empirical analysis of households' asset location decisions in a natural experimental framework, relying on the tax arbitrage model.

This article offers the first direct investigation of how the differential taxation of financial assets affects households' asset location in taxable and tax-deferred accounts with a tax arbitrage model. Using the 1998 and 2007 Surveys of Consumer Finances (SCF) data, I explore households' asset location patterns and relate these patterns to household characteristics, especially household marginal tax rates on interest and capital gains. To address the endogenous tax rates, I exploit the exogenous changes in tax rates created by the Bush tax acts in 2001 and 2003; they dramatically reduced the tax rates on interest, dividends, and long-term capital gains. The Tobit estimates suggest that households with greater tax rate differentials between interest income and capital gains (i.e., greater tax disadvantage of bonds relative to stocks) hold significantly higher shares of bonds in tax-deferred accounts and lower shares of bonds in taxable accounts. These empirical findings are consistent with the prediction of the tax arbitrage model, in support of the idea of households' tax-motivated asset allocation decisions. According to the after-tax capital asset pricing model (CAPM), households that face high tax rate differentials between bonds and stocks maintain portfolios tilted toward lightly taxed assets (stocks) and away from more heavily taxed assets (bonds) in their taxable accounts.

In addition, using Tobit estimates, it is possible to assess the impact of the Bush tax acts on households' asset location in taxable and tax-deferred accounts. The reduced tax rates for capital gains were greater than the reduction for interest, so bonds have become more tax-disadvantaged relative to stocks after the 2001 and 2003 tax acts. This feature induces households to shift their

heavily taxed bonds from taxable to tax-deferred accounts as a tax shelter. I quantify the magnitude of these asset location changes resulting from tax rate changes due to the tax acts.

From a theoretical perspective, I construct and use a new tax measure—tax rate differentials between interest income (bonds) and capital gains (stocks)—relying on the tax-arbitrage model, according to which investors move taxable bonds from taxable accounts to tax-deferred accounts to make tax-arbitrage profits, which increase as the tax rate differentials between bonds and stocks increase. Prior studies of the tax effects on households' asset location have used marginal tax rates on ordinary income, which cannot precisely measure the tax effects on households' asset location decisions, because they ignore different tax treatments across different financial assets. In contrast, the proposed new measure reflects the different tax treatments between bonds and stocks, which is critical to estimate the precise tax effects on households' asset locations in taxable and tax-deferred accounts. The new measure also can capture the effects of different tax treatments on households' asset allocation by reflecting the tax disadvantages of bonds over stocks.

In Section 2, I explain the tax arbitrage that derives from a change in asset location and derive the optimal asset location in taxable and tax-deferred accounts. There is a strong preference for holding taxable bonds in tax-deferred accounts and stocks in taxable accounts. Section 3 summarizes the major changes in tax rates made by the Bush tax acts. Section 4 describes the SCF data and explains the TAXSIM program that calculates the marginal tax rates from the survey data. In Section 5, I outline the empirical model for analyzing how different tax treatments among different financial assets affect households' asset location in taxable and tax-deferred accounts. Section 6 contains the empirical findings about the effects of tax rate differentials on households' asset location decisions. A brief conclusion appears last.

2. TAX ARBITRAGE FROM ASSET LOCATION

In this section, I use the tax arbitrage argument to derive the optimal location of asset holdings, in line with studies by Shoven and Sialm (2004) and Dammon, Spatt, and Zhang (2004). The tax arbitrage approach considers a *risk-preserving* change in the asset location to determine whether the after-tax returns on an investor's portfolio can be improved. The investor's main objective is to maximize the expected utility of after-tax wealth by holding assets in the right location.

2.1. No Borrowing or Short-Sale Constraints

The optimal asset allocation moves all tax-deferred wealth to the asset with the highest pre-tax yield. Investors then adjust the asset holdings in their taxable accounts, by borrowing or selling short if necessary, to achieve their optimal overall risk exposure. To derive this result, assume that investors must realize all capital gains each year and have unrestricted borrowing and short-sale opportunities in taxable accounts.[2]

Let the tax rates on ordinary income (dividends and interest) be τ_b, the tax rates on capital gains be τ_{cg}, the random pre-tax capital gain return on asset *i* be $\tilde{g}_i$, and the constant pre-tax yield on asset *i* be d_i. The yield is defined as the fraction of total asset value distributed as either dividends or interest. The random pre-tax return on asset *i* then can be expressed as $\tilde{r}_i = d_i + \tilde{g}_i$. For risky stocks (asset *s*), the random pre-tax return is $\tilde{r}_s = d_s + \tilde{g}_s$. For example, assume a stock that an investor purchases is priced at \$10 and the investor is paid \$4 as dividends. Then suppose that the stock price increases to \$12 in the next period. The dividend yield (d_s) on the stock is 0.4 $\left(\frac{\$4}{\$10}\right)$, and the pre-tax capital gain return ($\tilde{g}_s$) is 0.2 $\left(\frac{\$12-\$10}{\$10}\right)$. Thus, the pre-tax return ($\tilde{r}_s$)

[2] The main result still holds when investors realize part of their capital gains. With an assumption of partial capital gains realization, the only difference in the analysis would be to replace the statutory tax rates on capital gains with the effective tax rates.

on the stock is 0.6 $\left(\frac{\$12+\$4-\$10}{\$10}\right)$, which is the same as the return derived from $d_s + \tilde{g}_s$ $(= 0.4 + 0.2)$. Taxable bonds (asset b) are assumed to have no random capital gains ($\tilde{g}_b = 0$) and distribute only interest ($d_b = r$). Thus, the pre-tax return on taxable bonds is $\tilde{r}_b = r$, which is non-random (i.e., riskless).

Consider another investor with positive holdings of both riskless taxable bonds and risky stocks in taxable and tax-deferred accounts. The investor implements a risk-preserving portfolio change, such that a shift of one after-tax dollar from risky stocks to the riskless taxable bonds in the tax-deferred account is offset by a shift of x_s dollars from the riskless taxable bonds to risky stocks in the taxable account. This change in the location of the asset holdings leads to the following change in the investor's total wealth in the next period:

$$\begin{aligned}\Delta\tilde{w} &= \tilde{w}^{TDA}(marginal\ wealth\ change\ in\ Tax-Deferred\ Account)\\ &\quad +\tilde{w}^{TA}(marginal\ wealth\ change\ in\ Taxable\ Account)\\ &= [\mathrm{r}-(d_s+\tilde{g}_s)]+x_s\left[\{d_s(1-\tau_b)+\tilde{g}_s(1-\tau_{cg})\}-r(1-\tau_b)\right]. \qquad (1)\end{aligned}$$

If $x_s = \frac{1}{1-\tau_{cg}}$,[3] it is easy to show that for all possible values of random capital gains ($\tilde{g}_s$), the change in the investor's total wealth in the next period is given by

$$\Delta\tilde{w} = \frac{(r-d_s)(\tau_b-\tau_{cg})}{1-\tau_{cg}} = x_s(r-d_s)(\tau_b-\tau_{cg}). \qquad (2)$$

Because $\Delta\tilde{w}$ is independent of the random pre-tax capital gains ($\tilde{g}_s$), it represents a risk-free after-tax payoff that can be generated by simply shifting the location of the asset holdings. If $\Delta\tilde{w}$ is positive (i.e., the investor's total wealth increases after the change in asset location), the investor is strictly better off holding taxable bonds in the tax-deferred account and stocks in the

[3] This asset location change decreases financial risk by $\tilde{g}_s$ in tax-deferred accounts and increases it by $x_s[\tilde{g}_s(1-\tau_{cg})]$ in taxable accounts. Thus, the investor can preserve its risk exposure by setting $x_s = \frac{1}{1-\tau_{cg}}$.

taxable account.[4] If $\Delta\tilde{w}$ is negative, the investor is strictly worse off moving taxable bonds into the tax-deferred account.

The sign of $\Delta\tilde{w}$ depends on the sign of $(r - d_s)(\tau_b - \tau_{cg})$, because the amount of risk-adjusted money (x_s) is strictly positive. Thus, the investor prefers to allocate all tax-deferred wealth to the asset with the highest yield and holds all other assets in the taxable account, as long as $\tau_b > \tau_{cg}$.[5] After allocating the entire tax-deferred wealth to the asset with the highest yield, the investor adjusts the asset holdings with the targeted risk exposure in the taxable account by borrowing or selling short.[6]

The changes in the tax rates instituted by the Bush-era tax acts caused dividends and capital gains income to be taxed at the same rate, whereas interest income was taxed at the higher rate (i.e., $\tau_b > \tau_d = \tau_{cg}$). Then, Equation (2) becomes $\frac{r(\tau_b - \tau_{cg})}{1-\tau_{cg}}$, and the sign only depends on $\tau_b - \tau_{cg}$, which is positive in the U.S. tax system. In this case, it is optimal for the investor to hold taxable bonds in the tax-deferred account, regardless of the dividend yield on stocks. In summary, the investor must place the heaviest taxed asset (taxable bonds) in the tax-deferred account before any lower taxed assets are replaced there. This asset location policy provides the investor with the highest level of tax efficiency while maintaining the desired risk exposure of the overall portfolio. The tax arbitrage profit from the change in the asset location $(\Delta\tilde{w})$ increases monotonically with the tax rate differential between interest income and capital gains $(\tau_b - \tau_{cg})$.

---

[4] Because wealth in the tax-deferred account might be more valuable than wealth in the taxable account, there is no guarantee that the change in the expected utility of total wealth has the same sign as the change in the final wealth $(\Delta\tilde{w})$ if the taxable and tax-deferred account are affected differently. Appendix A contains a proof that shows that the change in the expected utility has the same sign as the change in total wealth.

[5] Under U.S. federal tax laws, tax rates on bonds are greater than tax rates on capital gains.

[6] The SCF data do not contain information about a coupon rate of each bond and a dividend yield on each stock that households hold in their portfolio. Thus, I conventionally assume that the asset with the highest yield is the taxable bond, because the historical data from 1998 to 2007 show that the pre-tax interest rate for T-bills is around 4.85%, higher than the S&P 500 dividend yield on average (1.55%).

2.2. Borrowing Constraints and Liquidity Needs

With unrestricted borrowing and short-sale constraints, the investor optimally holds only assets with the heaviest taxed asset (taxable bonds) in the tax-deferred account and mixed assets in the taxable account with the desired risk exposure by borrowing or selling short. If the investor has restrictions on borrowing and short selling, the investor holds the heaviest taxed asset in the tax-deferred account until he or she reaches borrowing or short-sale constraints in the taxable account. Then, the investor begins to allocate the remaining tax-deferred wealth to the next heaviest taxed asset, until the restrictions again bind. The investor keeps allocating to successively lower taxed assets in the tax-deferred account until he or she completely allocates his or her tax-deferred wealth. Thus, under the borrowing and short-sale restrictions, an investor may hold a mix of taxable bonds and stocks in the tax-deferred account.

Although the optimal asset location policy maximizes the tax efficiency of the portfolio, it also increases the portion of risky assets in the taxable account. An investor with relatively little taxable wealth or facing labor income shocks may wish to control taxable wealth to guarantee a minimum level of consumption. In this case, the investor has a reason to hold more heavily taxed but riskless bonds in the taxable account. Thus, liquidity needs can affect households' optimal asset location (i.e., tax-efficient corner solutions are not optimal with liquidity considerations).

For example, consider an investor who holds a mix of taxable bonds and stocks in the tax-deferred account and stocks in the taxable account. As long as taxable bonds have higher tax rates than stocks, this asset location is tax efficient without the liquidity consideration. Consider the risk-preserving change in the location of asset holdings. The investor shifts one after-tax dollar from taxable bonds to stocks in the tax-deferred account and $x_b \left(= \frac{1}{1-\tau_{cg}}\right)$ dollars from stocks to taxable bonds in the taxable account. Although this asset shift is tax inefficient, it

reduces the share of risky assets in the taxable account and potentially increases the funds to finance unexpected liquidity shocks. Thus, the investor is less likely to withdraw money from the tax-deferred account by paying the penalty. The marginal increment in the taxable wealth due to the shift from stocks to taxable bonds is

$$\widetilde{\Delta w}^{TA} = x_b\left[r(1-\tau_b) - \left\{d_s(1-\tau_b) + \tilde{g}_s\left(1-\tau_{cg}\right)\right\}\right] \equiv \tilde{G}^{TA}. \tag{3}$$

The marginal change in the tax-deferred wealth from shifting taxable bonds to stocks is

$$\Delta\widetilde{w}^{TDA} = \left[\frac{1-\tau_b}{1-\tau_b-f}\right]\widetilde{\Delta w}^{TA}\tilde{S} - [r-(d_s+\tilde{g}_s)] = \left[\frac{1-\tau_b}{1-\tau_b-f}\right]\tilde{G}^{TA}\tilde{S} - \tilde{G}^{TDA}, \tag{4}$$

where f is the penalty per dollar withdrawn from the tax-deferred account, $\tilde{G}^{TDA} \equiv [r-(d_s+\tilde{g}_s)]$, and $\tilde{S}$ is the indicator for an income shock. The indicator $\tilde{S}$ is equal to 1 if the investor cannot deal with the income shock using only his or her taxable wealth, and 0 otherwise. The incremental wealth in the tax-deferred account decomposes into two parts. The first term in Equation (4) indicates the marginal change in the tax-deferred wealth from being withdrawn to finance a shortfall in the taxable account when the investor has a large income shock. The second term in Equation (4) is the marginal change in the tax-deferred wealth from the differential pre-tax returns on taxable bonds and stocks.

Because the investor wants to maximize the expected utility of after-tax wealth, it is necessary to check the change in expected utility that arises from such as shift in asset location (which thereby changes the after-tax wealth). The change in expected utility by holding a mix of taxable bonds and stocks in the taxable account is

$$\begin{aligned}\Delta\mathrm{E}\left[\widetilde{U}\right] &= \mathrm{E}\left[\widetilde{U}'\Delta\widetilde{W}^{TA}\right] + \lambda E\left[\widetilde{U}'\Delta\widetilde{W}^{TDA}\right] \\ &= \mathrm{E}\left[\widetilde{U}'\tilde{G}^{TA}\right] + \left[\frac{\lambda(1-\tau_b)}{1-\tau_b-f}\right]E\left[\widetilde{U}'\left(\tilde{G}^{TA}\tilde{S}\right)\right] - \mathrm{E}\left[\widetilde{U}'\tilde{G}^{TDA}\right] \\ &= \mathrm{E}\left[\widetilde{U}'\tilde{G}^{TA}\right] + \left[\frac{\lambda(1-\tau_b)}{1-\tau_b-f}\right]E\left[\widetilde{U}'\left(\tilde{G}^{TA}\tilde{S}\right)\right],\end{aligned} \tag{5}$$

where λ is the shadow price of taxable wealth per dollar of tax-deferred wealth, and $\mathrm{E}[\tilde{U}'\tilde{G}^{TDA}] = 0$, by the assumption that the investor is indifferent between taxable bonds and stocks at the margin in the tax-deferred account. Because $\tilde{G}^{TDA} - \tilde{G}^{TA}$ is equal to $x_b[(r - d_s)(\tau_b - \tau_{cg})]$, it is the positive, risk-free, after-tax payoff, as denoted by *P*. This reasoning implies

$$\mathrm{E}[\tilde{U}'\tilde{G}^{TA}] = \mathrm{E}[\tilde{U}'(\tilde{G}^{TDA} - P)] = -P\mathrm{E}[\tilde{U}']. \tag{6}$$

Substituting into Equation (5) yields

$$\Delta\mathrm{E}[\tilde{U}] = -P\mathrm{E}[\tilde{U}'] + \left[\frac{\lambda(1-\tau_b)}{1-\tau_b-f}\right] E[\tilde{U}'(\tilde{G}^{TA}\tilde{S})] = \left[\left(\frac{\lambda(1-\tau_b)}{1-\tau_b-f}\right)\bar{E}[\tilde{G}^{TA}\tilde{S}] - P\right] E[\tilde{U}'], \tag{7}$$

where $\bar{E}$ is the expectation operator under a risk-neutral measure. The value of $\Delta\mathrm{E}[\tilde{U}]$ is positive when $\bar{\mathrm{E}}[\tilde{G}^{TA}\tilde{S}] > P\left[\frac{(1-\tau_b-f)}{\lambda(1-\tau_b)}\right]$. A notable element of Equation (7) is that investors who have enough taxable wealth to deal with the income shock without drawing the fund from the tax-deferred account ($\tilde{S} = 0$ with certainty) or who are certain to have big income shocks that require them to access the tax-deferred account ($\tilde{S} = 1$ with certainty) are strictly worse off (i.e., $\Delta\mathrm{E}[\tilde{U}] < 0$) when they hold taxable bonds in the taxable account to meet their liquidity needs.

The preceding analysis suggests that liquidity needs can influence the asset location decision. However, it is not likely to be a major concern for most investors, who generally have some non-financial income and ability to borrow to smooth their consumption levels. On the whole, liquidity needs alone likely cannot generate significant demand for taxable bonds in the taxable account. Thus, this study focuses on the tax effects on households' asset location decisions by controlling for borrowing constraints and liquidity considerations. The tax arbitrage profits from the change in asset locations increase (i.e., opportunity costs of having stocks in the tax-deferred

account increase) as the tax rate differentials ($\tau_b - \tau_{cg}$) increase. Therefore, I expect that the investor with the greater tax rate differential (i.e., stronger incentive to shelter taxable bonds into the tax-deferred account) will hold a higher share of bonds in the tax-deferred account, whereas there will be a lower share of bonds in the taxable account due to the risk-preserving portfolio changes. According to the after-tax CAPM, the investor with the greater tax rate differential prefers to hold the low-taxed asset in the taxable account and thus should hold a higher share of stocks in the taxable accounts. The study hypotheses are as follows:

H_1: A household with a greater tax rate differential between bonds and stocks holds a higher share of bonds in tax-deferred accounts.
H_2: A household with a greater tax rate differential between bonds and stocks holds a lower share of bonds in taxable accounts.
H_3: A household with a greater tax rate differential between bonds and stocks holds a higher share of stocks in taxable accounts.

3. THE BUSH TAX ACTS

Two major federal tax laws were passed during the presidency of George W. Bush: the Economic Growth and Tax Relief Reconciliation Act of 2001 (EGTRRA) and the Jobs and Growth Tax Relief Reconciliation Act of 2003 (JGTRRA). Prior to the passage of EGTRRA, the federal income tax rate structure consisted of five tax brackets, ranging from 15% to 39.6%. Then EGTRRA introduced a new 10% tax bracket and reduced individual income tax rates by 1%. Next, JGTRRA continued this precedent by accelerating tax rate reductions on dividends and capital gains. Table 1 summarizes the changes in the statutory tax rates on ordinary income, dividends, and long-term capital gains due to ETRRA and JGTRRA.

— Insert Table 1 about here —

As Table 1 reveals, the JGTRRA legislation contained several key provisions. First, it reduced most marginal tax rates on ordinary income above 15% by 2% and reduced the top marginal tax rate by 3.6%. These tax rate reductions had already been included in EGTRRA but

were scheduled to go into effect gradually, with a 1% rate reduction in 2004 and the remainder in 2006. Under JGTRRA, the scheduled reductions all occurred in 2003. Second, the marginal tax rates on long-term capital gains were reduced from 20% to 15% at the top income bracket and from 10% to 5% (and then to 0% in 2008) for the bottom income bracket. Third, dividends were taxed differently, depending on their category. Qualified dividends were paid by U.S. corporations or qualified foreign corporations and required investors to hold the stocks for more than 60 days. If the dividends were qualified, they were taxed at the long-term capital gain tax rates rather than at ordinary income tax rates. Thus, the marginal tax rates on qualified dividends dropped dramatically, from 35% to 15% at the top income bracket and from 10% to 5% at the bottom bracket, after JGTRRA. In contrast, ordinary dividends continued to be taxed at the level of ordinary income tax rates.

As a result of these changes in the statutory tax rates on ordinary income, capital gains, and dividends, the differentials in the tax rates between interest income and capital gains increased. That is, the tax disadvantages of bonds relative to stocks were bigger after JGTRRA. Figure 1 shows the change in tax rate differentials between interest and capital gains over the different income tax brackets. Because EGTRRA and JGTRRA provide exogenous variation in tax rates, I can use these structural changes to address the endogeneity problem of the marginal tax rates in Section 5.

— Insert Figure 1 about here —

4. DATA DESCRIPTION AND SUMMARY STATISTICS

The Survey of Consumer Finances (SCF) is a triennial data collection conducted by the Federal Reserve Board. The SCFs contain repeated, cross-sectional data and provide complete and disaggregate information on the portfolios held by a large sample of U.S. households. The

asset holdings across all financial intermediaries in the data make it possible to study the overall structure of the household portfolio, rather than just the structure of the components held at a single financial institution. The data also contain information about households' demographic characteristics, attitudes toward investment risk and financial decisions, and financial credit. The SCF data reflect an area-based probability sample of the U.S. population and households drawn from an Internal Revenue Service file of high-income returns. They oversample high-income households to identify the households' asset location behavior, in that financial asset holdings are strongly concentrated at the top of the income distribution. Sampling weights also are included in the SCF, so the estimates are weighted to represent the U.S. household population.[7]

The 1998 and 2007 SCF data appear in the empirical analysis; this data sample contains only households that hold assets in both tax-deferred and taxable accounts, considering the focus in this study on how different tax treatments among different financial assets affect a household's asset location in taxable and tax-deferred accounts. The sample also excludes households with negative tax rates on ordinary income and capital gains.[8] The number of observations in the data set is five times the actual number of respondents, because a multiple imputation technique replaces any missing values. These multiple imputations improve the precision of the point estimates by increasing the sample size. However, many statistical package programs treat each of the five replicates as independent observations, which inflates the statistical significance of the results. I correct all summary statistics, estimates, and standard errors for the multiple

[7] One disadvantage of the SCF data is that the household's state of residence is not included. Thus, it is not possible to calculate the households' state income tax rates, which also could help identify the effect of marginal tax rates on households' asset location decision in taxable and the tax-deferred accounts.

[8] Households that receive the earned income tax credits (EITC) and realize net capital losses have negative tax rates on ordinary income and on capital gains, respectively.

imputations.[9] Table 2 presents the summary statistics of households' tax rates, financial incomes, and demographic characteristics.

— Insert Table 2 about here —

4.1. Estimating the Marginal Tax Rates for SCF Households

The SCF data include detailed information on households' tax filing, adjusted gross income, and deductions but not the household's tax rates, for confidentiality reasons. To determine marginal tax rates, I used the TAXSIM web program at the National Bureau of Economic Research (NBER), which computes federal marginal tax rates on ordinary incomes and capital gains using relevant information provided by the SCF data.[10]

Next, using the statutory tax rates on capital gains from TAXSIM, I constructed the effective tax rates on capital gains. Poterba (1999) argues that the relevant capital gains tax rates may not be the statutory rates but rather the effective tax rates reflecting the deferral of capital gains realization. Because taxes are levied on realized capital gains, not accrued ones, investors can avoid capital gains taxes by deferring their capital gains realization. Unrealized capital gains also qualify for a "stepped-up" basis when investors defer their capital gains realization until death.[11] The deferral of capital gains tax and the "stepped-up" basis make the effective tax rates on long-term capital gains lower than the statutory tax rates. Previous studies (e.g., Ivković, Poterba and Weisbenner, 2005; King, 1984) that use effective tax rates on capital gains suggest that statutory tax rates on capital gains should be halved by the tax-deferral provision and then halved again by the "stepped up" basis provision. Thus, 25% of the statutory tax rates are used as the effective

[9] The SCF codebook provides the programming codes to correct for the inflated statistical significance from the multiple imputations. See Kennickell (1988) for detailed explanations of the imputation procedure in the SCF.
[10] The NBER's FORTRAN program, TAXSIM calculates tax liabilities and marginal tax rates under U.S. federal and state income tax laws from individual data. It is available at http://www.nber.org/~taxsim/. To convert the public SCF data into the variables required for TAXSIM, I used programming codes provided at the NBER website (http://www.nber.org/~taxsim/to-taxsim/scf/). Further procedures are explained in Appendix B.
[11] Bailey (1969) estimates that this provision reduced the effective tax burden on capital gains by about 50%.

tax rates on the capital gains in the estimation.[12]

To perform the analyses of households' asset location decisions, I construct a new tax measure, defined as the difference between the tax rates on interest and the effective tax rates on capital gains. Because tax arbitrage profits from changing the asset location rely on the tax rate differentials between interest income and capital gains, as discussed in Section 2, this new measure precisely captures the effects of the different tax treatments between bonds and stocks on households' asset location in taxable and tax-deferred accounts. The new tax measure also reflects the tax disadvantages of taxable bonds over stocks. The tax rate differentials thus can measure the effect of the different tax treatments between the different financial assets on households' asset allocation decisions. As the tax rate differential between interest and capital gains increases, so does the tax disadvantage of taxable bonds over stocks. This increase in tax rate differentials causes households to move their bonds from taxable to tax-deferred accounts.

4.2. Defining Financial Asset Categories

Financial assets are classified into six categories, on the basis of their tax treatments: bonds held in tax-deferred accounts, stocks held in tax-deferred accounts, taxable bonds, taxable stocks, tax-exempt bonds such as municipal bonds, and interest-bearing accounts. For most types of tax-deferred accounts, the SCF data ask respondents whether the account is invested all in stocks, all in interest-earning assets/bonds, split (and what percentage is in stocks), in real estate, in insurance, or other. This information serves to construct the asset composition of tax-deferred accounts. I describe these asset categories and their different tax treatments in more detail next.

4.2.1. Assets held in tax-deferred accounts

[12] Using the 25% of statutory tax rates for effective capital gains tax rates is a long-established convention in prior literature. The main empirical results still hold when the statutory tax rates on capital gains are used in the estimation. The estimates using the statutory tax rates are presented in Section 6.3.

This category includes all assets held in individual retirement accounts (IRAs), Keogh plans for the self-employed, and defined contribution plans, including 401(k) plans and employee stock ownership plans (ESOPs). Stocks held in tax-deferred accounts include the total value of stocks held directly or in mutual funds. Bonds in tax-deferred accounts include all of the interest-earning assets and bonds, as well as assets not specifically coded as equity.[13] Interest income and capital gains within tax-deferred accounts incur no tax liabilities until withdrawal. This deferral allows households to accumulate their retirement wealth at pre-tax rates of return.

4.2.2. Taxable bonds

This category includes federal government bonds, corporate bonds, certificates of deposit, and foreign bonds outside tax-deferred accounts, whether held directly or through mutual funds. Interest income within taxable accounts is taxed each year at the household's ordinary income tax rate.

4.2.3. Taxable stocks

This category includes all holdings of stocks outside tax-deferred accounts, whether directly held or in mutual funds, including brokerage accounts, investment clubs, and shares in a household's current employed company. Dividend income outside tax-deferred accounts is taxed each year at the household's ordinary income tax rate. Long-term realized capital gains are taxed at the household's capital gains tax rate. Short-term capital gains are taxed as ordinary income upon realization. The tax treatment of mutual fund dividends and realized capital gains is very similar to that of directly held stocks.[14]

4.2.4. Tax-exempt bonds

[13] Hardly any TDA assets are held in real estate, insurance, or other.

[14] The tax treatment of mutual funds is slightly heavier than that of directly held stocks because mutual funds generate short-term and long-term capital gains even if investors do not sell the stocks.

This category includes savings bonds and tax-exempt bonds, such as state and municipal bonds outside tax-deferred accounts. Although interest income from these assets is not taxed, coupon rates are lower relative to taxable bonds. Thus, holders of tax-exempt bonds pay implicit taxes, and this effective tax burden on tax-exempt bonds is the yield spread between comparable taxable bonds and tax-exempt bonds. Considering this aspect, the savings bonds, state bonds, and municipal bonds are classified as tax-exempt bonds.

4.2.5. Interest bearing accounts

This category includes checking accounts, saving accounts, and money market accounts that are not tax-exempt. Income within these accounts is taxed at the household's ordinary income tax rate. The main purpose of having these accounts is for short-term financial transaction and liquidity reasons, not for getting favorable tax treatment.[15]

4.3. Summary Information on Asset Holdings

Table 3 reveals the ownership of each asset category in the SCF data sample. First, there were substantial changes in the ownership of tax-deferred assets between 1998 and 2007. The ownership of bonds in tax-deferred accounts rose by 5%, whereas the probability of holding stocks in them fell by 4% between 1998 and 2007. Second, the probability of holding taxable bonds dropped by 6% during 1998–2007. In contrast, ownership of taxable stocks increased by 3%. Third, ownership of tax-exempt bonds, such as municipal and savings bonds, fell by 2%.

— Insert Table 3 about here —

Table 4 presents more detailed information on households' financial asset holdings in both taxable and tax-deferred accounts. The share of bonds held in tax-deferred accounts was 20.96% in 1998 and increased to 23.93% in 2007. As this pattern reflects, the asset allocation in tax-

[15] Because this category is not of interest for this study, it is excluded from the estimation.

deferred accounts shifted toward bonds and away from stocks, resulting from the Bush tax acts, which increased the tax disadvantages of bonds during 2001–2003. Thus, the share of bonds held outside tax-deferred accounts fell from 16.76% to 13.88%, whereas the share of stocks held in taxable accounts rose from 29.23% to 31.35%. Table 4 also shows the percentage of households that held positive amounts of financial assets in taxable or tax-deferred accounts. The percentage of households that held bonds or stocks in tax-deferred accounts rose from 50.77% to 56.86%, and the percentage of households with bonds, stocks, or tax-exempt bonds outside tax-deferred accounts also increased from 51.83% to 54.81%.

— Insert Table 4 about here —

5. ECONOMETRIC FRAMEWORK

To estimate how the different tax treatments among different financial assets affected households' asset location in taxable and tax-deferred accounts, I used the Tobit model for asset shares in the taxable and tax-deferred accounts as a function of households' marginal tax rate differentials. I also controlled for households' demographic characteristics and financial risk tolerance, as discussed next. The share of each financial asset category located in an account a for household i from the survey sample t is denoted $S_{a,i,t}$. The latent variable denoted by $S^{\star}_{a,i,t}$ indicates the share of the asset that would be notionally allocated to the account. For example, for households without bonds in the tax-deferred account, the shares of bonds in the tax-deferred accounts would be censored at 0; they would be censored at 1 if households invested all their tax-deferred wealth in bonds. The resulting censored regression model, or Tobit model, is given by

$$\begin{cases} S^*_{a,i,t} = \beta_1 \tau_{i,t} + X'_{i,t}\beta_2 + \beta_3 I(Year = 2007) + \varepsilon_{i,t} \\ S_{a,i,t} = \begin{cases} 0 & if\ S^*_{a,i,t} < 0 \\ S^*_{a,i,t} & if\ 0 \le S^*_{a,i,t} \le 1 \\ 1 & if\ S^*_{a,i,t} > 1 \end{cases} \end{cases}, \quad (8)$$

where $S^*_{a,i,t}$ is the latent share of the asset; $S_{a,i,t}$ is the observed share of the asset in the account a, whether in taxable or tax-deferred accounts; $\tau_{i,t}$ is the effective marginal tax rate differential between interest and capital gains; $X'_{i,t}$ is a vector of households' characteristics; and $I(Year = 2007)$ is a dummy for the 2007 SCF sample. The vector $X'_{i,t}$ includes the age, age dummy, education, sex, marital status, risk tolerance, household size, net worth, and other income of the head of the household.[16]

The parameter of interest is β_1, or the tax effects on asset locations in taxable and tax-deferred accounts. According to the prediction of the asset location model, households with greater tax rate differentials between interest income and capital gains would hold a higher share of bonds in the tax-deferred accounts. The coefficient for the tax rate differential (β_1) should be positive (negative) for the share of bonds in the tax-deferred (taxable) accounts.

The econometrics problem for the estimation is that the households' tax rates are endogenous. The main regressor $\tau_{i,t}$ is endogenous to the asset holdings in the account because households can affect their tax liabilities and thus their marginal tax rates through portfolio choices. Previous studies of taxes and portfolio choices deal with this problem by introducing a new proxy for the marginal tax rates that investors face. Feldstein et al. (1980) constructed an algorithm, called the "first dollar" approach, that avoids the potential endogeneity of the marginal tax rates, especially

[16] There is no restriction on accessing the tax-deferred accounts if the person's age is older than 59½ years. Thus, the age dummy is equal to 1 if the investor's age is older than 59½ years and 0 otherwise. As listed in the SCF data, the head of the household is a single individual; in a couple, it is the man in a mixed-sex couple or the older member of a same-sex couple.

with regard to the relationship between tax rates and households' portfolio choices.

However, to address the endogeneity problem of the tax rates, this study instead exploited the structural tax rate changes by the Bush tax acts, because the relevant information to implement the first dollar method is only available in 1998 SCF data and because tax rates instrumented by this method may still suffer endogeneity problems when households affect marginal tax rates through their labor supply. Because education is correlated with permanent income and thus marginal tax rates, I used a dummy for educational attainment as an instrumental variable (Eissa, 1996; Kawano, 2010; Moffitt and Wilhelm, 1998).[17] Yet, the dummy for educational attainment is uncorrelated with tax arbitrage asset location behavior, because households are unable to adjust their education level in response to the Bush tax acts within a short period of time. The dummy for the educational attainment is equal to 1 if the household head has a college degree or higher and 0 otherwise. Finally, an interaction term features the dummy for educational attainment and the year dummy for the 2007 SCF data. The estimated model is as follows:

$$S^{*}_{a,i,t} = \beta_1 \tau_{i,t} + X^{'}_{i,t}\beta_2 + \beta_3 I(Year = 2007) + \varepsilon_{i,t}$$

$$\tau_{i,t} = \gamma_0 + \gamma_1 I(EDU \geq colloge) + \gamma_2 I(EDU \geq college) \times I(Year = 2007)$$

$$+\gamma_3 I(Year = 2007) + X^{'}_{i,t}\gamma_4 + \eta_{i,t}, \qquad (9)$$

where $I(EDU \geq college)$ is the indicator for a college degree or above, and the other notations are as described in Equation (8). The interaction term between the education dummy and the year dummy, $I(EDU \geq college) \times I(Year = 2007)$, supports a distinction of the households into high- and low-treatment groups, according to the magnitudes of the tax rate changes by the Bush tax reforms, which vary across households' income distributions. The non-tax factors also can

[17] Moffitt and Wilhelm (1998) show that a variable that categorizes the group on the basis of their different tax treatments can be a valid instrumental variable for the tax rate changes.

affect households' asset holdings; they are in the vector $X_{i,t}^{'}$ and controlled in the estimation. The estimates of the first stage regression are presented in Table 5. The coefficient for the interaction term between the education dummy and the year dummy is negative because the increase in tax rate differential between interest and capital gains was smaller for households in the upper tax bracket.[18]

— Insert Table 5 about here —

In addition to the Tobit model, I run a two-tiered model to distinguish the tax effects on households' asset ownership decisions (i.e., extensive margins) from the effects on the share decisions of each asset categories (i.e., intensive margins). The Tobit estimates do not distinguish these two margins, because the Tobit model assumes that the parameters governing the asset ownership decisions are the same as the ones governing the allocation of financial assets. Because the two-tiered model relaxes this assumption, it separates the tax effects on the asset location at the intensive margins from those at the extensive margins.

In the first tier, I run a probit model, which captures the tax effect on households' asset ownership decisions:

$$P_{a,i,t}^{*} = \delta_1 \tau_{i,t} + X_{i,t}^{'}\delta_2 + \delta_3 I(Year = 2007) + \nu_{i,t}\,, \tag{10}$$

where $P_{a,i,t}^{*}$ is the indicator for the positive amount of the financial asset in the account a, taxable or tax-deferred accounts. If a household holds a positive amount of the asset in the account, the dependent variable is equal to 1, and it is 0 otherwise. Thus, the probit model is:

$$\begin{aligned} P_{a,i,t} &= 1 \text{ if } S_{a,i,t}^{*} > 0 \\ &= 0 \text{ if } S_{a,i,t}^{*} = 0\,. \end{aligned} \tag{11}$$

[18] The Conditional Likelihood Ratio (CLR) confidence interval derived from the weak instrument test is smaller than the Wald confidence interval. This test result suggests that the instruments are strong enough to ensure consistent estimates.

In the second tier, I run a log-linear regression conditional on positive holdings of the asset in the account, which captures the tax effects on the asset location at the intensive margins:

$$\log\left(S^{*}_{a,i,t} \mid P_{a,i,t} = 1\right) = \theta_1 \tau_{i,t} + X'_{i,t}\theta_2 + \theta_3 I(Year = 2007) + \xi_{i,t} \,. \tag{12}$$

In the two-tiered model, the endogenity problem of the tax rates can be addressed by implementing the same instrumental variables used in the Tobit regression.

6. EMPIRICAL FINDINGS

6.1. Households' Asset Location in Taxable and Tax-Deferred Accounts: Tobit Estimates

Table 6 presents the Tobit estimates of the tax effects on households' asset locations in taxable and tax-deferred accounts. Columns (1) and (2) show the estimates for the shares of bonds in the taxable and tax-deferred accounts without using instrumental variables. Because tax rate differentials are endogenous, these estimates are not consistent.[19] The rest of the columns in Table 6 present the coefficients and standard errors for the asset shares in the taxable and tax-deferred accounts, with the endogeneity of tax rate differentials addressed by the instrumental variable method. The coefficient for the tax rate differentials is positive and statistically significant ($\beta_1 = 0.058, p < 0.05$) for the share of bonds in the tax-deferred accounts in Column (3). The estimate shows that households with greater tax rate differentials between interest income and capital gains (i.e., the greater tax disadvantage of bonds relative to stocks) hold significantly higher shares of bonds in the tax-deferred accounts to exploit the preferential tax treatments of these tax-deferred accounts. Column (5) shows that the coefficient for the tax rate differentials is negative and statistically significant ($\beta_1 = -0.062, p < 0.05$) for the share of bond in the taxable accounts. That is, households with greater tax disadvantages of bonds relative

[19] I run the Hausman test for the model specification and find that $\chi^2(9) = 19.69$ and prob > $\chi^2 = .019$. Because it rejects the null hypothesis (H_0: the ordinary least square estimator is consistent), the estimates using instrumental variables are consistent.

to stocks hold significantly lower shares of bonds in taxable accounts because they move their heavily taxed bonds into tax-deferred accounts and need to preserve their targeted financial risk exposure in their overall portfolio. This result is consistent with the prediction of the tax arbitrage model.

— Insert Table 6 about here —

The empirical results in Table 6 also support the idea of households' tax-motivated *asset allocation*. According to after-tax CAPM (e.g., Auerbach and King, 1983; Litzenberger and Ramaswamy, 1979, 1980; Long, 1977), investors who face high tax rates should hold low-taxed assets, and those with low tax rates should hold more heavily taxed assets in the market equilibrium. Column (6) shows that the coefficient for the tax rate differentials is positive ($\beta_1 = 0.041, p < 0.10$) for the share of taxable stocks. That is, households with greater tax rate differentials between bonds and stocks tend to hold more stocks in their taxable accounts, because stocks are less heavily taxed assets to them. These results are consistent with previous work (e.g., Kawano, 2011; Poterba and Samwick, 2003) and provide empirical evidence of household allocation behavior in response to different tax provisions on different financial assets.

The remaining rows in Table 6 report the coefficients for households' demographic characteristics. The coefficient for age is positive and statistically significant for the share of bonds in both tax-deferred and taxable accounts; it is negative for the share of stocks in both accounts. These results offer some evidence of a link between age and asset allocation, consistent with the life-cycle model. Age-specific patterns of total asset holdings show that younger households tend to hold more risky assets (stocks) in their portfolio. Younger households have relatively less income over their lifetimes and are credit constrained; holding stocks with high

rates of return helps compensate for their low income.[20] The coefficient for the size of households is positive for the share of bonds in both tax-deferred and taxable accounts, such that when households have more members, they have greater needs for liquidity that cause them to hold more bonds in their portfolios. Finally, the coefficient for marital status suggests that married heads of households are more likely to hold bonds in tax-deferred accounts and hold significantly more stocks in taxable accounts.

Because the choice of portfolio shares is based on a model that results in corner solutions, the marginal effects of tax rate differentials on the observed choice of portfolio shares are of interest, rather than the latent choice of portfolio shares. Table 7 presents the Tobit estimates of the marginal effects on the observed portfolio shares. Compared with the estimates of the marginal effects on the latent portfolio shares in Table 6, the signs and statistical significance of the marginal tax effects on the observed portfolio shares in Table 7 stay the same and differ only in the magnitude of the coefficients.

— Insert Table 7 about here —

In addition to the Tobit estimates for each financial asset, I consider the possibility that households' asset location in taxable and tax-deferred accounts may correlate through the presence of unobservable factors. Consideration of this unobserved correlation may improve the Tobit estimates. For this analysis, a multivariate Tobit model with a correlated error structure was difficult to estimate while considering the correlation across four equations because of the unstable regions of the parameter space. Thus, a set of bivariate Tobit estimates for each possible pair of asset categories likely has information about the cross-correlation of asset categories.[21]

---

[20] Poterba and Samwick (1997) analyze the age profiles of asset holdings and portfolio allocations in detail.
[21] The programming codes for the bivariate Tobit model are available at http://ideas.repec.org/c/boc/bocode/s456864.html.

Table 8 shows the correlation matrix of the residuals from the bivariate probits and bivariate Tobit values. The cross-correlation for holding bonds in the taxable and the tax-deferred accounts in Panel (a) is negative, which means households that hold bonds in either account are less likely to hold bonds in the other type of account.

— Insert Table 8 about here —

With this correlation matrix, it is possible to estimate the bivariate Tobit model; those estimates are in Table 9. The t-statistics for the tax rate differentials are not improved by considering the correlations of unobservable factors of asset holdings in the estimation, because their correlations are not strong enough to improve the standard errors. The decrease in t-value for the tax rate differentials is significant in Column (3) because the correlation of the unobservable characteristics of holding tax-deferred bonds and tax-exempt bonds is weak.

— Insert Table 9 about here —

I assess the impacts of the Bush tax acts on households' asset location and allocation in taxable and tax-deferred accounts. The predicted changes in households' portfolio shares in response to the Bush tax acts, calculated using the Tobit estimates ($\hat{\beta}_1$and $\hat{\beta}_3$) in Table 6, can be computed as a percentage of the 1998 baseline:

$$\widehat{\Delta S}_{b,j} = \frac{\hat{\beta}_{1,j}(\tau_{b,2007}-\tau_{b,1998})+\hat{\beta}_{3,j}}{\sum_b s_{i,j}/n_b}, \tag{13}$$

where $\widehat{\Delta S}_{b,j}$ represents the predicted change in asset j's share in households' income tax bracket b, and n_b is the number of households in that tax bracket. Table 10 provides the net predicted changes as a percentage of the average shares in 1998 for households in that tax bracket. I focus on the predictions for tax-deferred bonds, tax-deferred stocks, taxable bonds, and taxable stocks, because the tax effects are statistically significant for these asset classes, and risk-preserving

portfolio changes are involved for these assets. Households in the 39.6% tax bracket should increase their shares of tax-deferred bonds by more than 25% due to the increase in tax-disadvantage of bonds relative to stocks after the Bush tax acts. Thus, households should reduce their portfolio shares of taxable bonds by the risk-preserving portfolio changes. These percentage changes should be considered cautiously though, because very large percentage changes arise from relatively small values in the denominator.

— Insert Table 10 about here —

6.2. Households' Asset Location in Taxable and Tax-Deferred Accounts: Two-Tiered Estimates

The estimation of the two-tiered model aims to separate the tax effects on the asset holdings at extensive margins (asset ownership decisions) from those at intensive margins (asset share decisions, conditional on positive asset holdings). Table 11 presents the probit coefficients and standard errors for the shares of financial assets in the taxable and the tax-deferred accounts (i.e., parameters governing the asset ownership decision in the first part). The coefficient for the tax rate differentials is significantly positive ($\delta_1 = 0.186, p < 0.05$) for the share of tax-deferred bonds and significantly negative ($\delta_1 = -0.240, p < 0.05$) for the share of taxable bonds. These empirical results suggest that households switch their asset holdings from bonds to stocks in taxable accounts and from stocks to bonds in tax-deferred accounts as the tax disadvantage of bonds relative to stocks increases.

— Insert Table 11 about here —

In the second part, to measure the tax effects on the change in asset holdings at the intensive margins, I estimated a log-linear model, conditional on positive asset holdings. Table 12 shows the coefficients and standard errors for the shares of each asset category in the taxable and tax-deferred accounts. The coefficient for the tax rate differentials is significantly positive ($\theta_1 =$

$0.110, p < 0.05$) for the logarithm of the share of tax-deferred bonds in Column (1) and significantly negative ($\theta_1 = -0.273, p < 0.01$) for the logarithm of the share of taxable bonds in Column (3). Conditional on positive holdings of bonds in taxable and tax-deferred accounts, households with greater tax rate differentials tend to hold a greater share of bonds in the tax-deferred, which accounts for the lower share of bonds in the taxable accounts to take advantage of favorable tax treatments of the tax-deferred accounts. Table 12 also presents the effects of income and demographic characteristics on the asset holdings at the intensive margins. Older households are more likely to hold riskless bonds in the taxable accounts and less likely to hold them in the tax-deferred accounts. More educated households are associated with higher shares of bonds in the tax-deferred accounts and lower shares of bonds in the taxable accounts.

— Insert Table 12 about here —

6.3. Robustness Check

To investigate the tax effects on households' asset location in taxable and tax-deferred accounts, the main analysis used effective tax rate differentials. However, because 25% of the statutory tax rates on capital gains are used as the effective tax rates on capital gains, the Tobit estimates might be sensitive to the choice of tax rate measure. As a robustness check, I replaced the effective tax rate differentials with the statutory tax rate differentials,[22] then estimated the Tobit model again. The first five columns in Table 13 present the estimates for the share of asset holdings in the taxable and tax-deferred accounts, which show that the qualitative results in the main analyses remain unchanged. That is, the estimates using the statutory tax rates supported the idea of households' tax-motivated asset location and allocation in taxable and tax-deferred

[22] The endogeneity problem of the tax rates is again addressed by the same instrumental variable method used in the main estimation.

accounts.

In addition, by relaxing the Tobit assumptions of normality and homoscedasticity,[23] I also implement semiparametric estimators (Powell, 1984, 1986): (1) censored least absolute deviations (CLAD) estimator which is robust to heteroskedasticity and asymptotic normality, and (2) symmetrically censored least squares (SCLS) estimator based on weaker assumption of symmetric distribution. The estimates from these two approaches are consistent with the Tobit estimates, and the coefficient differences are smaller than 0.01.

To conclude this analysis, I aimed to explain the deviation of the actual asset location from the optimal tax-minimizing asset portfolio. To explore which types of households make tax-efficient asset location, I estimated a regression model that could explain the difference between the share of bonds in taxable accounts and the share of bonds in tax-deferred accounts. This new specification with the same explanatory variables used in the main analyses is given by

$$Difference_{i,t} = \alpha_1 \tau_{i,t} + X_{i,t}^{'} \alpha_2 + \alpha_3 I(Year = 2007) + \zeta_{i,t}\,, \tag{14}$$

where $Difference_{i,t} \equiv Share\ of\ Bonds_{TA,i,t} - Share\ of\ bonds_{TDA,i,t}$. The theory of the tax-efficient asset location in Section 2 predicts that $Difference$ should not be positive. As Bergstressor and Poterba (2004) point out, this dependent variable has shortcomings for the estimation. The dependent variable, $Difference$, may vary widely even across tax-efficient households when they differ in their desired portfolio shares for bonds and stocks, and when they are constrained to hold different asset shares in taxable and tax-deferred accounts. For example, such tax-efficient households might have $Differences$ of -1, which would reflect that holding

[23] For testing normality, I regress a vector of ones on likelihood scores and generalized residuals raised to a power of 1 to 4, and run the same regression model including interaction terms of second moment of score and relevant variables for test of homoscedasticity. The tests show that the validity of Tobit assumptions is violated for some asset classes. For more detailed process of the tests, see Chapter 16 of Cameron and Trivedi (2010).

only stocks in the taxable accounts and only bonds in the tax-deferred accounts, or of zero, which would imply holding only bonds in taxable and tax-deferred accounts. The last column in Table 13 reports the estimates, which suggests a negative, statistically insignificant relationship between the household tax rate differentials and the tax-efficient asset location.

— Insert Table 13 about here —

7. CONCLUSIONS

This study investigates how different tax treatments across different financial assets affect households' asset location decisions in taxable and tax-deferred accounts. Unlike past studies, I construct a new tax measure based on tax rate differentials between interest income and capital gains. This new measure has advantages: It precisely captures households' asset location decisions by relying on the tax-arbitrage model, and it captures their allocation decisions reflecting the tax disadvantages of bonds relative to stocks. Finally, this study addresses the endogeneity problem of the tax rates by exploiting the structural tax rate changes by the Bush tax reforms, instead of implementing the "first-dollar" method. The tax-arbitrage model predicts that households with greater tax rate differentials between interest income and capital gains hold higher shares of bonds in tax-deferred accounts and lower shares of bonds in taxable accounts, in line with a risk-preserving portfolio change. The empirical results show that households with greater tax disadvantages due to bonds relative to stock (i.e., greater tax rate differentials between interest income and capital gains) hold significantly higher shares of bonds in tax-deferred accounts and lower shares of bonds in taxable accounts, which is consistent with the prediction of the asset location model. Also, the empirical findings support the idea of the households' tax-motivated asset allocation. Because bonds (stocks) are more (less) heavily taxed assets for households with greater tax rate differentials, they hold significantly lower (higher)

shares of bonds (stocks) in their taxable accounts.

In addition to the Tobit estimates, I estimate a two-tiered model to separate the tax effects on households' asset location at the extensive margins from the effects at the intensive margins. The estimates in the two-tiered model suggest that households' portfolio decisions in response to differential taxation on financial assets are consistent with the prediction of the asset location model, both at the extensive margins and at the intensive margins. Conditional on positive holdings of bonds in taxable and tax-deferred accounts, households with greater tax rate differentials have higher shares of stocks and lower shares of bonds in taxable accounts.

Taxation and households' asset location and allocation decisions already attract attention, in both applied tax policy debates and public finance. More than 60 million U.S. households hold positive amounts of both taxable and tax-deferred assets, and they must decide where to place their assets. This issue appears likely to become more important as the "baby boom" generation ages; their first priority is often asset accumulation for their retirement savings. The effects of taxation on households' asset location decisions are therefore likely to be a topic of growing interest and importance. When policymakers enact a new tax policy, the empirical findings in this study can help them predict how much and in which ways households will change their asset location and allocation in response to the new tax rates. Finally, this study does not elucidate the role of non-financial assets such as housing, nor does it not estimate a structural model of household asset location behavior. Further work should explore household asset location decisions based on the structural modeling and evaluate any welfare changes due to an introduction of a new tax policy.

REFERENCES

Amromin, G., 2003. Household Portfolio Choices in Taxable and Tax-Deferred Accounts: Another Puzzle? *European Finance Review* 7, 547-582.

Auerbach, A.J., King, M.A., 1983. Taxation, Portfolio Choice, and Debt-Equity Ratios: A General Equilibrium Model. *Quarterly Journal of Economics* 98, 587-610.

Bailey, M.J., 1969. *Capital Gains and Income Taxation.* Washington, DC: The Brookings Distribution.

Barber, B.M., Odean, T., 2004. Are Individual Investors Tax Savvy? Evidence from Retail and Discount Brokerage Accounts. *Journal of Public Economics* 88, 419-442.

Bergstresser, D., Poterba, J., 2004. Asset Allocation and Asset Location: Household Evidence from the Survey of Consumer Finances. *Journal of Public Economics* 88, 1893-1915.

Black, F., 1980. The Tax Consequences of Long-Run Pension Policy. *Financial Analysts Journal* 36, 21-28.

Bodie, Z., Crane, D.B., 1997. Personal Investing: Advice, Theory, and Evidence. *Financial Analysts Journal* 53, 13-23.

Cameron, A.C., Trivedi, P.K., 2010. *Microeconometrics using stata.* Stata Press, College Station, Tex.

Dammon, R.M., Spatt, C.S., Zhang, H.H., 2004. Optimal Asset Location and Allocation with Taxable and Tax-Deferred Investing. *Journal of Finance* 59, 999-1037.

Eissa, N., 1996. Tax Reforms and Labor Supply. *Tax Policy and the Economy* 10, 119-151.

Feldstein, M., Slemrod, J., Yitzhaki, S., 1980. The Effects of Taxation on the Selling of Corporate Stock and the Realization of Capital Gains. *Quarterly Journal of Economics* 94, 777-791.

Ivković, Z., Poterba, J., Weisbenner, S., 2005. Tax-Motivated Trading by Individual Investors. *American Economic Review* 95, 1605-1630.

Johnson, B.W., Moore, K., 2008. Differences in Income Estimates Derived from Survey and Tax Data. *Section on Survey Researh Methods*, 1495-1503.

Kawano, L., 2011. Taxes and Financial Portfolio Choices: Evidence from the Tax Rate Reductions of the 2001 and 2003 Tax Acts. *SSRN eLibrary.*

Kennickell, A. B. (1998). "Multiple Imputation in the Survey of Consumer Finances." *Federal Reserve Board Working paper.*

King, MA.D.F., 1984. *The Taxation of Income from Capital*. Chicago, IL: University of Chicago Press.

Litzenberger, R.H., Ramaswamy, K., 1979. The Effect of Personal Taxes and Dividends on Capital Asset Prices: Theory and Empirical Evidence. *Journal of Financial Economics* 7, 163-195.

Litzenberger, R.H., Ramaswamy, K., 1980. Dividends, Short Selling Restrictions, Tax-Induced Investor Clienteles and Market Equilibrium. *Journal of Finance* 35, 469-482.

Long, J.B., 1977. Efficient Portfolio Choice with Differential Taxation of Dividends and Capital Gains. *Journal of Financial Economics* 5, 25-53.

Moffitt, R., Wilhelm, M.O., 1998. *Taxation and the Labor Supply Decisions of the Affluent*. Cambridge, MA: National Bureau of Economic Research.

Poterba, J., 1999. Unrealized Capital Gains and the Measurement of After-Tax Portfolio Performance. *Journal of Wealth Management* 1, 23-34.

Poterba, J., Samwick, A., 1997. Household Portfolio Allocation over the Life Cycle. *National Bureau of Economic Research Working Paper Series* 6185.

Poterba, J., Samwick, A., 2003. Taxation and Household Portfolio Composition: US Evidence from the 1980s and 1990s. *Journal of Public Economics* 87, 5-38.

Powell, J.L., 1984. Least absolute deviations estimation for the censored regression model. *Journal of Econometrics* 25, 303-325.

Powell, J.L., 1986. Symmetrically Trimmed Least Squares Estimation for Tobit Models. *Econometrica* 54, 1435-1460.

Shoven, J.B., 1999. The Location and Allocation of Assets in Pension and Conventional Savings Accounts. *National Bureau of Economic Research Working Paper Series* 7007.

Shoven, J.B., Sialm, C., 2004. Asset Location in Tax-Deferred and Conventional Savings Accounts. *Journal of Public Economics* 88, 23-38.

Tepper, I., 1981. Taxation and Corporate Pension Policy. *Journal of Finance* 36, 1-13.

Zhou, J., 2009. The Asset Location Puzzle: Taxes Matter. *Journal of Economic Dynamics and Control* 33, 955-969.

Figure 1 Distribution of Tax Rate Differentials between Interest and Capital Gains

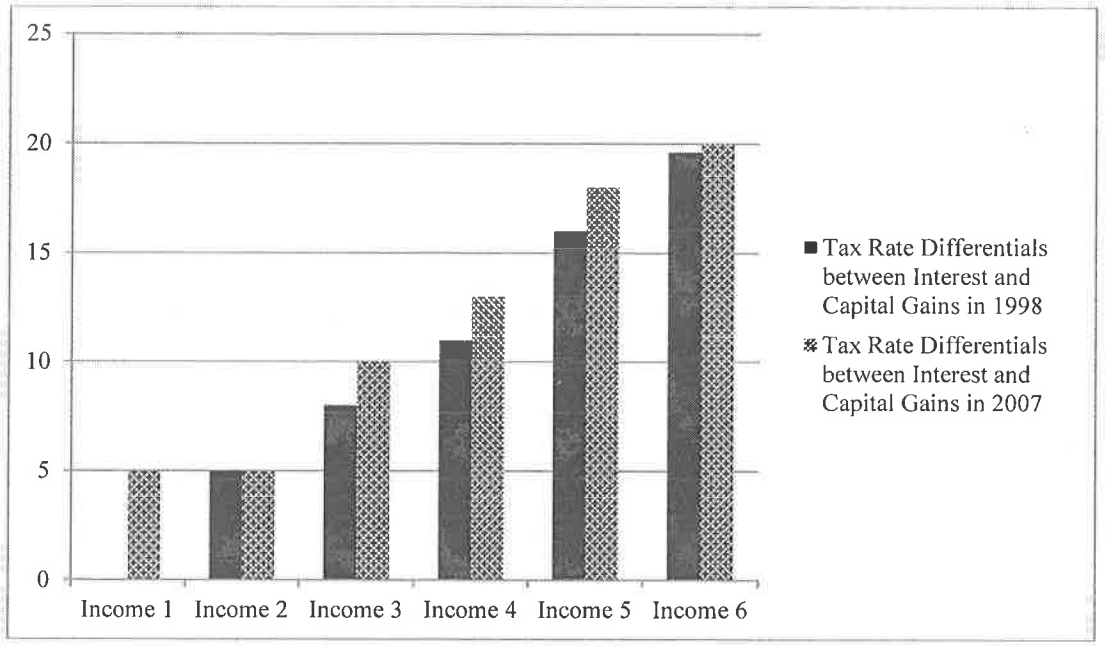

Table 1 Changes in Tax Rates (%) by the Bush Tax Acts

Before EGTRRA (2000)		After EGTRRA / Before JGTRRA (2002)		After JGTRRA (2003)	
Ordinary Income/Interest /Dividends	*Long-Term Capital Gains*	*Ordinary Income/Interest /Dividends*	*Long-Term Capital Gains*	*Ordinary Income/Interest/ Ordinary Dividends*	*Qualified Dividends/Long-Term Capital Gains*
		10	10	10	5
15	10	15	10	15	5
28	20	27	20	25	15
31	20	30	20	28	15
36	20	35	20	33	15
39.6	20	38.6	20	35	15

Source: Tax statistics from the Internal Revenue Service (IRS).

Table 2 Summary Statistics: 1998 and 2007 SCF Data

	1998 SCF			2007 SCF		
	Mean	Min	Max	Mean	Min	Max
Tax rate differentials (%)	7.37	0	19.6	10.10	0	20
Amount of money in taxable accounts (thousands of 2007 dollars)	121.79	0.01	334,000	170.06	0.01	345,000
Amount of money in tax-deferred accounts (thousands of 2007 dollars)	99.28	0.03	37,800	159.25	0.01	54,400
Income (millions of 2007 dollars)	0.10	0	128	0.14	0	117
Net worth (millions of 2007 dollars)	0.56	-19.1	652	0.95	-0.25	922
Mortgage (millions of 2007 dollars)	0.07	0	7.0	0.1	0	19.9
Head age (years)	46.03	19	95	48.63	21	95
Education (years)	14.14	1	17	14.46	1	17
Household size (#)	2.76	1	11	2.66	1	13
Financial risk averseness (1–4)	2.77	1	4	2.84	1	4
Number of observations (N)	2,193			2,337		

Source: Author's calculations, Survey of Consumer Finances. All averages are weighted by SCF sampling weights and are corrected for multiple imputations.

Table 3 Probability of Asset Ownership: 1998 and 2007

	1998	2007
Financial Assets Held in Tax-Deferred Accounts		
Tax-deferred bonds	40.91	46.24
Tax-deferred stocks	54.35	50.10
Financial Assets Held in Taxable Accounts		
Taxable bonds	35.86	29.14
Taxable stocks	39.36	42.17
Tax-exempt bonds	12.19	10.22
Interest-bearing accounts	93.77	94.74

Source: Author's tabulations from the Surveys of Consumer Finances. Households are weighted by SCF sampling weights in each year. and all averages are corrected for multiple imputations. Each asset category is described in the text.

Table 4 Asset Allocation in Taxable and Tax-Deferred Accounts: 1998 and 2007

	1998	2007
Financial Assets Held in Tax-Deferred Accounts (TDA)		
Bond as percentage of TDA financial assets	20.96	23.93
Stock as percentage of TDA financial assets	27.39	25.36
Percentage of households with bonds or stock in TDA	50.77	56.86
Financial Assets Held in Taxable Accounts (TA)		
Bond as percentage of TA financial assets	16.76	13.88
Stock as percentage of TA financial assets	29.23	31.35
Tax-exempt bonds as percentage of TA financial assets	5.66	5.48
Percentage of households with any financial assets in TA	51.83	54.81

Source: Author's tabulations from the Surveys of Consumer Finances. Households are weighted by SCF sampling weights in each year, and all averages are corrected for multiple imputations. Each asset category is described in the text.

Table 5 Estimates of the First Stage Regression

	Dependent Variable: Tax rate differential between interest and capital gains
$I(EDU \geq College)$	0.6130*** (0.1972)
$I(EDU \geq College) * I(Year = 2007)$	-0.0663** (0.0332)
$I(Year = 2007)$	-1.2531*** (0.1469)
Constant	8.8078*** (0.6057)
Observations	4525
R-squared	0.71
F-statistics	371.46

Notes: Effective tax rates on capital gains are used to construct the tax rate differentials between bonds and stocks. Asterisks denote significance at the 1% (***), 5% (**), and 10% (*) levels. Standard errors are in parentheses. Estimates are weighted by the SCF sampling weights and corrected for multiple imputations. All the other control variables are included in the estimation but not reported.

Table 6 Financial Asset Shares in Taxable and Tax-Deferred Accounts: Tobit

	Shares of bonds in TDA	Shares of bonds in TA	Shares of bonds in TDA	Shares of stocks in TDA	Shares of bonds in TA	Shares of stocks in TA	Shares of tax-exempt bonds in TA
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Tax rate differentials	0.0076***	-0.0045***	0.0581**	-0.0510**	-0.0618**	0.0407*	-0.0201
	(0.0011)	(0.0012)	(0.0252)	(0.0236)	(0.0314)	(0.0227)	(0.0270)
Year dummy	-0.0303**	-0.0137	0.1147**	-0.1564***	-0.1466*	0.0589	-0.0545
	(0.0137)	(0.0161)	(0.0570)	(0.0562)	(0.0764)	(0.0558)	(0.0642)
Risk averseness	0.0667***	0.0580***	0.1461***	-0.0624**	-0.0138	0.0079	0.0152
	(0.0090)	(0.0117)	(0.0324)	(0.0300)	(0.0407)	(0.0290)	(0.0347)
Net worth	-0.0226***	0.0016	-0.0352***	-0.0035	0.0101*	0.0008	0.0065
	(0.0054)	(0.0021)	(0.0072)	(0.0051)	(0.0052)	(0.0037)	(0.0048)
Income	-0.0221	-0.0011	-0.0983*	-0.0545	0.0634	-0.0491	0.0606*
	(0.0441)	(0.0190)	(0.0551)	(0.0539)	(0.0388)	(0.0314)	(0.0351)
Stock turnover ratio	-0.0027**	-0.0005	-0.0055***	0.0021**	0.0020	-0.0008*	0.0002
	(0.0013)	(0.0033)	(0.0017)	(0.0011)	(0.0036)	(0.0004)	(0.0018)
Mortgage	-0.0956	-0.0375	-1.3695***	0.7427*	0.9078	-0.4781	0.3330
	(0.2089)	(0.2511)	(0.4759)	(0.4303)	(0.6010)	(0.4192)	(0.4775)
Age	-0.0021***	-0.0021**	0.0136***	-0.0036	0.0081**	-0.0052	0.0042
	(0.0008)	(0.0010)	(0.0045)	(0.0042)	(0.0037)	(0.0040)	(0.0048)
Age > 59 ½ dummy	-0.0407*	0.0518**	0.0757	-0.1218***	-0.0510	0.1090**	0.0334
	(0.0226)	(0.0257)	(0.0487)	(0.0471)	(0.0590)	(0.0440)	(0.0532)
Sex	0.0155	0.0211	0.1548***	-0.0579	-0.1007	0.1090**	-0.0732
	(0.0252)	(0.0294)	(0.0586)	(0.0579)	(0.0722)	(0.0540)	(0.0635)
Marital status	0.0047	0.0041	0.0119**	-0.0087	-0.0023	0.0128**	0.0032
	(0.0049)	(0.0067)	(0.0059)	(0.0057)	(0.0074)	(0.0055)	(0.0069)
Education	-0.0242***	-0.0168***	-0.1004***	0.0405	0.0513	-0.0475*	0.0298
	(0.0033)	(0.0047)	(0.0294)	(0.0278)	(0.0377)	(0.0273)	(0.0324)
HH size	0.0013	0.0113	0.0234**	0.0141	0.0326**	-0.0111	-0.0061
	(0.0058)	(0.0080)	(0.0114)	(0.0106)	(0.0151)	(0.0105)	(0.0124)
Constant	0.8534***	0.4400***	0.6448***	1.1671***	0.5945***	0.2300**	-0.0909
	(0.0729)	(0.1019)	(0.1103)	(0.1073)	(0.1330)	(0.1022)	(0.1191)
Use instrumental variables?	No	No	Yes	Yes	Yes	Yes	Yes

Notes: Effective tax rates on capital gains are used to construct the tax rate differentials between bonds and stocks. Net worth, income, and mortgage are adjusted to 10 millions of 2007 dollars. The univariate Tobit estimates are presented. Asterisks denote significance at the 1% (***), 5% (**), and 10% (*) levels. Standard errors are in parentheses. Estimates are weighted by the SCF sampling weights and corrected for multiple imputations.

Table 7 Marginal Effects of Tax Rates on Portfolio Shares: Tobit

	Shares of bonds in TDA	Shares of stocks in TA	Shares of bonds in TDA	Shares of stocks in TA	Shares of tax-exempt bonds in TA
	(1)	(2)	(3)	(4)	(5)
Estimate of Marginal Effects					
	0.0416**	-0.0407**	-0.0419**	0.0365*	-0.0115
	(0.0200)	(0.0183)	(0.0213)	(0.0211)	(0.0151)

Notes: The table presents the marginal effect of a unit increase in the tax rate differential on the observed portfolio shares. This marginal effect is calculated as $\Phi(\frac{X\beta}{\sigma})\beta_i$. Effective tax rates on capital gains are used to construct the tax rate differentials between bonds and stocks. Asterisks denote significance at the 1% (***), 5% (**), and 10% (*) levels. Estimates are weighted by the SCF sampling weights and corrected for multiple imputations. All the other control variables are included in the estimation but not reported.

Table 8 Estimated Correlation Matrix

	Taxable bonds	Taxable stocks	Tax-exempt bonds
Panel (a): Probit			
Tax-deferred bonds	-0.17	0.19	-0.10
Tax-deferred stocks	0.15	-0.22	0.14
Panel(b): Tobit			
Tax-deferred bonds	-0.25	0.21	-0.13
Tax-deferred stocks	0.18	-0.26	0.11

Source: Author's calculations from the Surveys of Consumer Finances. Estimates are weighted by the SCF sampling weights and corrected for multiple imputations.

Table 9 Financial Asset Shares in Taxable and Tax-Deferred Accounts: Bivariate Tobit

	Shares of bonds in TDA (1)	Shares of bonds in TDA (2)	Shares of bonds in TDA (3)
Tax rate differentials	0.0624**	0.0525**	0.0612*
	(0.0313)	(0.0261)	(0.0324)
Year dummy	0.0194	0.0005	0.1048
	(0.0971)	(0.0621)	(0.0769)
Risk averseness	0.0469	0.0254	0.1055**
	(0.0530)	(0.0335)	(0.0416)
Net worth	-0.0182**	-0.0086*	-0.0396***
	(0.0077)	(0.0045)	(0.0067)
Income	-0.2911***	-0.2744***	-0.0621
	(0.0764)	(0.0710)	(0.0432)
Stock turnover ratio	-0.0022	-0.0015	-0.0036
	(0.0031)	(0.0026)	(0.0033)
Mortgage	-0.2993	-0.1346	-1.1450*
	(0.8136)	(0.4913)	(0.6420)
Age	-0.0023	-0.0027	-0.0123**
	(0.0072)	(0.0045)	(0.0057)
Age > 59 ½ dummy	0.0067	-0.0004	0.0725
	(0.0771)	(0.0489)	(0.0625)
Sex	0.0440	-0.0116	0.1262
	(0.0911)	(0.0628)	(0.0789)
Marital status	-0.0085	-0.0026	0.0085
	(0.0086)	(0.0061)	(0.0081)
Education	-0.0221	-0.0145	-0.0902**
	(0.0472)	(0.0310)	(0.0389)
HH size	-0.0001	-0.0032	-0.0107
	(0.0163)	(0.0116)	(0.0147)
Constant	0.4151**	0.5668***	0.5992***
	(0.1636)	(0.1203)	(0.1466)
Correlation of asset holdings	With bonds in TA	With stocks in TA	With tax-exempt bonds in TA

Notes: Effective tax rates on capital gains are used to construct the tax rate differentials between bonds and stocks. Net worth, income, and mortgage are adjusted to 10 millions of 2007 dollars. The bivariate Tobit estimates consider the correlation of unobservable factors of asset holdings. Asterisks denote significance at the 1% (***), 5% (**), and 10% (*) levels. Standard errors are in parentheses. Estimates are weighted by the SCF sampling weights and corrected for multiple imputations.

Table 10 Effects of the Bush Tax Acts on Households' Portfolio Shares

	Predicted Change in Portfolio Shares (1998 baseline)		
	Tax Brackets in 1998		
	31%	36%	39.6%
Tax-deferred bonds	32.96	32.61	25.73
Tax-deferred stocks	-25.40	-24.89	-28.30
Taxable bonds	-114.61	-97.07	-292.64
Taxable stocks	7.47	8.10	9.17
Tax-exempt bonds	-33.64	-35.84	-17.15

Notes: The predicted changes as a percentage of the 1998 baseline are computed as $\widehat{\Delta S}_{b,j} = \frac{\widehat{\beta}_{1,j}(\tau_{b,2007} - \tau_{b,1998}) + \widehat{\beta}_{3,j}}{\sum_b s_{i,j}/n_b}$, where $\widehat{\Delta S}_{b,j}$ represents the predicted change in asset j's share in households' income tax bracket b, and n_b is the number of households in that tax bracket. Each asset category is described in the text.

Table 11 Financial Asset Shares in Taxable and Tax-Deferred Accounts: Two-Tiered Model (Probit)

	First Part: Probit Regression				
	Share of bonds in TDA (1)	Share of stocks in TDA (2)	Share of bonds in TA (3)	Share of stocks in TA (4)	Share of tax-exempt bonds in TA (5)
Tax rate differentials	0.1855**	-0.1609**	-0.2402**	0.1312*	-0.1872
	(0.0929)	(0.0797)	(0.1218)	(0.0709)	(0.1547)
Year dummy	0.3554*	-0.5393***	-0.5973*	0.0969	-0.4192
	(0.2091)	(0.1878)	(0.3152)	(0.2670)	(0.3611)
Risk averseness	0.4585***	-0.2163**	-0.0747	0.0271	-0.1305
	(0.1209)	(0.1012)	(0.1709)	(0.1378)	(0.1936)
Net worth	-0.1176***	-0.0064	0.0429**	0.0027	0.0399
	(0.0352)	(0.0184)	(0.0213)	(0.0197)	(0.0254)
Income	-0.2632*	-0.0613	0.2442	-0.1463	0.3626**
	(0.1534)	(0.1792)	(0.1669)	(0.1721)	(0.1845)
Stock turnover ratio	-1.0179	2.6383***	0.0151	1.8151	-0.0183
	(0.8062)	(0.9339)	(0.0123)	(2.8015)	(0.0343)
Mortgage	-5.2219***	2.4707	3.6543	-1.4960	0.9066
	(1.9016)	(1.5063)	(2.6402)	(2.0518)	(2.9410)
Age	-0.0432***	0.0125	0.0296	-0.0125	0.0398
	(0.0165)	(0.0145)	(0.0234)	(0.0187)	(0.0275)
Age > 59 ½ dummy	0.1932	-0.3798**	-0.1716	0.3296	-0.2144
	(0.1849)	(0.1671)	(0.2609)	(0.2090)	(0.3055)
Sex	0.4336*	-0.2456	-0.3769	0.1730	-0.4467
	(0.2250)	(0.1908)	(0.3158)	(0.2612)	(0.3701)
Marital status	0.0356	-0.0291	-0.0182	0.0648**	-0.0213
	(0.0217)	(0.0199)	(0.0335)	(0.0260)	(0.0445)
Education	-0.3368***	0.1306	0.2036	-0.1448	0.2254
	(0.1102)	(0.0949)	(0.1559)	(0.1291)	(0.1868)
HH size	-0.0741*	0.0433	0.1103*	-0.0223	0.0449
	(0.0430)	(0.0364)	(0.0598)	(0.0507)	(0.0676)
Constant	1.3196***	2.4027***	1.4143**	-0.2283	-1.1163
	(0.4424)	(0.3708)	(0.6057)	(0.4948)	(0.6596)

Notes: Effective tax rates on capital gains help construct the tax rate differentials between bonds and stocks. Net worth, income, and mortgage are adjusted to 10 millions of 2007 dollars. Asterisks denote significance at the 1% (***), 5% (**), and 10% (*) levels. Standard errors are in parentheses. Estimates are weighted by the SCF sampling weights and corrected for multiple imputations. Estimates from the probit model are average marginal effects.

Table 12 Financial Asset Shares in Taxable and Tax-Deferred Accounts: Two-Tiered Model (Log-linear)

	Second-Part: Log-Linear Regression				
	Log (share of bonds in TDA) (1)	Log (share of stocks in TDA) (2)	Log (share of bonds in TA) (3)	Log (share of stocks in TA) (4)	Log (share of tax-exempt bonds in TA) (5)
Tax rate differentials	0.1097**	-0.0959**	-0.2728***	0.1051*	-0.0838
	(0.0557)	(0.0487)	(0.1015)	(0.0627)	(0.1115)
Year dummy	0.2487	-0.2507*	-0.6821***	0.1599	-0.1909
	(0.1514)	(0.1300)	(0.2401)	(0.1537)	(0.2610)
Risk averseness	0.2928***	-0.1496**	-0.1984	0.0459	0.0039
	(0.0822)	(0.0687)	(0.1310)	(0.0822)	(0.1498)
Net worth	-0.0735***	-0.0023	0.0470***	0.0007	0.0199
	(0.0226)	(0.0105)	(0.0167)	(0.0097)	(0.0174)
Income	-0.0763	-0.0270	0.3351**	-0.1285	0.2548*
	(0.1139)	(0.1169)	(0.1333)	(0.0877)	(0.1349)
Stock turnover ratio	-0.0213***	0.0005**	0.0249***	-0.0018**	0.0022
	(0.0032)	(0.0003)	(0.0058)	(0.0009)	(0.0053)
Mortgage	-3.2091**	1.3303	4.4227**	-1.4008	1.2690
	(1.4134)	(1.0047)	(2.2080)	(1.1227)	(1.9603)
Age	-0.0245**	0.0094	0.0395**	-0.0114	0.0172
	(0.0115)	(0.0098)	(0.0181)	(0.0110)	(0.0198)
Age > 59 ½ dummy	0.0595	-0.3089***	-0.2863	0.2279*	-0.0285
	(0.1291)	(0.1056)	(0.2023)	(0.1220)	(0.2220)
Sex	0.3337**	-0.1760	-0.6328***	0.3068**	-0.2633
	(0.1625)	(0.1262)	(0.2358)	(0.1498)	(0.2544)
Marital status	0.0134	-0.0264**	-0.0119	0.0346**	0.0011
	(0.0152)	(0.0130)	(0.0269)	(0.0145)	(0.0289)
Education	-0.1942**	0.0914	0.2620**	-0.1223	0.0880
	(0.0762)	(0.0627)	(0.1200)	(0.0756)	(0.1342)
HH size	-0.0419	0.0348	0.1106**	-0.0226	0.0177
	(0.0301)	(0.0248)	(0.0478)	(0.0289)	(0.0500)
Constant	-0.8468***	0.0910	0.0209	-1.6550***	-1.9018***
	(0.3215)	(0.2393)	(0.4786)	(0.2748)	(0.4654)

Notes: Effective tax rates on capital gains are used to construct the tax rate differentials between bonds and stocks. Net worth, income, and mortgage are adjusted to 10 millions of 2007 dollars. Asterisks denote significance at the 1% (***), 5% (**), and 10% (*) levels. Standard errors are in parentheses. Estimates are weighted by the SCF sampling weights and corrected for multiple imputations.

Table 13 Financial Asset Shares in Taxable and Tax-Deferred Accounts and Tax-Efficiency

	Share of bonds in TDA (1)	Share of stocks in TDA (2)	Share of bonds in TA (3)	Share of stocks in TA (4)	Share of tax-exempt bonds in TA (5)	Difference in share of bonds (6)
Tax rate differentials	0.0678***	-0.0281**	-0.0579**	0.0428*	-0.0178	-0.0067
	(0.0219)	(0.0142)	(0.0263)	(0.0222)	(0.0167)	(0.0228)
Year dummy	0.1133***	-0.0006	-0.0662**	0.0636**	-0.0217	-0.0920*
	(0.0331)	(0.0285)	(0.0332)	(0.0291)	(0.0242)	(0.0539)
Risk averseness	0.1184***	-0.0196	0.0048	-0.0343**	0.0122	-0.0400
	(0.0176)	(0.0161)	(0.0214)	(0.0174)	(0.0136)	(0.0296)
Net worth	-0.0188***	-0.0024	0.0094**	0.0059*	0.0049	0.0022
	(0.0038)	(0.0032)	(0.0042)	(0.0033)	(0.0030)	(0.0038)
Income	-0.0835***	-0.0135	0.0612**	-0.0199	0.0512**	0.0181
	(0.0319)	(0.0267)	(0.0312)	(0.0306)	(0.0240)	(0.0280)
Stock turnover ratio	-0.0051***	0.0016**	0.0028	-0.0022*	-0.0002	0.0027**
	(0.0011)	(0.0008)	(0.0022)	(0.0012)	(0.0012)	(0.0012)
Mortgage	-1.3089***	0.2069	0.6349	0.0817	0.1841	0.1896
	(0.3173)	(0.2880)	(0.3883)	(0.3195)	(0.2230)	(0.4130)
Age	-0.0104	-0.0019	0.0037	0.0011	0.0024	0.0019
	(0.0023)	(0.0023)	(0.0029)	(0.0024)	(0.0018)	(0.0041)
Age > 59 ½ dummy	0.0634*	-0.0590*	-0.0238	0.0545	0.0140	-0.0317
	(0.0336)	(0.0334)	(0.0390)	(0.0348)	(0.0268)	(0.0475)
Sex	0.1471***	0.0013	-0.0802	0.0363	-0.0521	0.0150
	(0.0437)	(0.0425)	(0.0493)	(0.0454)	(0.0327)	(0.0513)
Marital status	0.0163***	-0.0068	-0.0040	0.0115**	0.0001	-0.0111**
	(0.0059)	(0.0058)	(0.0065)	(0.0058)	(0.0049)	(0.0056)
Education	0.0764***	0.0009	-0.0227	-0.0076	0.0141	0.0259
	(0.0148)	(0.0144)	(0.0187)	(0.0159)	(0.0120)	(0.0273)
HH size	-0.0093	-0.0016	0.0137*	0.0052	-0.0043	-0.0007
	(0.0058)	(0.0056)	(0.0075)	(0.0061)	(0.0046)	(0.0101)
Constant	0.8711***	0.9523***	0.3609***	0.3334***	0.0108	-0.5383***
	(0.0679)	(0.0696)	(0.0963)	(0.0765)	(0.0603)	(0.1017)

Notes: Statutory tax rates on capital gains are used to construct the tax rate differentials between bonds and stocks. Net worth, income and mortgage are adjusted to 10 millions of 2007 dollars. The difference between the share of bonds in taxable accounts and the share in tax-deferred accounts is the dependent variable in last column. The univariate Tobit estimates are presented. Asterisks denote significance at the 1% (***), 5% (**), and 10% (*) levels. Standard errors are in parentheses. Estimates are weighted by the SCF sampling weights and corrected for multiple imputations.

APPENDIX A. VERIFICATION OF THE CHANGE IN EXPECTED UTILITY

This proof builds on the model used by Dammon, Spatt, and Zhang (2004). To verify that the change in expected utility has the same sign as $\Delta\widetilde{w}$, let U denote the household's utility function and $U^{'}$ denote the marginal utility function. Then, the change in expected utility is

$$\Delta \mathrm{E}[U] = \mathrm{E}[U^{'}\widetilde{w}^{TA}] + \lambda E[U^{'}\widetilde{w}^{TDA}] \text{ , (A1)}$$

where $\lambda > 1$ is the shadow price of taxable wealth per dollar of tax-deferred wealth. With the assumption that the investor has unrestricted borrowing and short-sale opportunities in taxable accounts, there must be indifference between bonds and stocks at the margin. Thus, the first-order optimality conditions must satisfy $\mathrm{E}[U^{'}(\Delta\widetilde{w}^{TA})] = 0$. Using $\widetilde{w}^{TDA} = \Delta\widetilde{w} - \widetilde{w}^{TA}$, the change in expected utility becomes $\Delta \mathrm{E}[U] = \lambda \Delta\widetilde{w} \mathrm{E}[U^{'}]$, which clearly shows that $\Delta \mathrm{E}[U]$ has the same sign as $\Delta\widetilde{w}$.

APPENDIX B. CALCULATION OF MARGINAL TAX RATES FROM THE SCF DATA

Because the SCF data do not have information about households' marginal tax rates, the TAXSIM program serves to calculate federal and state income tax liabilities from survey data available on the NBER website. To create TAXSIM variables from the public SCF data, I use program code provided by Kevin Moore at NBER, which assumes that all married or cohabiting couples file a joint tax return, because it is hard to disentangle each member's income, deductions, and other information from tax returns in the SCF data. The percentage of married or cohabiting couples who filed tax returns separately was 3.51% in 1998 and 3.62% in 2007, and thus, the issue with this assumption is relatively small. Total standard deductions and total itemized deductions for mortgage interest, investment interest expense, and charitable

contributions are also considered. Investment expenses consist of interest paid on the loans for investments.

To obtain the marginal tax rates on capital gains, I used annual income information related to net capital gains or losses from mutual funds and to the sale of stocks, bonds, and real estate, which I gathered from the SCF data. However, the SCF data do not have specific information about whether the capital gains are short- or long-term. To divide capital gains and losses into long- and short-term portions, I used aggregate data from the IRS SOI Individual report (table 1.4), in which the share of capital gains/losses that are long- and short-term is determined for three broad adjusted gross income (AGI) classes: less than 50K, 50K–100K, and more than 100K. The shares from this computation are then applied to the data (by AGI class). Johnson and Moore (2008) focus on income data derived from two sources, SCF and SOI, and they find that estimates of total income for each AGI group and tax year from these sources are very close.