ELSEVIER

Journal of Public Economics 87 (2002) 5–38

JOURNAL OF PUBLIC ECONOMICS

www.elsevier.com/locate/econbase

Taxation and household portfolio composition: US evidence from the 1980s and 1990s

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Received 13 August 2000; received in revised form 23 May 2001; accepted 29 May 2001

Abstract

This paper explores the relationship between household marginal income tax rates, the set of financial assets that households own, and the portfolio shares accounted for by each of these assets. It analyzes data from the 1983, 1989, 1992, 1995, and 1998 Surveys of Consumer Finances and develops a new algorithm for imputing federal marginal tax rates to households in these surveys. The empirical findings suggest that marginal tax rates have important effects on asset allocation decisions. The probability that a household owns tax-advantaged assets, such as tax-exempt bonds or assets held in tax-deferred accounts, is positively related to its tax rate on ordinary income. In addition, the portfolio share invested in corporate stock, which is taxed less heavily than interest bearing assets, is increasing in the household's ordinary income tax rate. Holdings of heavily taxed assets, such as interest-bearing accounts, decline as a share of wealth as a household's marginal tax rate increases.

Keywords: Household assets; Portfolio share; Taxation

The federal income tax in the United States places different tax burdens on different types of capital income. Interest and dividends are taxed more heavily than realized capital gains, and capital gains are not taxed on accrual but on realization. Interest on state and local government bonds is tax-exempt. Different

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0047-2727/03/$ – see front matter
PII: S0047-2727(01)00168-2

individuals face different federal marginal income tax rates. Ordinary income tax rates ranged from zero to just over 40% in the late 1990s, and the range was even larger prior to the Tax Reform Act of 1986. Taxation creates potentially significant differences between the pre-tax and post-tax returns available to individual investors. It also creates differences across investors in the relative tax burdens on different assets.

There have been relatively few empirical studies of how taxation affects portfolio allocation, although a substantial body of research has considered the theory of household portfolio choice in the presence of differential taxation. The lack of research on portfolio structure is due in part to the relative scarcity of reliable information on the asset holdings of the high-wealth households who hold a significant share of financial assets. Since 1983, however, the Federal Reserve Board has sponsored a triennial Survey of Consumer Finances that collects high-quality information on asset holdings. This survey includes a substantial number of high net worth households. In this paper, we exploit these data to explore how taxes affect portfolio choice with respect to financial assets. Our analysis focuses on financial assets, even though taxes may have an important influence on ownership decisions with regard to other assets such as real estate and equity in unincorporated business. By focusing on financial assets, we avoid a number of empirical problems that arise in measuring income flows, and before- and after-tax returns, on physical assets such as housing.

We classify financial assets into eight broad categories and examine the effect of taxes on household decisions about whether or not to own assets in each category, and on decisions regarding the portfolio share that is allocated to each of the assets. We conduct separate analyses of these empirical issues using each of the Surveys of Consumer Finances.

Under somewhat restrictive assumptions, theoretical models of differential taxation and portfolio structure yield clear predictions regarding the cross-sectional relationship between a household's marginal tax rate and its portfolio holdings. Unfortunately, because marginal tax rates are a function of a household's taxable income, which in turn is a function of its labor and capital income, it can be difficult to disentangle income effects from tax rate effects in a cross-section. We discuss this problem in some detail and explore several potential remedies.

This paper is divided into seven sections. The first summarizes existing models of portfolio choice in the presence of differential capital income taxation. It provides the conceptual basis for our empirical work. Section 2 summarizes previous empirical work on how taxes affect portfolio composition, and places our empirical strategy in context.

Section 3 describes the Survey of Consumer Finances data, explains our procedure for imputing marginal tax rates to households in the survey, and summarizes the changing distributions of marginal income tax rates during our sample period. The fourth section outlines our econometric framework for analyzing which assets households own and the portfolio shares allocated to each

of these assets. Section 5 presents our empirical findings on the discrete decisions households make about whether to hold particular asset categories. Section 6 presents parallel results on the amounts that households choose to invest in different asset categories. We also develop illustrative results that describe how changes in marginal tax rates might affect the structure of household portfolios. There is a brief conclusion.

1. Portfolio choice with differential taxation

If all assets were riskless, and if different investors faced different marginal tax rates on different assets, then investors would segregate into asset clienteles. This basic insight generalizes to the case in which returns are uncertain, but in the absence of strong assumptions, strict clienteles no longer arise. Auerbach and King (1983), building on earlier work by Brennan (1970), provide the most direct analysis of equilibrium portfolio choice in the presence of differential taxation. They show that if investors can obtain all possible pre-tax return streams from assets that generate returns in each tax format, then strict portfolio clienteles will emerge. Investors will specialize in the set of assets that are taxed most favorably for them. To illustrate the restrictive nature of this result, consider the situation when there are two types of securities, stocks and bonds. In order for strict clientele formation to occur, an investor who prefers bonds must be able to obtain any pre-tax return stream that is available on an equity security from a portfolio of bonds as well. This condition seems unlikely to be satisfied in practice.

When investors cannot span the set of pre-tax returns with assets from the asset class that they prefer for tax reasons, both tax and risk preferences will determine portfolio structure. When the capital asset pricing model framework is expanded as in Auerbach and King (1983) to allow for differential taxation of ordinary income and capital gains, and to allow for investor heterogeneity in tax rates, investors hold a combination of two portfolios of risky assets. One is the market portfolio, which represents the most efficient means of diversifying risk, and the other is a portfolio of assets on which the investor is lightly taxed compared to other investors. Investors who face high tax rates deviate from the market portfolio toward lightly taxed assets, and those with low tax rates deviate into more heavily taxed assets.

The analysis in Auerbach and King (1983) and most other studies assumes that various financial assets have immutable tax and return characteristics. Bonds, for example, generate highly taxed income, and offer less risky returns than corporate equities. Recent institutional changes in the tax environment in the United States and many other nations has eroded the plausibility of this assumption. The rise of tax-deferred retirement saving accounts has expanded the set of investment options available to many investors, who can now choose not only whether to hold a

particular asset, but also whether to hold such an asset in their taxable account or in a tax-deferred account.

Investments in tax-deferred accounts are taxed differently than the same investments would be if they were not held in these accounts, so the availability of these accounts expands the set of investment choices open to individuals. While tax-deferred accounts often are subject to special tax provisions, such as penalties for early withdrawal of assets as described in Poterba et al. (1998), for most households they offer a lower-tax method of accumulating resources for retirement. Shoven (1998) formalizes the 'asset location' problem facing investors with both taxable and tax-deferred accounts. Barber and Odean (2001) and Bergstresser and Poterba (2001) provide empirical evidence on the current behavior of investors.

The incentive to invest through tax-deferred accounts is an increasing function of an investor's marginal tax rate on investment income outside the tax-deferred account. Consider an investor who faces an ordinary income tax rate of τ while working and while retired, and who has an investment horizon of T. If this investor holds a taxable bond, which yields a compound annual return of r, then after T years, his after-tax wealth per dollar of initial investment is $e^{r(1-\tau)T}$. If the same investor allocates the amount of before-tax income that would generate 1 dollar of after-tax income, or $1/(1-\tau)$ dollars, to a tax-deferred account, then at retirement he would have e^{rT}. The ratio of wealth in the tax-deferred investment to that in the taxable investment is $e^{r\tau T}$, which is increasing in the investor's marginal tax rate.

2. Empirical evidence on taxation and portfolio choice

Several previous studies, surveyed in Poterba (2001), have developed empirical evidence on how taxes affect portfolio choice. Feldstein (1976), King and Leape (1998), Hubbard (1985), Scholz (1994), and Samwick (2000) are the studies that are most directly related to our analysis. Each examines how taxation affects the portfolio decisions of US households.

Feldstein (1976) analyzed portfolio data from the 1962 Survey of Financial Characteristics of Consumers, which was conducted when the top marginal tax rate in the federal income tax code was 91%. He found that a household's income had a substantial effect on the mix of assets it held, conditional on household net worth. His primary finding was that equity-holding was more common among higher income than lower-income households. In essence, this study used the pattern of asset holdings by income class, along with the link between income and tax rates, to conclude that tax rates affect portfolio choice. Any other model in which income, or a variable that is correlated with income, affects portfolio choice is also consistent with this evidence.

King and Leape (1998) present related evidence on the relationship between

marginal tax rates and portfolio choice. They find that tax variables affect the set of assets that investors decide to hold, but they find very limited support for a link between tax rates and the fraction of the household's portfolio that is held in different assets. They analyze data from a 1978 survey conducted by SRI International, and find that many investors have zero holdings of many broad asset categories such as corporate stock, corporate bonds, and tax-exempt bonds. They also find that most investors who hold tax-favored assets such as equity or tax-exempt bonds also hold more heavily taxed assets, contrary to the prediction of simple clientele models.

Hubbard's (1985) study of data collected by the US President's Commission on Pension Policy also finds a strong effect of taxes on asset allocation. This study uses estimates of the marginal tax rates facing different households that are based on the NBER TAXSIM program. This study moves beyond Feldstein's (1976) analysis by including marginal tax rates, as well as income, as explanatory variables for portfolio structure. The results suggest that variation in marginal tax rates, conditional on income, helps to explain differences in portfolio structure across households.

Scholz (1994) examines changes in portfolio structure over time and the potential role of taxation in driving these changes. His analysis, based on the 1983 and 1989 Surveys of Consumer Finances, finds relatively small changes in portfolio structure between these two years even though the Tax Reform Act of 1986 significantly affected marginal tax rates for many households. One notable exception is some restructuring of household debt into the tax-favored mortgage category.

One potential explanation of this finding, suggested in Gordon (1994), is that the long-term nature of many investments, particularly those in real estate, personal businesses, and common stock, make it difficult to find portfolio adjustments only three years after a major tax reform such as that in 1986. A similar argument can be raised with respect to our analysis. Since we relate cross-sectional portfolio patterns to current tax rates, we may not capture potentially important dynamic adjustments. Another difficulty with evaluating Scholz' (1994) findings is that when there are systematic changes in the tax structure, it can be difficult to determine how the portfolio of a given household should vary as a function of its tax rate. Each household's predicted portfolio change can depend on the tax changes facing all other households.

Samwick (2000) also studies changes in portfolio structure that may have been induced by the tax reforms of the last two decades. He uses an earlier version of the tax imputation algorithm that we apply, along with a less detailed econometric specification than the one used here, to examine time-series changes in both real and financial portfolio holdings. Despite the clear cross-sectional relationship between marginal tax rates and portfolio structure that we find below, he concludes that changes in the portfolio composition of different net worth groups over time are not primarily due to changes in their marginal tax rates.

These five studies explore the structure of household portfolios in the United States. There is less work on taxation and household portfolio structure in other nations, largely because of data limitations. Agell and Edin's (1990) study of taxes and portfolio structure in Sweden and Hochguertel's (1998) work on household portfolios in the Netherlands are notable exceptions.

3. Data description and summary information

The Surveys of Consumer Finances are a series of triennial surveys of the United States population designed to collect comprehensive data on household wealth. The 1983 survey was designed to be the first of a panel, but the re-interview surveys yielded only two thirds of the original sample in 1986 and one third in 1989. New households supplemented the 'panel' households in the 1989 sample, and all waves since 1989 have been conducted as unrelated cross-sections using the same basic survey questionnaire and sample design. The years of the surveys span the major tax reform in 1986, the more modest reforms in 1990 and 1993, and the substantial change in capital gains tax rates in 1997. We do not use the 1986 SCF because of its small sample size and limited detail on asset categories.

Each SCF sample is comprised of an area-probability sample of the United States population and a sample of households drawn from an Internal Revenue Service file of high-income returns. Avery et al. (1984), Heeringa et al. (1994), Kennickell and Woodburn (1992, 1997), and Kennickell et al. (1996) describe the construction of the samples and the sampling weights for each observation. Oversampling based on income helps to equalize the probability of each dollar of wealth in the economy — rather than each household in the population — appearing in the sample. The distinction is important when analyzing the distribution of assets and liabilities that are highly concentrated. One drawback of the SCF is that to preserve the anonymity of the high-income households in the sample, the household's state of residence is not reported. This precludes the calculation of the household's state income tax rate, a variable that could be of substantial help in disentangling the effects of income and marginal tax rates on portfolio choice.

3.1. Defining broad asset categories

To study how taxes affect the allocation of financial assets, we classify the financial assets into eight categories based on their tax treatment. These categories are taxable equity held directly, taxable equity held in mutual funds, equity held in tax-deferred accounts, bonds held in tax-deferred accounts, tax-exempt bonds, taxable bonds, interest bearing accounts, and other financial assets. We now describe these asset categories and their tax treatment in more detail.

3.1.1. Taxable equity held directly

This category includes all holdings of stocks outside of mutual funds and tax-deferred retirement accounts, including brokerage accounts, investment trusts, investment clubs, and shares in a company where a household member is employed. Dividend payments are taxed each year at the household's marginal tax rate on ordinary income. Upon realization, long-term capital gains and losses are taxed at the household's capital gains tax rate. The effective long-term capital gains tax rate is lower than the statutory rate on ordinary income. Short-term capital gains are taxed as ordinary income.

3.1.2. Taxable equity held in mutual funds

This category includes all holdings of stocks in mutual funds. The tax treatment of mutual fund dividends and realized capital gains is very similar to that on directly held equity, with the exception that mutual funds generate both short- and long-term capital gains in the course of normal operations, even if households do not sell or redeem their shares.

3.1.3. Assets held in tax-deferred accounts

This category includes all assets held in Individual Retirement Accounts (IRAs), Keogh plans for the self-employed, and defined contribution (DC) pension plans, including 401(k) plans and employee stock ownership plans (ESOPs). Equity holdings include all of the assets listed under taxable equity above. Bond holdings include all of the assets listed under taxable bonds and tax-exempt bonds below, as well as all responses not specifically coded as equity. Income on assets held in tax-deferred accounts is not taxed until it is withdrawn from the account; then it faces ordinary income taxation. Retirement account asset allocations were not reported in the 1983 SCF, so we impute 1983 values based on 1989 SCF data. In all years, we include only those assets associated with defined contribution plans on the current job, because the SCF does not include information about asset allocation for plans associated with previous jobs.

3.1.4. Tax-exempt bonds

This category includes all state and municipal bonds, whether held directly, in money market accounts, or in mutual funds held outside tax-deferred retirement accounts. Interest from these assets is tax-exempt. Capital gains or losses resulting from sales prior to maturity are taxed at the household's marginal tax rate on capital gains.

3.1.5. Taxable bonds

This category includes federal government bonds, corporate bonds, and foreign bonds, whether held directly or in mutual fund accounts, but not in tax-deferred retirement accounts. Interest payments on these assets are taxed each year at the household's ordinary income tax rate. Capital gains and losses on these assets are

taxable at the household's capital gains tax rate only if the assets are sold before maturity. This category also includes savings bonds, which generate interest income that is taxed as ordinary income but only when the bonds are redeemed.

3.1.6. Interest bearing accounts

This category includes checking accounts, saving accounts, certificates of deposit, and money market accounts that are not invested in tax-exempt assets. Income from these accounts is taxed at the investor's ordinary income tax rate.

3.1.7. Other financial assets

This category consists primarily of the cash value of whole life insurance policies and trust accounts. Income from both of these asset categories is taxed at rates below the ordinary income tax rate.

3.2. Summary information on portfolio holdings

Table 1 presents summary information on the ownership probabilities for the asset categories in each of the SCF data sets that we analyze. There are several clear patterns in the data. First, the ownership of tax-deferred accounts increases substantially between 1983 and 1998. Less than one household in five had a tax-deferred account with equities in 1983, compared with more than one household in three by 1998. The ownership of bonds in tax-deferred accounts also rises, but not as sharply. This in part reflects a shift in asset allocation within tax-deferred accounts away from bonds, and toward stocks, during the 1983–1998 period. Second, there is considerable variation in the distribution of assets across households. For example, less than half of the households hold stock in any form. This variation suggests that motives other than diversification are required to explain household portfolio choice. Finally, ownership of equity mutual funds rises very sharply during the 1983–1998 period. While only three percent of households

Table 1
Probability of ownership (percent) of each of eight asset classes: 1983–1998

	1998	1995	1992	1989	1983
Directly held equity	21.35	16.41	18.13	17.91	19.08
Equity mutual funds	14.93	11.26	8.35	5.86	3.03
Tax-deferred equity	38.10	30.40	25.67	20.42	19.51
Tax-deferred bonds	29.53	30.54	30.35	30.54	26.10
Tax-exempt bonds	6.45	6.44	6.79	6.40	3.31
Taxable bonds	23.53	26.17	27.29	28.14	23.99
Interest bearing accounts	90.35	87.22	87.24	85.52	87.63
Other financial assets	40.31	42.96	44.56	48.29	36.52

Source: Authors' tabulations based on data in Surveys of Consumer Finances. Households are weighted by sample weights in each year.

Table 2
Conditional ownership probabilities (percent) for eight asset classes: 1998

	Directly held equity	Equity mutual funds	Tax deferred equity	Tax deferred bonds	Tax exempt bonds	Taxable bonds	Interest bearing accounts	Other financial assets
Directly held equity	100.00	34.13	62.41	42.03	14.66	43.18	99.34	58.43
Equity mutual funds	48.79	100.00	65.25	36.62	23.27	48.93	99.45	57.80
Tax-deferred equity	34.97	25.57	100.00	50.33	9.76	35.10	98.64	49.47
Tax-deferred bonds	30.38	18.52	64.93	100.00	9.60	35.53	98.31	51.37
Tax-exempt bonds	48.54	53.89	57.64	43.98	100.00	54.87	99.16	62.66
Taxable bonds	39.17	31.05	56.84	44.59	15.04	100.00	99.23	58.06
Interest bearing accounts	23.47	16.44	41.59	32.13	7.08	25.84	100.00	42.69
Other financial assets	30.93	21.41	46.75	37.63	10.02	33.88	95.67	100.00

Notes: Each entry indicates the probability that a household owns the asset class indicated at the column head, conditional on owning the asset class indicated a the beginning of the row. Entries are based on authors' tabulations using the 1998 Survey of Consumer Finances, weighting households by their sampling weights.

reported mutual fund ownership at the beginning of our sample, fifteen percent reported ownership in 1998.

Table 2 shows the probability of a household holding each of the various asset categories, *conditional* on positive holdings of the other asset categories in 1998. For all asset categories except taxable stocks and stock mutual funds, we combine ownership of assets directly with ownership through intermediaries such as mutual funds. The table does not suggest the presence of strong, tax-related asset clienteles. For example, about 13% of the households who hold taxable bonds also hold tax-exempt bonds, and 56% of the households who own tax-exempt bonds also own taxable bonds. Over half of the households who own equity either directly or through taxable mutual funds also own equity in tax-deferred accounts, and nearly half of those who hold bonds in their tax-deferred accounts also hold some equity in their tax-deferred accounts.

Table 2 reveals interesting portfolio patterns that may not be directly linked to tax-motivated behavior. More than 48% of the households who hold stock through a mutual fund also own stock directly, while only one third of those who report direct equity holdings also report indirect holdings. This may reflect the presence of substantial numbers of small investors who directly own stock in only one or two firms, and are not using equity investment as an important part of a long-term financial plan.

Tables 3 and 4 provide additional information on the structure of household portfolios. The first panel of Table 3 shows the *average household's* portfolio share for each asset category. The average portfolio share for directly held equity is 6.12% in 1998, the highest in any year in the sample. The average share of interest bearing accounts, by contrast, is 48%. This share declines over the sample period, with the declines absorbed by increases primarily in equity mutual funds

Table 3
Average portfolio shares (percent): 1983–1998

	1998	1995	1992	1989	1983
Unconditional averages					
Directly held equity	6.12	4.15	4.34	4.40	4.94
Equity mutual funds	3.86	2.87	1.48	0.84	0.25
Tax-deferred equity	14.86	11.77	8.10	5.76	5.70
Tax-deferred bonds	9.81	10.78	10.92	10.57	7.89
Tax-exempt bonds	1.20	1.19	1.74	1.54	0.68
Taxable bonds	2.83	3.75	3.90	3.89	3.24
Interest bearing accounts	48.31	49.71	54.41	56.99	62.76
Other financial assets	13.00	15.78	15.11	16.00	14.54
Conditional averages					
Directly held equity	28.69	25.28	23.94	24.58	25.89
Equity mutual funds	25.85	25.53	17.78	14.39	8.23
Tax-deferred equity	39.01	38.73	31.55	28.21	29.22
Tax-deferred bonds	33.20	35.30	35.97	34.60	30.22
Tax-exempt bonds	18.67	18.45	25.55	24.13	20.60
Taxable bonds	12.02	14.34	14.28	13.83	13.52
Interest bearing accounts	53.47	56.99	62.37	66.64	71.62
Other financial assets	32.26	36.73	33.91	33.14	39.81

Notes: Unconditional averages refer to all households, while conditional averages refer to the households with positive holdings of the indicated asset class. Tabulations are based on authors' calculations using data from the Survey of Consumer Finances, weighting each household by its sampling weight.

and tax-deferred assets. The averages weight all households equally; they are not dollar-weighted measures of the share of each asset class in total portfolio value.

These statistics change dramatically when we compute *conditional* portfolio shares by averaging the portfolio shares for each asset only across those households that report positive holdings of the asset. In this case, the average share

Table 4
Aggregate portfolio shares (percent): 1983–1998

	1998	1995	1992	1989	1983
Directly held equity	27.35	18.99	17.61	19.39	26.43
Equity mutual funds	8.63	8.48	3.57	2.44	0.88
Tax-deferred equity	18.91	14.76	12.36	8.02	5.80
Tax-deferred bonds	8.76	11.17	13.66	11.72	8.86
Tax-exempt bonds	4.62	6.93	8.91	9.06	7.15
Taxable bonds	4.80	6.75	6.01	6.59	6.27
Interest bearing accounts	14.92	19.31	24.38	27.84	27.73
Other financial assets	12.01	13.61	13.49	14.95	16.87
Financial assets (Blns 1995 $)	12 727	8840	7082	7088	5391

Source: Authors' tabulations using various years of the Survey of Consumer Finances. Households are weighted by sample weights in each year.

of directly held corporate stock rises to 29%, and the average share of tax exempt bonds, which are held by relatively few investors, rises from 1.2 to 18.7%. The dramatic difference between the conditional and the unconditional statistics is due to the fact that many households hold relatively few asset categories.

Table 4 presents a different measure of the role of each asset in the portfolio: the fraction of the aggregate household portfolio that is accounted for by each asset category. These numbers are weighted average household portfolio shares, with each household weighted by the product of its sample weight and its total financial assets. The share of interest bearing accounts in the aggregate portfolio, 15%, is significantly smaller than the household-weighted average portfolio share of these assets. In 1998, over 27% of household financial assets was in tax-deferred accounts.

Table 4 tracks the decline in direct ownership of corporate stock and the rise in equity mutual fund ownership over our sample period. In 1983, corporate stock held directly accounted for more than 26% of total household financial assets. By 1992, this share had fallen to 17.6%. Partly as a result of rising share prices, it climbed to 19% by 1995 and 27% by 1998. At the same time, the share of equity mutual funds in household financial assets rose from less than 1% in 1983 to 8.6% in 1998. This growth in mutual fund ownership does not include the coincident growth in equity mutual fund ownership through tax-deferred accounts.

3.3. Marginal tax rates on investment income: 1983–1998

To understand the empirical basis for our cross-sectional studies of tax rates and asset holding, it is important to understand the shifting patterns of marginal tax rates facing US households. In 1983, the top marginal tax rate on interest and dividend income was 50%. This represented a substantial decline from the pre-1981 tax regime, when the top tax rate on such capital income flows was 70%. In 1983, long-term capital gains were taxed at a marginal tax rate equal to 40% of the statutory marginal tax rate on dividends and interest. This implied a top rate of 20% for high-income taxpayers. The decline in top marginal income tax rates that resulted from the Economic Recovery Tax Act of 1981 is potentially important, because the structure of portfolio holdings in 1983 may partly reflect choices made under an earlier tax regime with higher marginal tax rates on dividend and interest income.

The first major tax reform during our sample period is the Tax Reform Act of 1986. TRA86 continued the reduction in top marginal tax rates that had been part of ERTA, but it also eliminated the capital gains tax preference for most taxpayers. For very high-income taxpayers, TRA86 reduced marginal tax rates from 50% in 1986 to 39% in 1987 to 28% in 1988. TRA86 also introduced a hump-shaped pattern in marginal tax rates, with some taxpayers below the highest income groups facing a 33% marginal tax rate. While TRA86 eliminated the tax preference for realized capital gains that had been in effect in earlier years, the tax rate on

such gains was capped at 28%. This resulted in an increase in the statutory tax rate on gains for many high-income taxpayers with realized gains. For some high-income taxpayers, the post-1986 tax code retained an advantage for capital gains relative to dividend or interest income, but the statutory rate differential was only 5% in the early post-reform years. Even when the statutory tax rate on capital gains equals that on dividends, however, the effective capital gains tax rate can be lower, as a result of tax deferral for unrealized but accrued gains.

Tax changes in 1990 and 1993 partially reversed the changes in the top marginal tax rate that had been enacted in 1986. The 1990 tax reform, which affected tax returns for 1991 and subsequent years, replaced the 'hump-shaped' distribution of marginal tax rates under the 1986 law, 15–28–33–28, with an alternative 15–28–31 structure. Thus, it raised the top marginal tax rate on the highest income households to 31%. The 1993 reform, enacted as part of the Omnibus Budget Reconciliation Act of 1993 (OBRA93), was a further step in this direction. It raised the top marginal tax rate to 36% for joint filers with incomes above $140 000 ($115 000 for single filers), and to 39.6% (36% plus a 10% surtax) for individual or married taxpayers with taxable incomes of more than $250 000. Many high-income taxpayers face tax rates above this statutory maximum of 39.6% as a result of deduction phase-outs.

Neither the 1990 nor the 1993 tax reforms affected the top marginal tax rate on capital gains. By 1993, the tax rate differential between ordinary income, including dividends and interest, and realized capital gains, exceeded 12% for many high-income taxpayers. The Taxpayer Relief Act of 1997 reduced the top capital gains tax rate from 28 to 20%.

The effects of these various reforms can be summarized as follows. First, TRA86 reduced the incentive for high-income taxpayers to receive portfolio income in the form of capital gains rather than dividend or interest. These incentives for holding investments that generate capital gains rather than ordinary income should be greatest in the 1983 SCF. After 1993, and particularly after 1997, the incentive for receiving capital gains increased, although it did not return to pre-1986 levels. After the Taxpayer Relief Act of 1997 took effect, the difference between the top tax rate on ordinary income, and the tax rate on capital gains, was roughly 20 percentage points. That differential had been 30 percentage points before 1986. Second, TRA86 reduced the incentive for high-income taxpayers to hold tax-exempt debt. Third, TRA86 raised the capital gains tax rate, and thereby increased the benefit from tax-efficient management of capital gains and losses. Ceteris paribus, this should have discouraged high-income taxpayers from owning mutual funds, which do not necessarily optimize their tax liabilities, and encouraged direct ownership of gains-producing assets. Finally, TRA86 reduced the incentive for high-income taxpayers to invest through tax-deferred accounts. This occurred through reduction of marginal tax rates, elimination of the possibility of pre-tax IRA contributions for households with incomes above certain thresholds, and reduction of limits on contributions to 401(k) plans.

The foregoing discussion, and our analysis, does not consider tax changes on firms that might, in general equilibrium, affect the structure of household portfolios. For example, the reduction in *corporate* tax rates in 1986 placed the top personal tax rate (28%) below the top corporate tax rate (34%) and changed the incentives for organizing both investment and other activities in corporate vs. individual form. Fluctuation in the corporate tax rate also should have changed the incentives for corporations to finance their activities with debt versus equity securities, thereby altering the supply of assets to the household sector. Our empirical strategy asks whether, at a given point in time, those households with higher marginal tax rates are more likely to hold tax-favored assets. Using our results to analyze how major tax reforms might affect portfolio structure requires a general equilibrium framework that considers asset supplies as well as asset demands.

3.4. Estimating marginal tax rates for SCF households

To assess tax incentives for holding different assets, we estimate each SCF household's marginal tax rate on ordinary investment income. Although this tax rate is not the only relevant aspect of tax policy for portfolio decisions, most of the differences in tax incentives across households are due to cross-sectional variation in this tax rate. We use information on household income and demographic structure to estimate marginal tax rates.

Our algorithm for estimating marginal tax rates proceeds line-by-line down the Form 1040 and other relevant tax schedules. Filing status is determined by the household's marital status, with all married households assumed to file a joint return. Personal exemptions are estimated based on marital status and the number of dependents in the household under age 18. The SCF reports information on many of the components of total income. Wages and salaries, taxable interest, tax-exempt interest, dividends, alimony received, rents and royalties, business income, and farm income are all defined similarly in the SCF and for tax purposes.

Other components of income required for the 1040 are not reported in the SCF, or are not reported in as much detail on the survey as on tax returns. We have no data on refunds of state and local income taxes, other gains, and IRA distributions, so we set these income components to zero. All pension and unemployment compensation that is reported is assumed to be taxable. Social Security benefits are taxed according to the formula appropriate to each year.

The remaining component of adjusted gross income (AGI) is adjustments to total income. We have information on three adjustments. The self-employment tax is applied to all business and farm income. IRA and Keogh contributions can be imputed based on information in the survey, but we set these contributions to zero for the purposes of the marginal tax rates used in this paper. The SCF reports alimony paid. We set all other adjustments that are allowed on Form 1040, such as

moving expenses, to zero. Subtracting the total adjustments from total income gives the household's AGI.

The next step in the computations is to estimate the household's possibility of itemizing deductions on Form 1040 Schedule A. The SCF reports information on interest payments and charitable contributions. Deductions for local taxes are based on the reported value of real estate and personal property subject to tax. Itemization is determined by comparing the sum of these deductions to the standard deduction appropriate for the household's age and filing status. The lack of reported information on other possible deductions, such as medical expenses, state and local income taxes, casualty losses, and job expenses, is the biggest handicap in calculating tax rates in the SCF. The household's exemptions and deductions are then subjected to the limits based on income in the later survey years. Subtracting them from AGI yields the household's taxable income. Applying the appropriate tax rate schedule to taxable income gives the household's tax liability. Total taxes equal this liability measure, plus self-employment taxes and alternative minimum taxes. We did not compute tax credits such as the Earned Income Credit, since the SCF does not contain the information needed to evaluate many of the credits.

Fig. 1 summarizes the marginal tax rate patterns in 1983, 1989, and 1998. We omit the 1992 tax rates because they are very similar to the 1989 values, and the 1995 values because they are very similar to 1998. The horizontal axis represents the percentiles of the distribution of the marginal tax rate on ordinary income in each year. The vertical axis represents the value of the marginal tax rate, in percentage points. The distribution of marginal tax rates in each year is the result

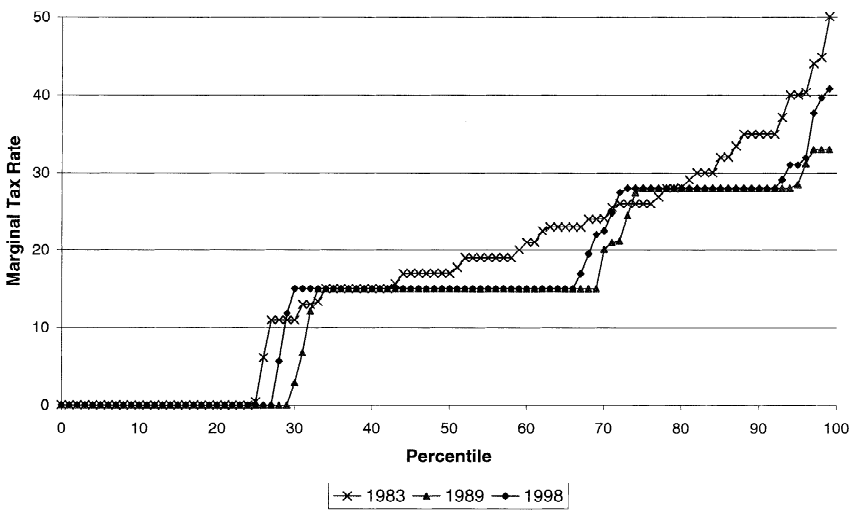

Fig. 1. Summary of the marginal tax rate patterns in 1983, 1989, and 1998.

of applying the tax-calculating algorithm to each household in the SCF sample, and then weighting each SCF household by its sampling weight. This yields a distribution of marginal tax rates that corresponds to the distribution for the US population.

Fig. 1 shows that in each year, between 25 and 30% of the households face a zero marginal tax rate. These are households whose current income is low enough that they do not have to pay tax. Beyond this point, the 1983 schedule is substantially different from that of the other years, with many short, flat portions denoting tax brackets, and a top rate of 50%. The effect of TRA86 in compressing the tax brackets is shown by the long, flat portions of the 1989 schedule, first at 15%, then at 28%, and finally at a top rate of 33%. The 1998 distribution is quite similar to that for 1989, except at the highest percentiles, where the marginal tax rates in 1998 are higher than the comparable rates in 1989. Fig. 1 illustrates the source of the identifying variation in our analysis, which corresponds to variation along the tax schedule for a given year.

Summary statistics can further document the changing pattern of marginal tax rates. The average marginal tax rate in 1983 was 17.6%, compared with 14.3% in 1989, 14.8% in 1995, and 15.3% in 1998. The tax changes for high-income households that were enacted in 1990 and 1993 raised the marginal tax rates at the top of the distribution, and these changes resulted in an increase in the average marginal tax rate (averaged over all households). The reforms in 1990, 1993, and 1997 had little effect, however, on households in the bottom two thirds of the taxable income distribution.

3.5. Portfolio structure and potential endogeneity of the household marginal tax rate

Our empirical analysis focuses on the correlation between marginal tax rates and various attributes of household portfolios. Simple correlations could be driven by a spurious link between portfolio structure and tax rates, however, since the measured marginal tax rate on another dollar of investment income to measure tax incentives may itself be affected by portfolio choices. To avoid this problem, we calculate marginal tax rates as the difference in a household's tax liability at a base level of income, $T(Y_B)$, and that base level of income plus an increment Δ. The tax liability at the incremented income level is $T(Y_B + \Delta)$. Given our two estimates of total tax liability, we calculate the household's marginal tax rate as $[T(Y_B + \Delta) - T(Y_B)]/\Delta$.

The marginal tax rate is a non-decreasing function of base income, which can in turn be affected by a household's portfolio choices. A household that allocates its entire portfolio to tax advantaged assets reduces its taxable income and, consequently, it may face a lower marginal tax rate than a household that holds a portfolio of the same value invested in more heavily taxed assets. Similarly, a household that has investments in tax-deferred assets may continue to make

contributions to them, thereby lowering its taxable income and marginal tax rate compared to a household that has the same income and portfolio value but no tax-deferred accounts.

To purge the marginal tax rate of this endogeneity, the base amount and the increment must be unrelated to the household's portfolio allocation decision. We define the base level of income for a household by artificially setting its investment income from interest, tax-exempt interest, dividends, and capital gains to zero. We set contributions to IRAs and Keoghs to zero, and we assume that reported wages are gross of employee contributions to employer-sponsored retirement plans. This choice of the base amount generates a 'first dollar' marginal tax rate on investment income. The increment to income that we use to calculate the household's marginal tax rate is the greater of 5% of the household's total financial assets, or $100. We choose 5% to approximate the nominal return on taxable interest bearing assets over the sample period. If this increment to taxable income moves the household from one tax bracket to another, the estimated marginal tax rate will be an average of the marginal tax rates corresponding to each of the two income brackets.

4. Econometric framework

We analyze two aspects of the household portfolio problem: whether to allocate any funds to a given asset category, and how much to allocate to each category with positive holdings. We estimate probit models for asset ownership and tobit models for portfolio shares as a function of a household's marginal tax rate. We control for a range of socioeconomic and demographic variables discussed below, and test whether a household's marginal tax rate is related to its portfolio choices.

To formalize our analysis, we denote positive holdings of asset j by household i with an indicator variable, D_{ij}, set equal to unity if household i holds asset j and to zero otherwise. Analogously, we define S_{ij} as the share of asset j in household i's portfolio of financial assets. In each of these cases, we define a latent variable that indicates the household's preferred choice. In the probit case, the latent variable D^*_{ij} indicates the desire to own the asset:

$$D^*_{i,j} = X_i \beta_j + e_{i,j} \tag{1}$$

In the tobit case, the latent variable indicates the share of the household's portfolio that would notionally be allocated to the asset:

$$S^*_{i,j} = X_i \gamma_j + u_{i,j} \tag{2}$$

Our tobit models allow for censoring both at zero, when the household does not hold the asset, and at one, when the household invests its entire portfolio in one asset class. Censoring at zero is much more common than censoring at one. The standard deviation of $u_{i,j}$ is denoted by σ_j.

Equilibrium models of taxes and portfolio choice predict which households in a cross-section should hold particular assets, and how much of their portfolio they should allocate to these assets, as a function of the household's position in the marginal tax rate distribution. These models predict that households with high marginal tax rates will hold portfolios skewed toward tax advantaged assets.

We estimate probit and tobit models on each cross-section. We present full results for 1998, as well as the marginal effects of the tax rate variable for all sample years. We estimate these models for eight different asset classes in each sample. One potential difficulty with our approach is that the errors in the latent variable models that generate asset demand are correlated across equations. In our specifications, however, the set of explanatory variables, X_i, is the same for all asset classes. If the specifications were linear, they would form a system of seemingly unrelated regressions, so the coefficient estimates, β_j and γ_j, would not depend on the cross-equation correlation matrix. Due to the nonlinearity of the probit and tobit functional forms, however, the value of the likelihood function can be improved by maximizing jointly over the model coefficients and the parameters of the correlation matrix.

Estimating eight-variate probit and tobit models is a non-trivial computational problem. When we experimented with smaller four-dimensional systems, we either had difficulties avoiding numerically unstable regions of the parameter space, or achieving convergence in reasonable time frames. To obtain some information on the nature and importance of these cross-correlations, however, we estimated a set of bivariate probits and bivariate tobits, considering each possible pair of asset classes. There were very few substantial changes in the coefficients in either of the probit or tobit models relative to the coefficients that we estimated in the univariate models. We therefore present estimates of the coefficients under the assumption that the correlation matrices for the errors in the latent variable Eqs. (1) and (2) are diagonal. We also report estimates of the correlation matrices based on residuals from many bivariate probit and tobit equations.

Two complications arise in the tobit specifications for portfolio shares but not in the discrete choice probit equations. The first is that the marginal effects of each explanatory variable on the portfolio share in asset j must sum to zero across all assets. These restrictions need not apply to the marginal effects in the ownership probits, because ownership of one financial asset does not preclude ownership of any other. If these were linear models, the adding up constraint would be satisfied by the coefficients, because it is satisfied in the data. The nonlinearity of our models does not ensure such an outcome, however, so we must impose these constraints. Greene (2000, p. 909) shows that the marginal effect of explanatory variable k on the expected portfolio share is given by:

$$\frac{\mathrm{d}E(S_{ij})}{\mathrm{d}X_i^k} = \sum_i \left[\Phi\left(\frac{1 - \gamma_j' X_i}{\sigma_j} \right) - \Phi\left(\frac{-\gamma_j' X_i}{\sigma_j} \right) \right] \gamma_j^k \tag{3}$$

where Φ denotes the cumulative standard normal distribution function, the

summation on the right hand side of (3) is over households in the sample, and X_i^k is the kth element of the vector of explanatory variables for household i. The marginal effect of X_i^k on the amount that household i holds in asset j is the product of its coefficient in the equation for the jth asset and the probability that the latent variable for a given observation falls between the upper and lower limits associated with the tobit.

In light of (3), the constraint that a change in explanatory variable k has no effect on the sum of all portfolio shares requires:

$$\sum_j \frac{\mathrm{d}E(S_{i,j})}{\mathrm{d}X_i^k} = \sum_j \sum_i \left[\Phi\left(\frac{1-\gamma_j' X_i}{\sigma_j}\right) - \Phi\left(\frac{-\gamma_j' X_i}{\sigma_j}\right) \right] \gamma_j^k = 0. \tag{4}$$

Imposing these restrictions (one for each explanatory variable k) on the coefficients requires estimating the system of eight equations jointly, because the restriction for each explanatory variable depends on all of the parameters in all of the equations. However, when we assume that the errors are uncorrelated across equations, the log-likelihood function is the sum of the log-likelihood functions for each separate asset demand equation. This simplifies the estimation problem, because we can evaluate eight univariate normal integrals, rather than the eight-dimensional normal integral that would be associated with the problem assuming correlated errors.

The second complication is that 1419 households (7.2% of the 19 756 total) report no holdings of any financial assets. There are 390 such households (9.51%) in 1983, 283 (7.57%) in 1989, 268 (6.86%) in 1992, 274 (6.37%) in 1995, and 249 (5.8%) in 1998. We assume, for estimating our tobit models, that these households have some unreported holdings of interest bearing accounts. We therefore assume that these households are censored at 1 for interest bearing accounts and 0 for all other assets. The estimated coefficients when these households are excluded from the sample are similar to those based on this crude data fix.

There is also a potential econometric concern associated with the tobit specifications. The tobit model constrains the coefficients associated with the discrete decision to own an asset to be the same as those on the choice of how much to own, conditional on ownership. In some cases this restriction may be inappropriate. We test for the equality of the coefficients across the probit and tobit specifications below.

We control for a number of variables that might also influence household portfolio decisions through their correlation with household risk aversion or investment opportunities. These include categorical variables for household income, net worth, and basic demographic attributes, such as the size of the household and the age, gender, marital status, education, and risk aversion of the household head. We define the head of a married household to be the spouse with the higher labor income or, if both spouses earn the same income (usually zero), the older spouse. We classify the household as risk averse if it reports that it is

unwilling to take financial risk in exchange for higher returns. We also include indicator variables for the occupation and industry of the head of household. The occupation categories are Executives or Professionals; Clerical, Technical, and Sales; Service Workers; Crafts; Laborers; Farmers; Retired; and Not in the Labor Force. The industry categories are Agriculture and Forestry; Mining, Construction, and Manufacturing; Services; and Public Administration.

We define household income as the sum of wages and salaries, income from professional practices, businesses, or farms, rental and royalty income, unemployment insurance or worker's compensation, (net) child support or alimony, welfare programs, and disability or retirement programs such as Social Security or private pensions.[1] This income measure does not include income from financial assets, thereby avoiding potential endogeneity of the income and portfolio choice variables.

Table 5 shows the proportions of the sample respondents in each of the discrete categories for each cross-sectional survey. All income and net worth categories are reported in thousands of 1995 dollars. The income tabulations show movement toward higher real income categories, away from income levels under $50 000 and toward income levels over $75 000. Most of the change occurred between the 1983 and 1989 surveys. There was also movement toward higher net worth categories, with categories under $250 000 losing observations and categories over $250 000 gaining observations. These changes partly reflect the increase in real incomes and real net worth over our sample period.

5. Empirical findings: asset ownership patterns

Table 6 shows the probit coefficients and standard errors for each of the eight asset categories for the 1998 SCF. The coefficient for the marginal tax rate, denoted MTR in the tables, is positive and statistically significant in the equations for directly-held taxable equity, taxable equity mutual funds, tax-deferred equity, tax-deferred bonds, tax-exempt bonds, and interest-bearing accounts. These findings offer modest support for the importance of taxes in affecting household portfolio decisions. All of the assets that are taxed less heavily than taxable bonds have positive and statistically significant coefficients on the marginal tax rate variable. The one finding that is inconsistent with the standard models of how taxes affect portfolio choice is the positive and statistically significant coefficient on interest-bearing accounts. Since interest-bearing accounts are probably used for

[1] In an earlier draft of this paper, we included income from financial assets in total family income. With this income definition, the marginal tax rate was not positive and statistically significantly different from zero in any tobit for equity held directly. It was negative in two of the samples. With capital income excluded, the effect of the marginal tax rate is estimated to be positive in all samples and significant in two.

Table 5
Summary statistics on Survey of Consumer Finances sample: 1983–1998

	1998	1995	1992	1989	1983
Income					
($000, 1995 dollars)					
0–15	27.70	28.42	30.02	30.32	27.03
15–25	15.62	16.54	17.50	16.06	18.80
25–50	29.49	29.41	26.97	27.65	32.02
50–75	14.11	13.96	13.28	14.64	14.01
75–100	6.29	5.38	5.65	5.10	4.50
100–250	5.45	5.04	5.52	5.29	3.19
250 +	1.33	1.26	1.06	0.95	0.46
Net worth					
($000, 1995 dollars)					
0–50	45.22	46.70	48.53	47.00	47.37
50–100	14.88	17.35	15.05	14.39	17.66
100–250	20.43	20.89	20.83	20.84	20.74
250–1000	15.43	12.05	12.48	14.01	11.47
1000 +	4.05	3.01	3.11	3.77	2.76
Education					
Some high school	18.35	19.52	20.62	25.40	28.22
High school diploma	29.73	29.43	29.46	30.58	30.74
Some college	23.66	23.87	21.73	20.69	19.85
College degree	16.76	15.84	15.77	12.20	10.53
Post college	11.50	11.34	12.42	11.13	10.66
Age					
Under 25	5.31	5.33	5.19	5.84	6.61
25–34	18.62	19.57	20.70	22.43	22.57
35–44	23.09	23.28	23.09	21.58	20.42
45–54	19.32	18.36	16.51	15.58	15.57
55–64	12.64	12.20	12.72	13.46	15.45
65 +	21.02	21.26	21.79	21.12	19.38
Unwilling to take risk	39.01	45.61	49.67	48.99	43.45
Female	41.32	42.89	41.07	40.22	36.44
Married	57.85	57.91	57.41	58.39	60.58
Household size	2.59	2.58	2.62	2.72	2.68
Households (Millions)	102.55	99.01	95.92	93.02	83.92
Observations	4305	4299	3906	3143	4103

Notes: Authors' tabulations based on Surveys of Consumer Finances, weighting each household by its sampling weight. Demographic characteristics pertain to the head of the household.

transaction purposes, rather than as a long-term investment vehicle, by most households, however, it is not clear that this result should be interpreted as relating to portfolio decisions.

The coefficients on the income and wealth categories are also informative. Most

Table 6
Probit estimates for financial asset ownership: 1998

Independent variables	Taxable equity (Directly held)		Taxable equity (Mutual funds)		Tax-deferred equity		Tax-deferred bonds		Tax-exempt bonds		Taxable bonds		Interest bearing accounts		Other financial assets	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Constant	−2.001	0.540	−2.117	0.434	−1.879	0.357	−2.251	0.369	−3.167	0.607	−2.783	0.449	0.177	0.466	−0.690	0.354
MTR	0.596	0.261	0.659	0.254	0.779	0.243	0.728	0.235	0.780	0.290	0.450	0.237	1.099	0.526	0.308	0.237
Income																
15–25	0.195	0.095	0.023	0.104	0.209	0.088	0.373	0.086	−0.172	0.133	−0.057	0.091	0.460	0.115	−0.001	0.077
25–50	0.050	0.091	0.004	0.095	0.492	0.081	0.425	0.081	−0.144	0.114	0.178	0.082	0.903	0.133	0.168	0.074
50–75	0.153	0.110	0.044	0.114	0.532	0.100	0.422	0.100	−0.072	0.133	0.151	0.101	1.008	0.228	0.139	0.096
75–100	0.206	0.124	0.024	0.126	0.674	0.120	0.496	0.117	−0.073	0.152	0.279	0.117	0.824	0.405	0.085	0.115
100–250	0.080	0.121	0.083	0.121	0.510	0.115	0.319	0.114	−0.136	0.138	0.053	0.113	0.781	0.333	0.095	0.112
250 +	0.213	0.133	−0.019	0.129	0.567	0.127	0.393	0.123	0.075	0.142	0.018	0.122	−0.363	0.406	0.088	0.122
Net worth																
50–100	0.478	0.100	0.646	0.107	0.305	0.083	0.213	0.082	0.583	0.158	0.377	0.087	0.886	0.170	0.261	0.076
100–250	0.770	0.089	0.755	0.096	0.419	0.076	0.392	0.075	0.704	0.142	0.589	0.079	0.921	0.168	0.477	0.070
250–1000	1.124	0.092	1.151	0.097	0.619	0.082	0.476	0.079	1.163	0.143	0.729	0.083	1.081	0.243	0.790	0.076
1000 +	1.926	0.109	1.252	0.110	0.552	0.101	0.279	0.097	1.843	0.153	0.937	0.099	1.537	0.334	1.077	0.095
Education																
High school	0.311	0.114	0.212	0.123	0.165	0.089	0.432	0.086	−0.052	0.135	0.360	0.094	0.512	0.095	0.172	0.073
Some college	0.522	0.116	0.334	0.124	0.238	0.093	0.417	0.091	0.107	0.137	0.440	0.097	0.736	0.113	0.076	0.078
College degree	0.704	0.118	0.504	0.126	0.333	0.098	0.453	0.097	0.108	0.140	0.506	0.102	1.366	0.203	0.167	0.084
Post college	0.687	0.125	0.661	0.129	0.409	0.104	0.434	0.102	0.334	0.142	0.633	0.106	0.719	0.199	0.239	0.092
Age																
25–34	0.126	0.154	0.046	0.169	0.513	0.134	0.444	0.146	0.274	0.278	0.074	0.134	−0.178	0.139	−0.083	0.111
35–44	−0.001	0.155	−0.091	0.167	0.633	0.133	0.613	0.145	0.003	0.276	0.034	0.134	−0.070	0.145	0.021	0.109
45–54	−0.012	0.155	−0.148	0.167	0.463	0.136	0.473	0.146	−0.013	0.274	−0.094	0.136	0.014	0.155	0.002	0.110
55–64	0.083	0.163	−0.333	0.173	0.546	0.143	0.669	0.150	−0.021	0.276	−0.164	0.142	0.380	0.174	0.069	0.117
65 +	0.061	0.172	−0.237	0.178	−0.069	0.152	0.509	0.157	0.429	0.278	−0.008	0.148	0.460	0.188	0.159	0.125
Risk averse	−0.507	0.065	−0.620	0.074	−0.578	0.056	−0.078	0.055	−0.219	0.087	−0.183	0.059	−0.287	0.081	−0.184	0.051
Female	0.028	0.059	0.018	0.058	0.008	0.053	0.054	0.052	0.098	0.070	0.155	0.053	0.006	0.093	0.041	0.049
Married	0.022	0.071	0.129	0.071	0.142	0.063	0.168	0.061	−0.069	0.087	0.127	0.062	−0.071	0.111	0.082	0.059
HH Size	−0.017	0.023	−0.061	0.023	−0.061	0.020	−0.024	0.019	−0.046	0.029	0.063	0.019	−0.009	0.030	−0.013	0.018

Source: Authors' estimates based on 1998 Survey of Consumer of Finances data. See text for further discussion.

asset categories show an increasing probability of ownership at higher net worth levels. For all categories of assets except directly held equity and tax-exempt bonds, most of the increase occurs in moving from net worth under $50 000 to net worth levels up to $1 000 000. For the income coefficients, ownership of directly held equity, tax-deferred equity and bonds, and interest bearing accounts is significantly higher at higher income levels. With the exception of directly held equity, most of the increase occurs in moving from income under $15 000 (the omitted category) to income levels up to $250 000.

The remaining rows of the table show the coefficients for the demographic variables. Higher education, at least through the level of a college degree, is associated with a higher probability of ownership for each of the assets. There are a variety of patterns of ownership by age across assets, generally without statistical significance. Some exceptions are higher ownership rates for interest bearing accounts and other financial assets for older households and higher ownership of tax-deferred equity at lower ages. Poterba and Samwick (2001) present a more detailed analysis of the age profiles of asset ownership and portfolio allocation, along with tests for the differences in portfolio composition across birth cohorts.

Households who report that they are unwilling to take on financial risk are less likely to own all types of assets. None of the coefficients on the gender of the household head are statistically significant. Married households are significantly more likely than unmarried households to own equity mutual funds, equity and bonds in tax-deferred accounts, and taxable bonds. Larger households are more likely to own taxable bonds and less likely to own taxable equity, tax-deferred accounts, and interest-bearing accounts.

Table 7 presents estimates of the 'marginal effects' of marginal tax rates, based on probit estimates for each year of the SCF. The marginal effect of X^k in the probit equation for asset j equals the sample average value of $\phi(\beta_j' X_i)\,\beta_j^k$. One asterisk indicates that the coefficient on which the marginal effect is based is statistically significant at the 10% level, and two asterisks indicate significance at the 5% level. The upper panel of Table 7 reports the marginal effect of a 1 percentage point increase in the marginal tax rate. The lower panel shows the marginal effect of a 10-percentage point increase in the marginal tax rate, relative to the baseline asset ownership probability for each asset class.

To facilitate the interpretation of the results in the table, consider the marginal effect for directly held equity in 1998. The estimate of 0.215 implies that a 10-percentage point increase in the marginal tax rate would raise the probability of ownership by 2.15 percentage points. Table 1 shows that the percentage of households that own equity directly is 21.35%. Thus, a 2.15-percentage point increase in direct equity ownership would represent a 10.1% increase in the probability of directly owning stock; this is the entry in the lower panel of Table 7.

When expressed as a percentage of the baseline ownership probabilities, the effect of a 10-percentage point increase in the marginal tax rate varies considerably across asset categories. Both tax-exempt bonds and taxable equity

Table 7
Marginal effects of changes in marginal tax rate on probability of asset ownership probit models: 1983–1998

	1998	1995	1992	1989	1983
Estimate of marginal effect					
Directly held equity	0.215**	0.096	0.468**	0.160	0.505**
Equity mutual funds	0.251**	0.471**	0.450**	0.635**	0.274
Tax-deferred equity	0.272**	0.174**	0.205	0.311**	0.619**
Tax-deferred bonds	0.273**	0.179**	0.270**	0.112	0.732**
Tax-exempt bonds	0.303**	0.449**	0.893**	0.765**	0.836**
Taxable bonds	0.170*	0.140	0.440**	0.216*	0.515**
Interest bearing accounts	0.285**	0.219	0.072	0.337*	0.499**
Other financial assets	0.107	0.121	0.054	0.028	0.320**
Effect of a 10-percentage point MTR increase on ownership (as percent of baseline ownership probabilities)					
Directly held equity	10.1	5.8	25.8	8.9	26.5
Equity mutual funds	16.8	41.8	53.9	108.4	90.6
Tax-deferred equity	7.1	5.7	8.0	15.2	31.7
Tax-deferred bonds	9.2	5.9	8.9	3.7	28.0
Tax-exempt bonds	47.0	69.8	131.5	119.5	252.4
Taxable bonds	7.2	5.3	16.1	7.7	21.5
Interest bearing accounts	3.2	2.5	0.8	3.9	5.7
Other financial assets	2.7	2.8	1.2	0.6	8.8

Notes: The top panel shows the marginal effect of a unit increase in the marginal tax rate on the expected probability of ownership. The lower panel divides 0.10* (top panel estimate) by the probability that a household owns the asset class, as shown in Table 1. Asterisks indicate statistical significance at the 5% (**) and 10% (*) significance levels. See text for further discussion.

mutual funds show large effects of the marginal tax rate. The increases are 47 and 17% in 1998, respectively. In contrast, the three categories taxed as ordinary income — taxable bonds, interest bearing accounts, and other financial assets — show smaller percentage effects. The same is true of taxable equity held directly.

Table 7 shows that there is a reasonable degree of consistency from one SCF to the next in the set of asset categories for which ownership is most highly correlated with marginal tax rates. There is a positive and statistically significant effect of tax rates on tax-deferred equity and bond ownership in four of the five surveys. The positive effect on ownership of taxable equity mutual funds is observed for four years, and the effect on taxable equity held directly is present for three years. The effect on tax-exempt bond ownership is present for all five years.

The lower panel of Table 7 shows some changes over time in the estimated proportional impact of a ten percentage point increase in marginal tax rates. In 1983, for example, the effect of such a tax change on holdings of tax-exempt bonds was much larger than that corresponding change in 1998. The entries in the upper panel of Table 7 show that this was primarily the result of a decline in the estimated marginal effect of tax rates on tax-exempt bond holdings. For other asset

categories, such as equity mutual funds, the proportional effects in the lower panel have declined largely because of increases over time in the baseline ownership probabilities. These increases have reduced the proportional impact of a marginal change of a given size.

The results in Table 6 show that ownership decisions for different financial assets are correlated through the effects of observable variables such as the marginal tax rate, income, and wealth. Ownership decisions may also be correlated through the presence of unobservable factors, which are captured in the error terms in the latent variable equations. To explore this issue, in Table 8 we report the correlation matrix of the residuals from all possible bivariate probits for pairs of asset classes, using data for 1998. All of the correlations are positive, indicating that once a household owns assets in any asset class, it is more likely to own assets in each of the other asset classes as well, even conditioning on income and wealth. The correlations involving tax-exempt bonds and equity mutual funds tend to be higher than those for other asset categories.

The positive correlations may have several explanations. One is that establishing ownership of one asset, such as an equity mutual fund, reduces the marginal cost of establishing ownership of other assets. For example, once an investor does enough research and pays the fees to own a stock index fund, it may be easier for that investor to establish ownership of a municipal bond fund at the same fund family. Another possibility is that potential investors differ in their costs — out of pocket, psychic, and otherwise — of researching investment options and making investments. Those who face lower costs, for example because they are more skilled at library or internet research, may be more likely to invest in not just one, but many, asset categories.

Table 8
Estimated correlation matrices from bivariate probits: 1998

	Directly held equity	Equity mutual funds	Tax deferred equity	Tax deferred bonds	Tax exempt bonds	Taxable bonds	Interest bearing accounts	Other financial assets
Directly held equity								
Equity mutual funds	0.213							
Tax-deferred equity	0.221	0.170						
Tax-deferred bonds	0.014	−0.032	0.224					
Tax-exempt bonds	0.172	0.408	0.052	0.137				
Taxable bonds	0.229	0.259	0.096	0.142	0.332			
Interest bearing accounts	0.226	0.201	0.249	0.264	0.210	0.259		
Other financial assets	0.121	0.067	0.024	0.074	0.070	0.155	0.086	

Note: The entry for each cell is the estimated correlation parameter from a bivariate probit estimated on the pair of asset classes listed in the row and column headers. See text for further discussion.

6. Empirical findings: the allocation of household portfolios

We now explore how tax rates affect the portfolio shares allocated to each of the financial asset categories. We focus on results using the 1998 SCF, and report marginal effects of tax rates on portfolio shares for all of the other SCF cross-sections.

6.1. Basic portfolio share results

Table 9 shows the coefficients and standard errors for each of the eight tobit equations for 1998. An increase in the marginal tax rate leads to a statistically significant increase in the share of the portfolio allocated to direct holdings of corporate stock, and to a significant decrease in the portfolio share allocated to interest bearing accounts. The coefficients for tax-deferred bonds, taxable bonds, and tax-exempt bonds are positive but significant only at the 10% level. The coefficient for equity held through mutual funds is positive but insignificant. The coefficients for tax-deferred equity and other financial assets are negative but not statistically significant.

Table 9 also shows the effects of income, net worth, and demographics on portfolio shares. Higher levels of net worth are associated with lower portfolio shares of interest bearing accounts and with higher portfolio shares of all other financial assets except tax-deferred equity and other financial assets. Higher levels of income are associated with higher portfolio shares of tax-deferred equity and bonds and lower portfolio shares of interest bearing accounts. There are several notable patterns in the coefficient estimates for the various demographic variables. Higher levels of education are associated with lower portfolio shares of interest bearing accounts and with higher portfolio shares of all other assets except tax-deferred bonds. There is little systematic effect of age, gender, and household size. Married households tend to have greater portfolio shares of taxable bonds and tax-deferred equity and bonds and lower portfolio shares of other financial assets. Risk aversion is negatively related to tax-exempt bonds and all types of equity investment. It is positively related to investments in tax-deferred bonds and interest-bearing accounts.

Table 10 shows the marginal effects of tax rate increases on asset allocation for each of our sample years. The results show that the tobit marginal effects vary from year to year both in absolute size and in the statistical significance of the results for particular equations. The pattern in Table 10 is somewhat different from that in Table 7, where there was substantial consistency in the coefficient patterns from one year to the next. In Table 10, we find that the marginal effect of the tax variable on directly-held equity is statistically significant in 1998, 1992, and 1983. The tax effect on the portfolio share of equity in mutual funds is positive and statistically significant at the 5% level in 1995 and 1989 and at the 10% level in

Table 9
Tobit estimates of financial asset shares: 1998 (Adding up constraints imposed on marginal effects)

Independent variables	Taxable equity (Directly held)		Taxable equity (Mutual funds)		Tax-deferred equity		Tax-deferred bonds		Tax-exempt bonds		Taxable bonds		Interest bearing accounts		Other financial assets	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Constant	−0.378	0.116	−0.422	0.105	−0.241	0.121	−0.506	0.138	−0.758	0.125	−0.553	0.104	1.004	0.096	0.136	0.125
MTR	0.199	0.080	0.124	0.077	−0.002	0.079	0.158	0.086	0.173	0.089	0.090	0.050	−0.222	0.067	−0.087	0.076
Income																
15–25	0.019	0.030	−0.011	0.030	0.036	0.026	0.107	0.030	−0.060	0.034	−0.021	0.023	−0.050	0.032	−0.019	0.031
25–50	−0.051	0.029	−0.009	0.028	0.170	0.026	0.119	0.029	−0.037	0.032	0.003	0.019	−0.142	0.028	0.002	0.027
50–75	−0.045	0.036	−0.004	0.035	0.201	0.032	0.130	0.036	−0.031	0.038	−0.009	0.023	−0.169	0.032	0.002	0.032
75–100	−0.033	0.039	0.008	0.039	0.226	0.036	0.141	0.041	−0.039	0.044	0.000	0.024	−0.175	0.033	−0.038	0.036
100–250	−0.070	0.038	0.035	0.035	0.199	0.036	0.095	0.039	−0.050	0.039	−0.020	0.026	−0.131	0.033	−0.013	0.035
250 +	−0.041	0.041	−0.013	0.037	0.163	0.038	0.086	0.042	0.022	0.039	−0.026	0.027	−0.096	0.033	−0.037	0.036
Net worth																
50–100	0.092	0.032	0.134	0.032	0.056	0.027	0.038	0.032	0.121	0.048	0.049	0.019	−0.194	0.031	0.006	0.030
100–250	0.164	0.029	0.154	0.028	0.057	0.024	0.062	0.027	0.120	0.036	0.083	0.018	−0.298	0.027	0.055	0.027
250–1000	0.248	0.030	0.242	0.028	0.059	0.026	0.033	0.027	0.240	0.036	0.089	0.019	−0.394	0.027	0.072	0.028
1000 +	0.551	0.034	0.232	0.031	−0.058	0.030	−0.088	0.034	0.432	0.040	0.129	0.022	−0.483	0.030	0.105	0.031
Education																
High school	0.053	0.030	0.024	0.030	0.002	0.026	0.115	0.029	−0.028	0.035	0.078	0.021	−0.129	0.034	0.017	0.032
Some college	0.095	0.031	0.041	0.031	0.023	0.028	0.092	0.031	0.011	0.036	0.089	0.021	−0.138	0.034	−0.029	0.032
College degree	0.139	0.032	0.085	0.032	0.033	0.029	0.093	0.033	0.003	0.037	0.108	0.022	−0.183	0.034	−0.034	0.033
Post college	0.115	0.035	0.121	0.033	0.038	0.030	0.083	0.035	0.037	0.038	0.116	0.023	−0.188	0.035	−0.039	0.034
Age																
25–34	−0.024	0.047	−0.042	0.053	0.130	0.038	0.082	0.045	0.026	0.058	0.018	0.033	−0.088	0.051	−0.038	0.048
35–44	−0.061	0.048	−0.067	0.052	0.176	0.037	0.165	0.045	−0.040	0.058	−0.004	0.031	−0.127	0.051	−0.018	0.047
45–54	−0.057	0.048	−0.071	0.052	0.143	0.038	0.129	0.045	−0.038	0.058	−0.010	0.032	−0.084	0.051	−0.020	0.047
55–64	−0.014	0.050	−0.134	0.054	0.155	0.040	0.194	0.046	−0.052	0.059	−0.019	0.034	−0.127	0.052	−0.010	0.048
65 +	0.000	0.053	−0.106	0.054	−0.005	0.042	0.143	0.047	0.059	0.060	0.031	0.036	−0.076	0.054	0.026	0.050
Risk averse	−0.117	0.020	−0.141	0.021	−0.155	0.018	0.005	0.020	0.007	0.028	−0.019	0.014	0.185	0.021	0.042	0.020
Female	−0.002	0.017	0.007	0.017	−0.017	0.016	0.011	0.018	0.006	0.020	0.024	0.012	−0.009	0.017	0.004	0.017
Married	−0.014	0.021	0.028	0.022	0.008	0.020	0.036	0.021	−0.013	0.024	0.023	0.015	−0.016	0.021	−0.021	0.021
HH Size	−0.001	0.006	−0.018	0.007	−0.014	0.006	−0.004	0.007	−0.013	0.008	0.011	0.004	0.006	0.007	0.013	0.007
σ	0.372	0.008	0.326	0.010	0.377	0.007	0.399	0.009	0.305	0.013	0.235	0.010	0.389	0.005	0.418	0.009

Source: Authors' estimates based on 1998 SCF. Each tobit model allows for censoring at portfolio shares of zero and one. See text for further discussion.

Table 10
Marginal effects of changes in marginal tax rate on portfolio shares Tobit models 1983–1998

	1998	1995	1992	1989	1983
Estimate of marginal effect					
Directly held equity	0.066**	0.012	0.098**	0.011	0.069**
Equity mutual funds	0.026	0.053**	0.025*	0.036**	0.003
Tax-deferred equity	−0.001	0.018	0.024	0.003	0.083**
Tax-deferred bonds	0.050*	0.012	0.054	−0.012	0.107**
Tax-exempt bonds	0.022*	0.049**	0.096**	0.087**	0.031**
Taxable bonds	0.023*	0.019	0.061**	0.014	0.049**
Interest bearing accounts	−0.144**	−0.130**	−0.222**	−0.105*	−0.357**
Other financial assets	−0.042	−0.034	−0.136**	−0.034	0.016
Effect of a 10-percentage point MTR increase on portfolio shares (as percent of baseline unconditional average share)					
Directly held equity	10.7	2.9	22.6	2.5	14.0
Equity mutual funds	6.7	18.5	17.0	43.0	10.0
Tax-deferred equity	−0.1	1.6	2.9	0.6	14.5
Tax-deferred bonds	5.1	1.1	5.0	−1.2	13.6
Tax-exempt bonds	18.4	40.9	55.0	56.1	45.4
Taxable bonds	8.0	5.1	15.7	3.5	15.0
Interest bearing accounts	−3.0	−2.6	−4.1	−1.8	−5.7
Other financial assets	−3.2	−2.1	−9.0	−2.1	1.1
P-values for tests of joint significance					
MTR coefficients	0.003	0.000	0.000	0.001	0.000
Lagrange multipliers	0.001	0.003	0.303	0.003	0.959

Notes: The top panel shows the marginal effect of a unit increase in the marginal tax rate on the expected portfolio share. The middle panel divides 0.10* (top panel estimate) by the unconditional average portfolio share reported in Table 3. Asterisks indicate statistical significance at the 5% (**) and 10% (*) significance levels. The bottom panel presents the *P*-values from the test of the joint significance of the tax variables in the eight equations and Lagrange multipliers on each of the adding up constraints for the explanatory variables. See text for further discussion.

1992. The most robust findings are the positive effect of the tax rate on the portfolio share of tax-exempt debt and the negative effect of the tax rate on ownership of interest-bearing accounts, which are statistically significant at the 5% level in four of the years and at the 10% level in the fifth.

At the bottom of Table 10, we report two tests of the joint significance for the estimated marginal tax rate coefficients. The first pertains to the marginal tax rate variables in all eight of the equations. In all five sample years, the null hypothesis that the coefficients on the eight tax variables are all zero is easily rejected at the 1% level. Thus, while the patterns on individual tax variables are not particularly strong, the estimates show solid support for the importance of tax rates in predicting portfolio shares. The second test pertains to the constraints, one for each explanatory variable (excluding the constant), that the marginal effects on each variable sum to zero across all eight financial assets. The null hypothesis that the

Lagrange multipliers are zero (i.e. that the constraints are not binding) is rejected in three of the five sample years. These rejections show the importance of imposing the constraint on the system of equations during the estimation.

6.2. Testing the Tobit specification

The tobit specification requires that the parameters governing the allocation of financial assets conditional on ownership are the same as those governing the ownership decision. This restriction is not unreasonable on a priori grounds, since the factors that cause a household to own a positive amount of an asset are likely to be the same as those that cause a household to invest a larger positive amount in the asset. Empirically, we can test the validity of this restriction by comparing the estimated ratio of γ_i/σ from Eq. (2), the tobit model, to the coefficient (β_i) on the same variable in the probit model (Eq. (1)). We are most interested in whether this restriction is true for the marginal tax rate variable. The probit coefficients in Table 6 and the tobit coefficients in Table 9 show that this restriction will be violated for interest bearing accounts and other financial assets, since these coefficients are positive in the probit and negative in the tobit.[2]

We tested the equality restriction on the marginal tax rate coefficients across the probit and tobit estimates for all of the assets for all of our sample years. For the 1998 sample, the null hypothesis was rejected for taxable equity in mutual funds and tax-deferred equity, in addition to interest bearing accounts and other financial assets. Over all the sample years, the null hypothesis was rejected in approximately half of the cases.

To gauge the importance of these rejections of parameter constancy between the probit and tobit models, we estimated a set of tobit models in which the equality restrictions on all of this coefficients across the probit and tobit models were relaxed. We could do this for models in which there is censoring of the portfolio share only at zero and without imposing the adding up constraints on the marginal effects. We compared the coefficients in these portfolio share equations with the coefficients from tobit equations that are analogous to those shown in Table 9 without imposing the adding up constraints on the marginal effects. For most asset classes, the estimates of the portfolio share coefficients from these two approaches are very similar. The coefficient differences are smaller than 0.01 for five of the asset classes. Critically, the estimated coefficient on the tax rate is smaller in the less restrictive version in the equation for interest bearing accounts. This suggests that our tobit specification is not underestimating the magnitude of this coefficient in a way that would be expected if the tobit functional form were badly

[2] We base these tests on the tobits without the adding up constraints imposed in order to examine the functional form restriction directly. Imposing the constraint can cause the tobit estimate to differ from the probit coefficient even if the functional form restriction is appropriate.

confounding the positive effects in the ownership decision and the negative effects in the portfolio share decision.

6.3. Are tax rate effects simply nonlinear income effects?

One difficulty with empirical tests like ours is that the marginal tax rate may be affected by other variables, such as income, that exert an independent impact on portfolio choices. If we do not adequately control for these other variables in our empirical models, we may incorrectly conclude that tax rates affect portfolio choices. In our main empirical specifications, we include explanatory variables for income, net worth, age, education, occupation, and industry categories, as well as other demographic variables, to capture these effects. The income variable that determines marginal tax rates is not precisely the same as the variable that we include in our specifications, but they are similar. Since marginal tax rates are nonlinear functions of household income, one concern is that estimated marginal tax rate effects on portfolio shares are just income effects. To address this concern, we considered two alternative specifications for the income controls in our main specification for the 1998 data. These estimates for the tobit model are shown in Table 11. The first column repeats the findings for the marginal effects of the marginal tax rate from Table 10, for ease of comparison.

The first alternative specification replaces the seven income categories in our main specification with a more exhaustive set of 20 categories. Specifically, we included the deciles of the income range below $150 000, quintiles of the income range between $150 000 and $300 000, and quintiles of the income range above $300 000 (all specified in constant 1995 dollars). Table 11 shows that these estimates are very similar in both magnitude and significance to those in our main specification. Our main results are therefore robust to a finer definition of the income categories.

The second alternative specification replaces the dummy variables for these twenty categories with a piece-wise linear spline consisting of segments between the nineteen income levels that serve as the breakpoints between each of these categories. This modification allows for the correlation of income and the marginal tax rate within categories to be absorbed by the income variables. The estimates are shown in the third column of Table 11.[3] The use of the spline rather than the indicator variables for income has very little effect on the magnitude and significance of the marginal tax rate variables. As with the finer set of income dummies, the marginal effects with the spline regression are always within 0.015 of the marginal effects in the main specification.

[3]We were unable to estimate this model without some restriction on the range on the income variable in the top and bottom categories, in which the piece-wise linear segments were quite large. For the results shown in Table 11, we censored the income variable at zero on the left and restricted the top segment to be $200 000, starting from a value of $840 000.

Table 11
Tests of robustness of Tobit estimates of financial asset shares: 1998

	Baseline case (Table 10)	Expanded income dummies	Income spline spline	Homeowner interaction		
				MTR* rents	MTR* owns	Owner dummy
Estimate of marginal effect						
Directly held equity	0.066**	0.054**	0.057**	0.058	0.067**	0.001
Equity mutual funds	0.026	0.024	0.025	0.043	0.024	0.008
Tax-deferred equity	−0.001	0.006	−0.003	0.096	−0.012	0.044**
Tax-deferred bonds	0.050*	0.044*	0.043	0.095*	0.044	0.017
Tax-exempt bonds	0.022*	0.020*	0.019*	0.041	0.020*	0.002
Taxable bonds	0.023*	0.023*	0.023*	0.036	0.020	−0.001
Interest bearing accounts	−0.144**	−0.133**	−0.129**	−0.276**	−0.130**	−0.063**
Other financial assets	−0.042	−0.039	−0.037	−0.091	−0.032	−0.008
P-values for tests of joint significance						
MTR coefficients	0.003	0.017	0.015		0.021	
Lagrange multipliers	0.001	0.053	0.000		0.000	

Notes: Authors' estimates based on data from 1998 Survey of Consumer Finances. The top panel shows the marginal effect of a unit increase in the marginal tax rate on the expected portfolio share. The first column repeats the results from the first column of Table 10. The specification in the second column expands the set of income categories from 7 to 20. The third column replaces the expanded set of dummy variables with a piecewise linear spline through the same 20 categories. The last three columns pertain to a specification in which the marginal tax rate is interacted with dummies for whether the household rents and for whether the household is a homeowner. The columns report the marginal effects of the two marginal tax rate interactions and the dummy for whether the household is a homeowner. Asterisks indicate statistical significance at the 5% (**) and 10% (*) significance levels. The bottom panel presents the *P*-values from the test of the joint significance of the tax variables in the eight equations and Lagrange multipliers on each of the adding up constraints for the explanatory variables. See text for further discussion.

Income can affect both portfolio share and tax rates; hence, the potential endogeneity considered above. Another variable that might have the same effect is homeownership. Although we have not focused this paper on holdings of non-financial assets, housing is one physical asset that is widely owned and might affect both marginal tax rates and asset holdings. The link between homeownership and marginal tax rates arises because homeowners can typically claim some tax deductions that renters cannot claim, thereby reducing their taxable income and marginal tax rates. Homeownership may also affect asset selection and portfolio composition, since homeowners may have different risk preferences than those who rent their homes.

If taxes affect homeownership, and homeownership induces a change in financial asset portfolios, then our main estimates will confound this effect with the direct effect of taxes on financial portfolios. To investigate this possibility, we estimate an alternative tobit specification in which we replace the marginal tax rate

variable with three variables: the interaction of the tax rate with an indicator variable for whether the household rents, the interaction of the tax rate with an indicator variable for whether the household owns its home, and an indicator variable for whether the household owns its home. This specification allows for a different intercept and marginal tax rate effect by homeownership status, while constraining the effects of other explanatory variables to be the same across the two groups.

The marginal effects of the three new variables are shown in the last three columns of Table 11. Two clear patterns emerge. First, in almost all cases, the signs of the tax effects are the same for both owners and renters as they are in the main specification. The magnitudes of the tax effects on portfolio shares are larger for renters than for owners; in most cases, they are twice as large. However, in none of the eight equations are the coefficients underlying these marginal effects statistically significantly different across the two groups. Second, the marginal effects of the indicator variable for homeownership are typically positive for tax-advantaged assets, suggesting higher average portfolio shares for homeowners, although these effects are statistically significant in only two of the eight equations. These findings suggest that our earlier findings of significant effects of tax rates on portfolio shares were not driven by differences in housing status across different investor groups.

6.4. Residual cross-correlation in the Tobit models

We closed our presentation of the probit models by reporting cross-correlations for the residuals from the estimating equations for each asset class. To estimate the correlation matrix for the tobit residuals, we fix the tobit model coefficients for 1998 at the values reported in Table 9. For each pair of tobit models, we then maximize the joint likelihood function as a function of the correlation between the residuals in the two latent variable equations. Table 12 presents the resulting correlation estimates.

The estimated correlations for the residuals between most asset pairs are negative. The one exception to this rule arises with respect to taxable bonds. A higher portfolio share in this asset class is associated with a higher portfolio share for directly-held equity and equity mutual funds, as well as tax-deferred and tax-exempt bonds. The generally negative correlations between the residuals from the tobit models imply that if the household allocates a larger share of its portfolio to one asset, on average, its holdings in other assets are lower. This may reflect simply an adding-up constraint across assets. The residual correlations from the probit models can be positive, since there is no constraint requiring that a household that owns one asset cannot own another asset. With respect to the share of wealth held in different assets, however, the household budget constraint dictates that allocating 1% of wealth to a given asset reduces, by 1%, the amount of wealth that can be allocated to other assets.

Table 12
Estimated correlation matrices of bivariate tobits, SCF 1998

	Directly held equity	Equity mutual funds	Tax deferred equity	Tax deferred bonds	Tax exempt bonds	Taxable bonds	Interest bearing accounts	Other financial assets
Directly held equity								
Equity mutual funds	−0.017							
Tax-deferred equity	−0.059	−0.014						
Tax-deferred bonds	−0.129	−0.106	−0.001					
Tax-exempt bonds	−0.032	0.221	−0.127	0.027				
Taxable bonds	0.012	0.122	−0.072	0.025	0.204			
Interest bearing accounts	−0.337	−0.270	−0.424	−0.348	−0.240	−0.279		
Other financial assets	−0.076	−0.059	−0.153	−0.065	−0.073	−0.016	−0.516	

Note: The entry for each cell is the value of the correlation parameter that maximizes the likelihood function for a bivariate tobit for the assets listed in the corresponding row and column of the table when the coefficients are fixed at their values in Table 9.

7. Conclusions

A household's marginal tax rate on ordinary income displays a substantial correlation both with the set of financial assets that the household owns and with the share of the household's portfolio that is allocated to various financial assets. Although the results vary from one cross-sectional survey year to another, they are broadly consistent with simple theoretical models of portfolio selection in the presence of taxes. Households with higher marginal income tax rates are more likely to own tax-advantaged assets such as publicly traded stock and tax-exempt bonds than are comparable households with lower marginal tax rates. High marginal tax rate households are also more likely to hold assets in tax-deferred accounts such as IRAs, Keoghs, and defined contribution pension plans. These findings emerge in our analysis both of ownership decisions and of the allocation of portfolio shares. They are robust to controlling for differences in income and net worth across households.

While we find that higher marginal tax rate households are more likely to hold equities, which are tax favored relative to bonds, we also find some evidence that they are more likely than lower tax rate households to hold equity mutual funds. Dickson and Shoven (1995) note that many equity mutual funds impose much higher taxes on their investors than the investors would face if they purchased stocks directly. How the tax treatment of asset returns interacts with other factors in determining investor demand for individual corporate stocks, and for equity mutual funds, is an open issue for future work. Bergstresser and Poterba (2002) present some evidence consistent with tax-sensitive behavior on the part of some mutual fund investors, but additional investigation using data on household portfolios is clearly needed.

The findings presented here suggest several other directions for further research.

One of the most important concerns the efficiency cost of tax-induced distortions in portfolio structure. We have not estimated a structural model of household portfolio behavior. A natural next step would involve specifying and estimating such a model, and using it to calculate the deadweight loss imposed by the tax system. A second potential extension concerns asset supply. Our results suggest that a tax change like that in 1993, which increased the marginal tax rate on households at the top of the income distribution, should increase the demand among these households for tax-exempt bonds and for investments through tax-deferred accounts. The move from taxable to tax-deferred accounts can be accomplished without any changes in the supplies of assets in the economy. To increase the holdings of tax-exempt bonds among high-income households, however, it is necessary to either reduce the holdings among lower-income households, or to increase the supply of these bonds. Future work could usefully combine our demand-side analysis with a plausible model of asset supply.

Finally, we have not considered the speed and method of portfolio adjustment in the aftermath of a tax change. Our analysis cannot shed light on whether investors sell existing asset holdings to adjust their portfolios when tax reform shifts the relative after-tax returns on different assets, or whether adjustment takes place primarily through differential purchasing patterns for new assets. This distinction could have important implications for the time horizon over which household portfolios adjust. Kennickell and Starr-McCluer (1996) present descriptive statistics on the panel of the SCF covering 1983 and 1989. These data may yield further insight on the dynamics of portfolio adjustment. The role of tax changes in stimulating asset sales and in portfolio adjustment more generally is another direction for extending this work.

Acknowledgements

We are grateful to Daniel Bergstresser for research assistance and to Rochelle Antoniewicz, Rosanne Altshuler, Alan Auerbach, Julie Collins, Joel Dickson, Bill Gale, Roger Gordon, Jon Gruber, Stefan Hochguertel, Burton Hollifield, Arthur Kennickell, William Randolph, Karl Scholz, Doug Shackelford, Joel Slemrod, two anonymous referees, and many seminar participants for helpful comments. This research was supported by the National Institute on Aging, the National Science Foundation, the Smith-Richardson Foundation, and the Nelson Rockefeller Fund in Economics at Dartmouth College.

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