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Precautionary Savings Motives and Tax Efficiency of Household Portfolios: An Empirical Analysis

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Executive Summary

Theoretical portfolio models with taxable and tax-deferred savings require savers to locate higher-tax assets such as bonds in their tax-deferred retirement accounts (TDAs) while keeping low-tax assets (equities) in taxable accounts. Yet, observed portfolio allocations are often not tax efficient. This paper empirically evaluates one of the explanations for this puzzle that rests on the simultaneous presence of uninsurable labor income risk and limited accessibility of TDA assets. Together, these elements lead some borrowing-constrained households to forgo tax efficiency in favor of allocations that provide more liquidity in bad income states—an outcome labeled as *precautionary portfolio choice*. The analysis of household-level portfolio data from the Survey of Consumer Finances suggests that both the choice of whether to hold a tax-efficient portfolio and the degree of portfolio tax inefficiency are related to the presence and severity of precautionary motives.

1.1 Introduction

Portfolio choices of individual investors often appear puzzling to economists. This chapter focuses on one of the puzzles: the widespread tax inefficiency of asset allocations of households investing in taxable and tax-deferred accounts (TDAs). Although theoretical portfolio models require locating higher-tax assets such as bonds in tax-preferred accounts, households routinely violate this rule in practice. Understanding this choice is particularly important in light of the active political debate over privatization of public pension schemes, which would shift the responsibility for making retirement portfolio choices to households. Some studies estimate that tax-inefficient allocations result in sizable

welfare losses.[1] This chapter offers a somewhat different perspective by focusing on the empirical investigation of the underlying reasons for such irrational behavior. This chapter also provides evidence that losses from tax inefficiency can be, at least partially, regarded as costs borne by liquidity-constrained households to protect themselves against exposure to uninsurable labor income risk.

Self-directed retirement accounts have become one of the main avenues for household savings in the United States, totaling about 7.5 trillion dollars at the end of 2006.[2] Such accounts are granted favorable tax treatment and typically allow accumulation of retirement assets at pretax rates of return. To ensure that TDA savings are used for their intended purpose, this powerful tax incentive is counterbalanced by a variety of restrictions on accessibility of TDA assets. With TDAs households must choose not only the appropriate mix of stocks and bonds that differ in their tax treatment and risk-return characteristics, but also decide on how much of each asset to locate in each of the two account types that offer varying degrees of liquidity and tax preference. This joint portfolio decision became known as the asset *location* and *allocation* problem (Shoven 1999).

This problem has a clear-cut and intuitive solution, whose origins date back to the pioneering work of Black (1980) and Tepper (1981) on optimal portfolio choices of corporations interested in funding their defined-benefit pension plans. The solution is based on exploiting arbitrage opportunities that arise from being able to shelter high-tax assets inside tax-favored retirement accounts. In particular, households are advised to hold *all* higher-tax-burden assets inside TDAs. Only in cases when desired holdings of high-tax assets exceed TDA capacity can some of them spill over into taxable accounts. These strictly specialized asset location choices have acquired the label of *tax efficient*.[3] Tax-efficient portfolios appear to be optimal even in complex environments of recent theoretical models that accommodate optimal timing of capital gains realizations and stochastic tax rates (Huang 2006), availability of tax-exempt bonds (Shoven and Sialm 2004), step-up of tax basis at death, and stochastic labor income (Dammon, Spatt, and Zhang 2004).

The robustness of these results presents an empirical challenge because observed portfolios are often not tax efficient. Survey data commonly show that the majority of U.S. households simultaneously hold high-tax-burden bonds in their taxable accounts and low-tax-burden assets (e.g., equities) in their TDAs (Poterba and Samwick 2001; Berg-

stresser and Poterba 2004). These households could improve their after-tax returns by simply rearranging the location of their assets.

The goal of this chapter is to provide an empirical evaluation of the observed portfolio choices in the context of models that emphasize the importance of limited TDA accessibility for households facing income or consumption shocks. One such model is by Amromin (2003), in which households are exposed to uninsurable labor income risk, manifested through catastrophic and very infrequent unemployment spells.[4] These shocks create precautionary savings motives for borrowing-constrained households. When such households are subject to TDA liquidity restrictions, the precautionary motives induce a tradeoff between their desire to maintain tax-efficient allocations and concern over the need to make costly withdrawals from retirement accounts in the event of bad income draws. As a result, a model with both labor income risk and accessibility restrictions can generate optimal portfolio allocations that are not tax efficient.[5]

Of most interest, however, are the model's predictions about the cross-sectional distribution of household portfolio choices. The first testable prediction of the model is that households with weak precautionary savings motives (due to a high level of accumulated assets or low labor income risk) or those not subject to TDA liquidity restrictions (over the age of 60) should have tax-efficient portfolios. The rest of the households, in contrast, are predicted to have mixed—precautionary—asset allocations.

The other key message of the model is that the *degree* of tax efficiency—how close a given portfolio is to the "bonds in TDA, equities in taxable accounts" dictum—is inversely related to the intensity of precautionary motives. In other words, households with stronger precautionary motives are expected to have higher equity shares in TDAs and lower equity shares in taxable accounts. The prediction itself is quite intuitive. When access to TDA assets is very costly, TDAs are used primarily to accumulate retirement wealth. In contrast, liquid taxable accounts are much better suited for smoothing potential income shocks. Thus, households that face high labor income risk and have limited liquid financial resources satisfy their strong precautionary motives by choosing a safer portfolio mix in the taxable investment account and by decreasing their TDA contributions. To address their retirement savings concerns, they increase the share of equities in their tax-deferred accounts. Tax efficiency gets trumped both by precautionary motives in taxable accounts and by retirement savings motives in TDAs.[6]

Earlier theoretical and numerical studies of the effects of precautionary motives on portfolio choice (Kimball 1993; Bertaut and Haliassos 1995, 1997) considered a single investment habitat. They found that the presence of precautionary motives leads to lower portfolio equity shares. Empirical support for this hypothesis has been mixed.[7] However, as argued above, precautionary motives are likely to have opposing effects on equity holdings in taxable and tax-deferred accounts. Hence, differentiating between account habitats in empirical tests provides a novel way to identify precautionary effects in portfolio composition.

Household-level data from the Survey of Consumer Finances (SCF) is used here to test both predictions: who holds tax-efficient portfolios and whose portfolios are more tax efficient.[8] Empirical results lend support for the key insights of the model. In particular, households with more volatile labor income and those subject to early withdrawal penalties on TDA assets are less likely to choose tax-efficient portfolios. In addition, factors associated with stronger precautionary savings motives—such as having a higher fraction of one's wealth in a tax-deferred account or a riskier labor income process—indicate stronger precautionary portfolio choices, consisting of a safer taxable account allocation and a riskier TDA mix.

These findings bear on several policy questions pertaining to the rules for tax-deferred savings plans and the revenue costs projections for such plans. Various budget-forecasting models are affected by assumptions of what assets are held in retirement accounts—since portfolio composition of TDAs directly influences their tax cost estimates (e.g., Burnham 2004). Since this chapter explicitly focuses on how these portfolio choices vary with household characteristics and institutional TDA features faced by specific households, it can potentially enrich the existing tax policy analysis. Suppose, for instance, that TDA assets were exempted from early withdrawal penalties in cases of job loss. The results of this chapter suggest that in this new setting, households may rebalance their taxable and tax-deferred portfolios, as they would be able to satisfy their precautionary motives that derive from labor risk considerations by holding high-tax-burden bonds in TDAs. This would improve household welfare but result in lower overall tax revenues—both from capital income and withdrawal fees. Moreover, assets held in more liquid TDAs would have higher equivalent taxable wealth values (Poterba 2004), which may encourage households to increase their contributions to such accounts. Thus, rule modifications aimed at lowering the insur-

ance cost for precautionary households are likely to affect revenue cost estimates of tax-deferred savings—by both influencing TDA flows and the overall portfolio composition.

Several recent empirical studies provided systematic analyses of household portfolio allocations between and within taxable and tax-deferred accounts. Bergstresser and Poterba (2004) present extensive evidence of heterogeneity in habitat-specific portfolio location and allocation choices in the SCF and evaluate the extent to which household portfolios deviate from tax-efficiency. Although the authors discuss the effects that age, wealth, income, and marginal tax rates have on these choices, their study does not explicitly consider the effects of labor income risk or liquidity constraints. Barber and Odean (2004) estimate relative preferences for holding various assets (e.g., munis, stocks, mutual funds) in taxable or tax-deferred brokerage accounts. While these data are sufficient to analyze whether households are tax-efficient, they cannot be used to address the extent of tax inefficiency. In contrast, the empirical investigation in the present chapter considers the entire portfolio of household financial assets and evaluates it in the context of a specific dual-habitat portfolio model with precautionary savings motives.

The rest of the chapter is structured as follows. Section 2 briefly reviews the existing literature and contrasts its theoretical predictions with observed household portfolios, while imputing the cost of the discrepancy. Section 3 outlines the properties of portfolio allocations in a dual-habitat precautionary model, while section 4 describes the data and sets up the empirical tests. Section 5 presents econometric analysis, and section 6 summarizes the results and offers directions for future research.

1.2 How Common and How Costly are Tax-Inefficient Portfolios?

There exists a recent body of theoretical literature on portfolio decisions of investors with both taxable and tax-deferred savings options. The dual-habitat portfolio problem is solved numerically (Shoven and Sialm 2004), analytically (Huang 2006), or through a combination of analytical arguments and numerical methods (Dammon, Spatt, and Zhang 2004). As stated earlier, the general message that emerges from solutions to these models is that the primary goal of the asset location decision is to achieve Tepper-Black tax efficiency. In the United States, equities are tax-favored in several respects. They are taxed at lower rates than interest-paying assets, are subject to tax breaks when used for bequests, and af-

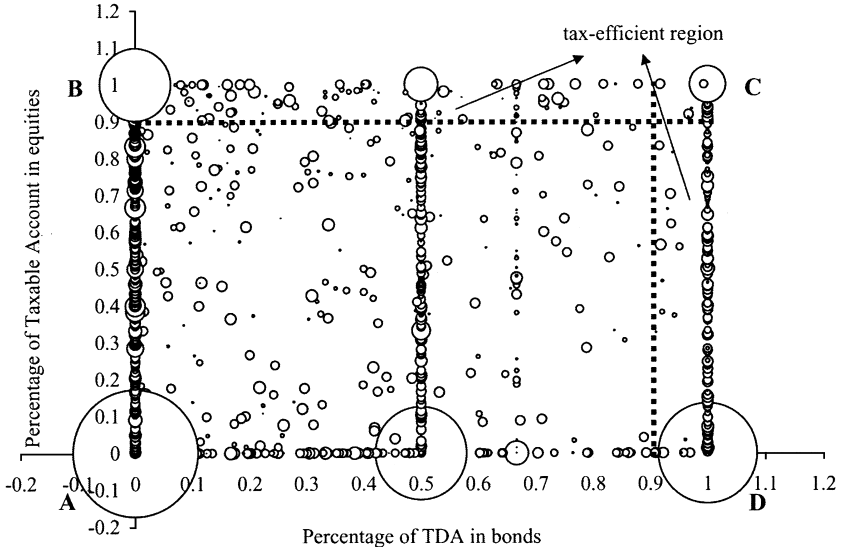

Figure 1.1
Distribution of Portfolio Allocations in TDA and Taxable Accounts in the 2001 Survey of Consumer Finances

a. TDA (tax-deferred account) wealth includes assets in IRA, Keogh, 401k and 403b plans. Investable tax account wealth excludes checking, but contains almost all other financial assets such as stocks, taxable and tex-exempt bonds, U.S. savings bonds, mutual funds, CDs, and money market accounts. By contrast, Bergstresser and Poterba (2003) also exclude money market and savings accounts from their definition of investable taxable assets. Positive investable wealth households are those with investable wealth in both account habitats.

b. "Equities" in taxable accounts (as well as TDAs) are defined as "low-tax" assets. While this primarily means stocks and stock mutual funds, it also includes other tax-preferred such as tax-exempt municipal bonds and U.S. savings bonds. Doing so acknowledges differences in tax treatment of safe and liquid securities and makes the observed lack of tax-efficiency all the more puzzling.

c. Households in the tax-efficient frontier (segments BC and CD) may hold both bonds and stocks in their portfolios. Their "low-tax" assets (as defined in b) are kept in taxable accounts, spilling over into TDA only if their desired bond (or "high-tax") holdings do not exhaust TDA capacity. All other mixed-asset households are tax-inefficient. The tax-efficient region is represented by a 10% band around this strict definition of Tepper and Black to allow for measurement error.

ford a timing choice for realization of capital gains and subsequent tax payments. Hence, it is believed to be better to locate bonds in retirement accounts which defer taxation, have no use for timing capital gains or losses, and are ill-suited for bequest planning. In this context, tax efficiency means giving preference to bonds in TDAs whenever possible.

These theoretical findings translate into the following empirical pre-

diction: there should never be any equity holdings in TDAs as long as there are bond holdings in taxable accounts. In the extreme case of unlimited borrowing in taxable accounts, the specialization of accounts is complete—the retirement account is always entirely dedicated to bonds. When borrowing in taxable accounts is limited it is possible to observe equities in TDAs, provided the overall desired bond holdings do not exhaust TDA capacity. Conversely, if the overall desired bond holdings exceed the limits of the retirement account, the spillover goes in the other direction—the surplus bonds are observed in taxable accounts. Both cases, however, rule out keeping equities in TDAs while simultaneously holding bonds in taxable accounts.

Observed portfolio allocations do not conform to these predictions. Figure 1.1 presents data on portfolio choices of U.S. households in the 2001 SCF that had assets in both taxable and tax-deferred accounts. The horizontal axis represents the share of a tax-deferred account held in bonds, and the vertical axis represents the share of taxable account held in equities. Taking bonds and equities to be a short-hand for high- and low-tax assets for the moment, each of the axes measures the extent to which tax-appropriate assets are held in each of the two accounts.[9] Consequently, points farther away from the origin are more tax-efficient. The Tepper-Black results suggest that all households should locate along the outer, tax-efficient, frontier—segments BC where stocks spill over into TDA, and CD where bonds spill over into the taxable account. The size of each point is proportional to the number of households making this particular portfolio allocation choice, making it easier to assess the prevalence of tax-efficient portfolio choices. As summarized in table 1.1, among households with positive investable financial wealth in both account types in the 2001 SCF, 4.3 percent had all-stock portfolios, 8.2 percent had all-bond portfolios (both of which would technically be tax efficient), and an additional 21.9 percent were located on the tax-efficient frontier.[10] The rest of these households—nearly two-thirds in all—do not adhere to Tepper-Black tax efficiency.[11] Moreover, the relative share of tax-inefficient households has been growing steadily over time, mirroring the rise in stock ownership through tax-deferred retirement plans. The data also suggest that tax-efficient households are wealthier, on average. Although tax-efficient households make up a third of the population, they control nearly a half of financial wealth.

The top panel of table 1.2 summarizes the number of households making tax-inefficient portfolio choices by age group and reports the median and total amounts of mis-located assets in the 2001 SCF. Tax-inefficient

Table 1.1
Classification of Portfolio Allocations by Tax Efficiency in 1995–2001

	1995		1998		2001	
	N	%	*N*	%	*N*	%
All households (mln.)	99.0		102.5		106.5	
Positive investable wealth HHs[a]	32.8	33.1	43.6	42.6	48.7	45.7
All-bond households: {1,0}	3.0	9.2	3.5	8.0	4.0	8.2
All-stock households: {0,1}	1.9	5.7	1.6	3.8	2.1	4.3
Tax-efficient region HHs[b]	9.2	28.1	10.6	24.4	10.7	21.9
Tax-inefficient households	18.7	57.0	27.9	63.9	31.9	65.6

Source: 1995, 1998, and 2001 Surveys of Consumer Finances
[a] Positive investable wealth households are those with investable wealth in both account habitats, as defined in footnote (a) to figure 1.1.
[b] Households in the 10% band around the Tepper-Black tax-efficient frontier, as depicted by the dotted lines in figure 1.1.

portfolio allocations are commonplace in every age group but—as shown by the earlier work by Bergstresser and Poterba (2004)—the extent of deviations from tax efficiency is fairly limited. In each age group, a transfer of less than ten thousand dollars would be sufficient to attain tax efficiency for the majority of households.

One way to gauge the dollar cost of observed tax inefficiency is by computing equivalent taxable wealth measures developed by Poterba (2004). Conceptually, equivalent taxable value of one dollar in TDA assets is given by \$z in taxable assets that replicate the after-tax TDA payoff at some time T. The value of z depends on a number of factors—such as the tax rates on asset returns and TDA withdrawals, the investment horizon, and the level of returns. Among other things, Poterba (2004) shows that a dollar in TDA bond holdings generates higher equivalent taxable wealth than a dollar in TDA equity holdings (i.e., $z_{\text{bonds}} > z_{\text{stocks}}$), quantifying the magnitude of gains from tax-efficient location choices.

Consequently, the cost of tax inefficiency can be approximated by the difference between equivalent taxable wealth measures associated with the observed portfolio allocations and allocations that follow the Tepper-Black pecking order rules. To construct hypothetical Tepper-Black portfolios each dollar in TDA equities is converted into a dollar in TDA bonds, while the opposite conversion (from bonds to stocks) of $\$(1-\tau)/(1-\tau_{si})$ takes place in the taxable account. Such rebalancing preserves the after-tax exposure to equities and is carried out until there are

Table 1.2
Extent and Cost of Tax Inefficiency in a Cross Section of U.S. Households

Panel A. Propensity and extent of tax-inefficient choices

Age group	HHs with positive investable wealth[a]	Tax-inefficient HHs[b]	"Mis-located" assets ($)	
			Total ($ bln)	Median ($)
< 30	4.6 M	3.4 M	10.6	778
30–39	10.0 M	7.0 M	61.5	2,646
40–49	14.2 M	10.1 M	180.2	5,222
50–59	10.1 M	7.1 M	189.1	7,005
60–69	5.3 M	2.8 M	101.1	10,462

Panel B. Gains in equivalent taxable wealth[c] from tax-efficient rebalancing

	pre-JGTRRA[d]		post-JGTRRA[e]	
	Total ($ bln)	Median ($)	Total ($ bln)	Median ($)
< 30	1.6	125	2.8	230
30–39	7.4	283	13.8	548
40–49	13.2	264	27.9	612
50–59	5.6	140	15.4	491
60–69	0.3	2	1.9	123

Source: 2001 Survey of Consumer Finances
[a] Positive investable wealth households are those with investable wealth in both account habitats, as defined in footnote (a) to figure 1.1.
[b] Households in the 10% band around the Tepper-Black tax-efficient frontier, as depicted by the dotted lines in figure 1.1.
[c] Equivalent taxable wealth is defined as in Poterba (2004), with specific parameterization choices detailed in text.
[d] Ordinary income tax rate applies to interest income and TDA withdrawals, capital gains effectively taxed at 10% (20% statutory rate).
[e] Ordinary income tax rate applies to TDA withdrawals, to interest income is taxed at the statutory capital gains rate of 5 or 15%, capital gains have an effective tax burden of 2.5 or 7.5%.

either no more equities in TDA or bonds in taxable accounts.[12] The resulting TDA portfolio is converted to its taxable equivalent using the same set of (z_{bonds}, z_{stocks}) factors that were applied to the observed portfolio. The results of this exercise for a specific parameterization of z are reported in the bottom panel of table 1.2.

The figures in the two leftmost columns of panel B are based on one of the scenarios reported in table 6 in Poterba (2004). This scenario assumes bond returns of 4 percent, equity returns of 9 percent (with a dividend yield of 2 percent and 7 percent rate of capital gains), TDA withdrawal

at age seventy, the 2001 marginal tax rate schedule, and pre-JGTRRA tax treatment of capital income. The two rightmost columns differ in assuming the post-JGTRRA tax treatment, with dividend income taxed at the statutory capital gains rate of 5 or 15 percent, and the effective rate on capital gains set at half the statutory level to reflect the value of gain deferral (Poterba 1998).

A comparison of these two scenarios reveals that by widening the gap between tax burdens on stocks and bonds JGTRRA has substantially increased the cost of tax-inefficient portfolios, more than doubling it in the aggregate (from twenty-eight to sixty-two billion dollars). Although z decreases monotonically with age, the costs of tax inefficiency are hump-shaped, reflecting the fact that levels of mislocated assets grow steadily with age. In spite of the high aggregate costs of tax inefficiency, the loss for a median tax-inefficient household is rather limited. Still, about 2.9 million households in the post-JGTRRA regime (one million with the pre-JGTRRA tax schedule) abandon at least five thousand dollars in equivalent taxable wealth. The following section takes a closer look at one possible explanation for this puzzling behavior.

1.3 Precautionary Dual-Habitat Model of Portfolio Choice

One plausible modeling strategy for explaining why households hold tax-inefficient portfolios is to introduce further sources of risk and to emphasize limited accessibility of TDA assets for preretirement consumption. Taken together, nonfinancial risk and relative TDA illiquidity require a tradeoff between tax efficiency and asset accessibility. Although holding bonds outside TDAs results in suboptimal portfolio returns, locking away lower-risk assets in TDAs may prove costly if a household is hit by a bad income shock coinciding with poor market returns.[13] As a result, households may choose to hold bonds outside TDA as means for smoothing their consumption and bonds in TDA as tax-efficient investment vehicles.

A dual-habitat portfolio model set up in such fashion shares two central features of precautionary savings models—uninsurable risk and credit market imperfections. As shown by Kimball (1990) and Carroll (1997), prudent households in such environment choose to hold buffer stocks of assets—which is commonly referred to as *precautionary savings behavior.*[14] The canonical precautionary savings models did not take a stand on asset composition of buffer assets. However, later theoretical (Kimball 1993) and numerical single-habitat studies (Bertaut and

Haliassos 1997) found that precautionary motives lead to less risky portfolio choices—that is, buffer stocks held in the form of safe and liquid assets. In the context of dual-habitat portfolio allocation models, such safe and liquid assets could be manifested through tax-inefficient holdings of bonds outside of retirement accounts.[15]

Amromin (2003) presented numerical solutions for one such model in which income risk takes the form of catastrophic low-frequency unemployment spells and households choose the level of consumption, portfolio composition, and contributions to each account type. Under certain parameter assumptions this model can generate *precautionary portfolio effects*, defined as deviations of portfolio choices of liquidity-constrained households facing labor income risk from the benchmark of tax efficiency. These effects are predicted to intensify with the strength of household precautionary motives.

The first result of the precautionary dual-habitat model is that it can accommodate tax-efficient behavior for certain households. This is analogous to the results reported in the traditional precautionary savings literature, whereby even with uninsurable income risk there may be agents that are either not exposed to that risk or are wealthy enough not to be affected by credit constraints (Carroll 1997; Carroll, Dynan, and Krane 2003). In other words, households with sufficiently high overall wealth can satisfy precautionary needs with equities in the taxable account. Similarly, households that are not affected by TDA liquidity restrictions can afford to concentrate on making tax-efficient location choices.

The other key message of the model is that precautionary portfolio effects are stronger for households with more pressing precautionary needs. The intensity of precautionary motives can be captured in a number of different ways that aggregate into two broad classes: (a) level of exposure to nondiversifiable risk, and (b) tightness of liquidity constraints. For example, households that have a higher share of their wealth confined to TDA are subject to a tighter liquidity constraint—since less of their overall wealth is readily accessible. For a given level of labor risk, such households face a higher likelihood of having to make expensive TDA withdrawals. They attempt to lessen this likelihood by decreasing the optimal equity share in their taxable account *and* by cutting back on TDA contributions. Since these households want to be prudent without completely forgoing the higher return potential of equity investments, they compensate for lower taxable equity shares with higher TDA equity shares.[16]

The finding that equity shares in the two account types move in op-

posite directions in response to precautionary savings motives allows one to construct an alternative empirical test of the effects of such motives on portfolio composition. As discussed in the introduction, earlier tests have focused on composition of the *overall* portfolio and have produced mixed results. This may not be surprising if households indeed respond to, say, higher labor income risk by lowering equity shares in taxable accounts and building up equity shares in TDAs. In this case, separating taxable and TDA holdings and looking at joint determinants of asset composition in each account type represents a sharper test. Admittedly, predictions of a particular numerical model do not rise to the level of an analytical proof, but they are suggestive enough to merit empirical investigation.

There are two important empirical advantages of using precautionary dual-habitat portfolio model to produce testable restrictions. The first is that the existing precautionary savings literature provides a clear guide for mapping model design to the data. In particular, it allows uninsurable risk to be defined through a variety of stochastic processes—labor income, demographic shocks, etc.—all of which can be measured at the household level. It also identifies household characteristics related to precautionary savings behavior, such as measures of wealth and ability to access credit markets.

The second advantage is that the idea of having TDA accessibility restrictions bind at the time of adverse labor income shocks conforms well to the existing tax law. Indeed, liquidity needs that arise from predictable lifecycle events—such as house purchase and college expenses—are exempt from withdrawal penalties on non employer-sponsored TDAs (IRA and rollover IRA).[17] No such exemption exists for using TDA assets to smooth labor income shocks. If a TDA owner remains employed following a household labor income shock, he or she can tap assets in employer-sponsored accounts (e.g., 401k and 403b plans) only by applying for a hardship withdrawal. Such withdrawals are allowed only in a limited number of circumstances and, even if approved, trigger early withdrawal penalties. In the case of job loss, any TDA assets not rolled over into a new TDA within sixty days are subject to a 10 percent penalty. This penalty effectively applies even in the case of borrowing against TDA, which is a common feature of many retirement plans. Under the current law, a participant that loses her or his job while carrying a loan balance has to repay the entire loan immediately in order to avoid penalties. Hence, in any labor income shock scenario, all ways of accessing any TDA assets for current consumption are costly.

1.4 Empirical Framework

The discussion in the previous section suggested that (1) existence of precautionary savings motives coupled with TDA accessibility constraints may lead some households to forgo tax-efficient portfolio allocations, and (2) stronger precautionary motives may result in greater deviations from Tepper-Black efficient portfolio choices. This section maps these two predictions into specific empirical tests.

1.4.1 Extensive Margin of Tax Efficiency—Which Households Are Tax Efficient?

As argued earlier, households not subject to precautionary motives or liquidity restrictions on their TDA holdings have little incentive to sacrifice tax-efficiency of their portfolio choices. Hence, the likelihood of holding tax-efficient portfolios is expected to be higher for households that:

(1) have penalty-free access to their retirement wealth—that is, are over the age of fifty-nine;

(2) have more financial or housing wealth, so they are less liquidity constrained;

(3) have a lower share of their wealth held in TDAs, which restrict accessibility;

(4) have less risky labor income processes;

(5) have health insurance coverage for all household members;

In the extensive margin tests all households are broken into two sets—tax-efficient households that do not simultaneously keep bonds in taxable accounts and equities in TDAs, and everyone else. This means that households that completely specialize in a single asset class (i.e., whose portfolios are all-stock or all-bonds) are classified as tax efficient by default.

1.4.2 Intensive Margin of Tax Efficiency—How Tax Efficient Are Households?

One can think of stronger precautionary savings motives as deriving from two sources: (1) higher background risk, and (2) tighter liquidity constraints. These pressures can be captured by variables listed in (1)–(5) above. It is intuitive that higher income uncertainty and decreased

Table 1.3
Precautionary Portfolio Effects

	Expected Effect	
Explanatory Variables	TDA % in equities	Taxable % in equities
Tighter liquidity constraints		
(Higher share of wealth in TDA, presence of TDA accessibility restrictions, lower housing equity)	+	–
Higher background risk		
(Higher probability of unemployment, higher volatility of labor income, lack of health care coverage)	+	–

ability to smooth consumption would be generally associated with lower equity holdings in liquid taxable accounts. The implications for composition of tax-deferred accounts are less straightforward. On one hand, high labor income risk may decrease the fraction of TDA in equities by depressing *total* stock holdings. On the other, TDA equity exposure can increase in response to rebalancing towards safer buffer holdings outside TDAs. Which effect dominates depends heavily on the overall location and allocation decision of the household.

The precautionary portfolio effects, based in part on the numerical results in Amromin (2003), are summarized in table 1.3.

Table 1.3 restates the notion that households with stronger precautionary motives would choose portfolios that are farther away from the tax-efficient frontier (i.e., have more stocks in TDA and fewer stocks in taxable accounts). In terms of figure 1.1, tighter liquidity constraints or higher background risk (or both) will push portfolio allocations closer to the origin. As indicated in the table, empirical tests will be extended to proxies of risk and liquidity beyond those evaluated in the numerical model. It is worth noting that in addition to measuring liquidity constraints, the share of TDA holdings in overall wealth also proxies for the location choice. Given the simultaneity of contribution and allocation decisions, it is particularly important to account for the location choice in evaluating portfolio composition.

These empirical predictions are quite different from those derived from models that allow only tax-efficient outcomes. For instance, such models would predict a positive relationship between share of wealth in TDA and equity shares in both accounts, due to the asset spillovers discussed earlier. They also have no explicit role for either accessibility re-

strictions or background risk in determining the tax efficiency of portfolio choice.

1.4.2 Data Description

The data used in this study come from three of the latest Surveys of Consumer Finances (conducted in 1995, 1998, and 2001). The surveys are conducted by the Board of Governors of the Federal Reserve System and cover a substantial cross-section of U.S. households in each survey year. There are 4,299, 4,305, and 4,442 households (respectively) in the surveys studied here. The surveys ask a wide array of questions on every aspect of household balance sheet—for example, amount and type of liquid and illiquid assets, nature and value of proprietary business holdings, availability and price of credit, sources of earnings. Of particular value for studies of household portfolio composition is the fact that the SCF oversamples wealthy households, which tend to have richer portfolio structures. Each survey makes available a set of sampling factors that allow one to reweight the sample to produce population statistics. Unless otherwise noted, all descriptive statistics utilize population weights.

The surveys attempt to uncover precise composition of household financial portfolios. Unfortunately, information on allocations to narrowly defined asset classes exists only for funds kept in taxable investment accounts. By contrast, the composition of TDA holdings—whether individual (like IRA and Keoghs) and employer sponsored (i.e., 401k, 403b)—has to be inferred from categorical responses. For example, the question on allocation of IRA holdings asks, "How is the money in this account invested? Is most of it in . . . ?" The question is followed by a menu list with separate categories for cash, stocks, bond holdings (both direct and through mutual funds), and several additional options for combinations of these assets. Clearly, some assumptions are needed to translate these qualitative measures into dollar figures. If a respondent declared that "most holdings" were contained in a single asset category, the entire account value is assigned to that category. If a combination of categories is reported, the account value is allocated in equal proportions. The resulting raw allocations of assets in retirement portfolios closely match those in earlier studies (Ameriks and Zeldes 2004).

The necessity to impute equity shares in retirement accounts in this fashion explains the agglomeration of observations at certain points on the x-axis in figure 1.1. For example, a vertical line at 50 percent TDA allocation

corresponds to holdings of households with only one of the two types of retirement accounts (IRA or Keogh, or 401k or 403b) who reported that their tax-deferred assets were split between equities and bonds.

In order to conduct empirical tests, key model components need to be given operational meaning. This chapter defines investable household wealth as total quasi-liquid financial assets that can be explicitly allocated between investments with equity- or bond-like properties. The taxable account component of such wealth includes nearly all financial instruments—such as mutual fund investments, savings accounts, and CDs. It specifically excludes checking accounts on the grounds that they are used primarily for transaction purposes, as well as housing and proprietary business wealth, and human capital wealth.[18] The tax-deferred component of investable wealth consists of retirement accounts that allow participants to choose asset allocation. This category includes most of the defined contribution plans (e.g., 401k and 403b)—as well as individual retirement accounts such as IRA and Keogh—but it omits imputed values of future guaranteed pension income (Social Security and defined-benefit plans).

A particularly important task is to define *stocks* and *bonds*. Typically, bonds have been interpreted directly as corporate, municipal, and government bonds traded on financial markets. The ownership of such assets is extremely skewed in the population, and they do not nearly exhaust the set of financial instruments that provide relatively safe return and are highly liquid. Since this chapter focuses on the precautionary behavior of households, this set of assets is augmented with money market and savings accounts—which face the same tax treatment as conventional bonds. However, to define tax efficiency properly one needs to account for differences in tax treatment among bond-like assets. In particular, since municipal bonds and U.S. savings bonds receive preferential tax treatment, here they are counted as low-tax equities that should be located in taxable accounts. Consequently, the share of equities held in taxable accounts is defined as the sum of directly held stocks, stock mutual funds, munis, and U.S. savings bonds, divided by total investable taxable wealth. This definition also highlights the puzzle identified in Shoven and Sialm (2004) and Poterba, Shoven, and Sialm (2004)—holding munis in taxable accounts allows households to satisfy their precautionary motives and be tax-efficient at the same time. Yet, as shown in figure 1.1, and analyzed in the following section, households do not follow this practice.

To obtain a measure of conditional moments of labor income processes, standard deviations of labor income shocks are computed from

the 1985–1993 data in the Panel Study of Income Dynamics. The choice of the functional form for the labor income process and the econometric method for estimating its components are similar to Carroll and Samwick (1998) and Vissing-Jørgensen (2002). The details of estimation, as well as data selection criteria, are specified in the Appendix. After conditional moments of labor income are computed for each household in the sample, they are averaged within each occupation-education group. Cross-sectional probabilities of unemployment for each such group are also obtained from the Job Tenure Supplement of the Current Population Survey. These group means are then used as point estimates of labor income uncertainty for corresponding demographic cells in the SCF.

1.5 Empirical Results

1.5.1 An Outline of the Econometric Model

As described in the preceding section, the empirical task is twofold—to evaluate the choice of whether to be tax-efficient (the extensive margin) and to evaluate the degree of observed tax-inefficiency in household portfolios (the intensive margin). An econometric analysis of these decisions is complicated by several factors. One of them is that the tax efficiency of portfolios is determined simultaneously with the choice of how much assets to locate in TDAs. Another is that both the extensive and the intensive margins of tax-efficiency are summarized in the data by limited variables. In case of the former, the decision is given by a binary variable. In case of the latter, the degree of tax-inefficiency is summarized by the share of taxable and tax-deferred accounts invested in equities—which by construction are restricted to the [0,1] range. Consequently, an analysis of tax efficiency of portfolio choices requires an econometric model of limited dependent variables with endogenous regressors. The model and the corresponding estimator are specified explicitly in the technical Appendix B.

Both the intensive and the extensive margins of tax efficiency are modeled as functions of variables discussed previously. Specifically, illiquidity of household wealth due to its TDA holdings is captured by the share of wealth held in TDA and an indicator of being subject to the early withdrawal penalty. Labor income risk is proxied by the estimates of the conditional variance of the log of labor income and of the probability of unemployment, and an indicator for households with two or more income earners. As long as these income streams are not perfectly

positively correlated, dual-earner households have (ceteris paribus) less volatile labor income. Indicators of whether the main self-reported motive for savings is precautionary—whether all members of household are covered by health insurance—and whether the household has enough liquid assets to satisfy self-reported liquidity needs serve as additional measures of the existence of measurable precautionary motives.[19] Measures of household wealth include both financial and housing assets, and demographic characteristics are captured by education category dummies and a quadratic in age.

1.5.2 The Location Choice—Determinants of Share of Wealth Held in TDA

Both the intensive and extensive margin decisions depend on the share of wealth held in TDA, which is determined simultaneously with portfolio composition. Although the estimator described in Appendix B is somewhat different, it is helpful to think of a standard approach to dealing with the resulting endogeneity of the TDA wealth share—a two-stage instrumental variable model. Consequently, this subsection looks at the first-stage regression, that of the share of wealth in TDA (*swlth*TDA) on the variables listed above and a number of instruments. In addition to its statistical merits, the estimation of the determinants of *swlth*TDA—the proxy for the location decision—is of interest in its own right.

I consider alternative choices of the instrumental variable are considered: size of the firm where the head of the household works, household eligibility for high-limit employer-sponsored retirement plan, and the size of employer match. Ideally, each of these variables would be related to the portfolio shares in each account (or the absolute tax efficiency) only through *swlth*TDA.

This assumption is somewhat contentious for the firm size instrument. One could argue that households' job choices are not randomly distributed across firm sizes, but rather reflect underlying risk preferences. One way to assess this concern is to look at a self-reported measure of willingness to take financial risks—available in the SCF. Table 1.4 displays the means of various risk-taking categories by firm size. There is no strong evidence that conditional means of household attitudes toward financial risk vary with size of firms that employ them. This is particularly true of the extreme categories—"willing to take very high investment risk" and "unwilling to take any risk."[20]

In contrast, the other two instrumental variables—household eli-

Table 1.4
Distribution of Self-Reported Willingness to Take Financial Risks, by Firm Size

	Firm Size (number of employees)				
Share responding as:	<10	10–19	20–99	100–499	>500
Take very high investment risks (%)	7.9	5.6	6.9	5.3	5.9
Take above average risks (%)	23.2**	25.1*	27.9	27.4	31.5
Take average risks (%)	51.5*	50.5	44.8	48.6	46.1
Take no risks (%)	17.3	18.8	20.4	18.7	16.4

Source: 1995, 1998, and 2001 Surveys of Consumer Finances.
Note: sample is restricted to households with positive investable wealth in both account types.
* Difference of means between a given size category and largest firms (>500) statistically significant at 5% level.
** Significant at 1% level.

gibility and the size of employer match—are less likely to influence portfolio choice directly.[21] An accurate measure of eligibility can be constructed from a number of SCF questions about features of employment-related pension coverage. This chapter follows the methodology in Pence (2006) to identify households that are eligible for (but do not necessarily participate in) high-limit defined contribution retirement plans. An important addition is the extension of the definition of eligibility to self-employed households. Under the current tax code, unincorporated businesses have the right to open IRA-type accounts that have high contribution limits and nearly unrestricted choice of investments.[22]

Given potential drawbacks of these instruments, table 1.5 estimates two versions of the regression for *swlth*TDA. The model is estimated on a subset of households that have both taxable and tax-deferred accounts, in order to avoid including trivial zero-portfolio choices. Not surprisingly, the share of wealth in TDA has a strong positive relationship with each of the three instruments that proxy for availability and attractiveness of employer-sponsored retirement accounts whose contribution limits are much higher than IRAs. Also, as expected, strict limits on contributions to retirement accounts result in a strong inverse relationship between the level of wealth and its share in TDAs.[23] Households that save primarily for precautionary reasons keep less of their wealth in TDAs, as do those that are subject to early TDA withdrawal penalties (although the latter relationship has only marginal statistical significance). As indicated by the comparison of the two panels of table 1.5, these results are quite robust to the choice of instrument.

Table 1.5
Determinants of Location Choice

	Panel A		*Panel B*		
Regressors	Coefficient	Robust Standard Error	Coefficient	Robust Standard Error	Eq (1) group
Employer match (in ppt)	0.741 ***	(0.075)	0.754 ***	(0.097)	IV
Eligible for 401k (1 = yes)[a]	0.072 ***	(0.012)			
Firm size			0.016 ***	(0.002)	
Subject to early withdrawal penalty (1 = yes)	–0.028 *	(0.017)	–0.031 *	(0.016)	M
Financial wealth[b]	–0.032 ***	(0.008)	–0.037 ***	(0.003)	W
Housing wealth[b]	–0.004	(0.003)	–0.003	(0.009)	
Cond. std. deviation of labor income	–0.211 ***	(0.031)	–0.146 ***	(0.026)	L
Probability of being unemployed	0.048	(0.166)	–0.118	(0.172)	
Health care coverage dummy (1 = yes)	–0.013	(0.015)	–0.013	(0.016)	
Dual earner household dummy (1 = yes)	0.031 ***	(0.008)	0.036 ***	(0.008)	H
Precautionary savings household	–0.029 ***	(0.008)	–0.030 ***	(0.007)	
Enough assets to cover liquidity needs (1 = yes)	–0.220 ***	(0.008)	–0.216 ***	(0.009)	
Age of head of household	0.021 ***	(0.002)	0.021 ***	(0.002)	D
Age -squared ($\times 10^{-2}$)	–0.021 ***	(0.002)	–0.022 ***	(0.002)	
Education (no high school diploma)	–0.059 ***	(0.020)	–0.054 ***	(0.020)	
Education (some college)	–0.041 ***	(0.012)	–0.041 ***	(0.012)	
Education (college or more)	–0.026 ***	(0.003)	–0.029 ***	(0.100)	
Number of dependents	–0.006 **	(0.003)	–0.005 *	(0.003)	
Availability of DB plan at work	0.010	(0.007)	–0.009	(0.007)	
1995 year dummy	–0.026 ***	(0.008)	–0.022 ***	(0.008)	
1998 year dummy	–0.007	(0.008)	–.006	(0.008)	
Constant	0.248		0.250		
Mean share of wealth in TDA	0.405		0.405		
N (obs.)	6,476		6,476		
Measure of fit (adjusted-R^2)	0.219		0.221		

Source: 1995–2001 Surveys of Consumer Finances
Notes: 2-stage instrumental variable/AGLS model, with first-stage regression coefficients. Dependent variable is the share of financial wealth held in TDA.The two panels differ in the choice of an instrumental variable for the endogenous share of wealth invested in TDA. Panel A uses 401k eligibility (and employer contribution match), while panel B uses firm size.

[a] Eligible for any high contribution limit, self-directed retirement plan such as 401k, 403b, Keogh, SEP-IRA, etc.
[b] γ-transformation applied to wealth measures
***, **, and * indicate statistical significance at 1, 5, and 10 percent level, respectively.

Notably, the share of wealth in TDAs is also found to depend negatively on the level of risk in household's labor income. As conditional standard deviation of the log of labor income declines from its 75th percentile value (0.42) to 25th percentile (0.20), the share of wealth held inside TDA increases by between 3.1 to 4.5 percentage points (using coefficient estimates in panels A and B). Empirically, the shift from 75th to 25th percentile of labor risk can be thought of as moving from the standard deviation of labor income growth associated with college-educated entrepreneurs to that of high-school-educated clerical and administrative support workers. Households that can rely on dual labor income streams also hold a higher share of their wealth in TDA. These findings are important because they suggest that the location decision of a household is an active choice variable influenced by the level of uncertainty in labor income, and not just a deterministic function of household wealth. That is, of the two households with identical wealth levels, the one with greater income uncertainty will have contributed less of its wealth to the tax-deferred retirement account.

1.5.3 Which Households Are More Likely to Be Tax Efficient?

At an extreme, all households that are not subject to TDA withdrawal penalties would have fully tax-efficient portfolios. Although the data are inevitably more ambiguous, there is clear evidence in support of this conjecture. Whereas nearly 60 percent of households with positive investable wealth aged sixty and above maintain tax-efficient portfolios, only 32 percent of those below this age threshold are tax efficient.

To account for other factors influencing the choice of whether to be tax efficient, we estimate a probit variant of the model described in Appendix B. The estimated coefficients of this model are presented in table 1.6.[24] Analogous with definitions in table 1.1 and figure 1.1, the dependent variable takes on a value of one if household portfolio lies in the 10 percent band around the tax-efficient frontier. The results are broadly consistent with the hypotheses put forth in section 1.4.1. In particular, households with higher values of *swlth*TDA are significantly less likely to maintain tax-efficient portfolios. Departing from its mean sample value of 40 percent, each percentage point increase in the share of wealth held in TDA is associated with a 1.2 percentage point reduction in the likelihood of holding a tax-efficient portfolio. All else equal, households with a greater share of wealth in retirement accounts are more liquidity constrained—which increases the odds of tapping TDA funds early to smooth income shocks.

Table 1.6
Which Households Are Tax Efficient?

Regressors	Coefficient	Standard Error	Marginal effect[a]	Eq (1) group
Share of wealth in TDA	–3.161 ***	(0.429)	–1.237	M
Subject to early withdrawal penalty (1 = yes)	–0.175 **	(0.086)	–0.069	
Financial wealth[b]	0.090 **	(0.045)	0.035	W
Housing wealth[b]	–0.010	(0.017)	–0.004	
Cond. std. deviation of labor income	–0.419 ***	(0.155)	–0.164	L
Probability of being unemployed	0.270	(0.901)	0.106	
Dual earner household dummy (1 = yes)	0.008	(0.046)	0.003	
Health care coverage dummy (1 = yes)	–0.064	(0.083)	–0.025	H
Precautionary savings household	–0.063	(0.043)	–0.025	
Enough assets to cover liquidity needs (1 = yes)	–0.612 ***	(0.104)	–0.239	
Age of head of household	0.041 ***	(0.015)	0.016	D
Age -squared ($\times 10^{-2}$)	–0.038 **	(0.015)	–0.015	
Education (no high school diploma)	–0.126	(0.112)	–0.049	
Education (some college)	–0.214 ***	(0.066)	–0.082	
Education (college or more)	–0.144 ***	(0.055)	–0.056	
Number of dependents	–0.008	(0.016)	–0.003	
Availability of DB plan at work	–0.065 *	(0.039)	–0.026	
1995 year dummy	0.098 **	(0.047)	0.039	
1998 year dummy	0.024	(0.044)	0.009	
Constant	0.572			
N (obs.)	6,469			
Measure of fit (pseudo-R^2)	0.042			

Source: 1995–2001 Surveys of Consumer Finances
Note: 2-SIV/AGLS probit model of tax-efficient portfolio choice, estimates of structural coefficients. Dependent variable: 1 if household portfolio is "tax-efficient," 0 otherwise. A tax-efficient portfolio is one that contains all "high-tax" assets in tax-deferred accounts (TDA), while "low-tax" assets are held in taxable accounts (CSA). "Low-tax" assets are defined here as equities and municipal bonds held directly or through mutual funds, and U.S. savings bonds. A portfolio is considered to be tax-efficient if at least 90% of asset value in each of the accounts is allocated in the manner described above.
[a] Marginal effects evaluated at the mean for continuous variables, or as discrete changes from 0 to 1 for dummies.
[b] γ-transformation applied to wealth measures
***, **, and * indicate statistical significance at 1, 5, and 10 percent level, respectively.

One way to avoid this is by holding tax-inefficient portfolios, as implied by the negative coefficient estimate. Being subject to early withdrawal penalties remains important in the multivariate setting, decreasing the likelihood of tax-efficiency by about 7 percentage points.

The hypotheses regarding the effects of wealth and labor income risk receive somewhat mixed support in the data. Although households with more financial wealth are more likely to be tax efficient, this analysis has failed to detect an independent effect of housing wealth. Similarly, standard deviation of the log of labor income is estimated to have a statistically significant negative effect on household tax efficiency. However, other measures of labor income risk do not generate statistically identifiable effects—and neither does health insurance coverage. Still, none of these coefficient estimates is inconsistent with the hypothesis of an inverse relationship between the precautionary savings motives and likelihood of portfolio tax efficiency.

Households that have sufficient taxable assets to satisfy their self-reported precautionary needs are found less likely to hold tax-efficient portfolios. Controlling for total financial wealth, such households are characterized by high equity holdings in both account types. Consequently, the only way for such households to avoid being labeled "tax inefficient" is through holding very little (less than 10 percent) of their taxable accounts in bondlike assets—which few of them do. The puzzling finding of the likelihood of tax efficiency declining monotonically with age (until the age of sixty) has its explanation in a similar source. The age profile of stock market participation rises quickly through the peak earnings years (Ameriks and Zeldes 2004; Banks, Blundell, and Smith 2004). In recent years, initial equity ownership occurred primarily through employer-sponsored TDAs (Gale and Pence 2006). These TDA equity holdings coupled with taxable money market accounts accumulated by households early on in their lifecycle, lead to an association between tax-inefficiency and increases in equity participation with age. This mechanism is also the likely source for a strong negative time trend in tax efficiency, as much of the increase in the number of positive financial wealth households between 1995 and 2001 could be attributed to TDA participation (see table 1.1).

1.5.4 What Determines the Degree of Tax Inefficiency in Household Portfolios?

The above analysis of the stark binary choice of whether to hold tax-efficient portfolios highlights the key reasons for empirical shortfalls of

the Tepper-Black type models. However, the question of greater practical interest is the *extent* of household tax inefficiency. The investigation of this question can take two distinct forms. Bergstresser and Poterba (2004) provide a comprehensive analysis of the absolute magnitudes of misallocated assets, which are directly related to estimates of financial losses resulting from tax inefficiency. Taking a somewhat different focus, this chapter looks to identify specific causes for deviations of household portfolios from tax-efficient benchmarks by analyzing portfolio composition in each of the two account types. This approach also provides a novel test of the effects of precautionary motives on portfolio choices.

Portfolio allocations in both accounts are modeled jointly, in order to account for simultaneity of such choices. This is accomplished by choosing a bivariate tobit model with correlated error structure, where error terms in each equation include unobserved (or omitted) household-specific factors. The resulting econometric model is specified fully in Appendix B.

Portfolio Choice in Taxable Account The estimation results of the bivariate tobit model of portfolio choice are presented in table 1.7. The left panel shows coefficient estimates for portfolio choice in the taxable account. The estimated coefficients are of correct sign and most are statistically significant. As hypothesized in section 1.3.2, households with higher values of *swlth*TDA have lower equity shares in their taxable portfolios. This effect has strong economic significance—moving a household from the 25th percentile of *swlth*TDA (0.12) to the 75th percentile (0.66) while holding wealth levels unchanged would decrease the equity share in taxable account by 18.5 percentage points. Being subject to withdrawal penalties is found to have a negative, though not statistically significant, effect on the taxable account equity shares. In contrast, measures of labor income uncertainty have strong negative effects on the share of taxable portfolio dedicated to equities. The smaller magnitude of marginal effects of these regressors (e.g., increasing standard deviation of the log of wages from the 25th to the 75th percentile value leads to a decline in equity share of 2.4 percentage points) is not surprising in light of the results in the previous section. Holding more housing wealth (and hence having better access to credit markets) is associated with higher taxable equity shares, but having health insurance coverage (and thus being exposed to less background risk) is not. Another interesting finding is that households saving primarily for precautionary motives have somewhat less equity exposure in their taxable

Table 1.7
How Tax Efficient Are Households?

	Panel A. Taxable portfolio		*Panel B. Tax-deferred (TDA) portfolio*	
Regressors	Coefficient	Standard Error	Coefficient	Standard Error
Share of wealth in TDA	–0.343 ***	(0.128)	0.506 ***	(0.153)
Subject to early withdrawal penalty (1 = yes)	–0.032	(0.030)	0.051 *	(0.028)
Financial wealth[a]	0.299 ***	(0.015)	0.133 ***	(0.015)
Housing wealth[a]	0.012 **	(0.005)	0.004	(0.006)
Cond. std. deviation of labor income	–0.117 **	(0.050)	0.082 *	(0.050)
Probability of being unemployed	–0.570 **	(0.262)	–0.158	(0.272)
Dual earner household dummy (1 = yes)	0.023 *	(0.014)	0.008	(0.016)
Health care coverage dummy (1= yes)	–0.036	(0.022)	–0.055 **	(0.028)
Precautionary savings household	–0.039 ***	(0.013)	–0.008	(0.014)
Enough assets to cover liquidity needs (1 = yes)	0.146 ***	(0.031)	0.148 ***	(0.037)
Age of head of household	–0.012 ***	(0.004)	–0.014 ***	(0.005)
Age -squared ($\times 10^{-2}$)	0.006	(0.005)	0.006	(0.005)
Education (no high school diploma)	–0.047	(0.031)	0.023	(0.034)
Education (some college)	0.025	(0.019)	0.080 ***	(0.022)
Education (college or more)	0.057 ***	(0.016)	0.080 ***	(0.018)
Number of dependents	0.005	(0.005)		
Availability of DB plan at work			0.028 **	(0.013)
1995 year dummy	0.020	(0.014)	–0.095 ***	(0.016)
1998 year dummy	0.030 **	(0.013)	–0.024	(0.015)
Constant	–0.180		0.251	
Correlation ($\varepsilon_{CSA}, \varepsilon_{TDA}$)	0.21 ***			
N (obs.)	6,476		6,476	
Nonlimit observations	4,914		5,152	

Source: 1995–2001 Surveys of Consumer Finances
Note: 2-SIV/AGLS Bivariate tobit model of portfolio choice, estimates of structural coefficients. Dependent variables: share of an account type (taxable or TDA) held in equities. A tax-efficient household would be expected to hold a higher fraction of its taxable account in equities and a lower fraction of its tax-deferred account (TDA) in equities. Hence, higher values of regressors that have a positive sign in panel A and a negative sign in panel B indicate more tax-efficient portfolio choices.
[a] γ-transformation applied to wealth measures
***, **, and * indicate statistical significance at 1, 5, and 10 percent level, respectively.

portfolios, even after controlling for numerous proxy measures of such motives. While the results in panel A are suggestive of the importance of the strength of precautionary motives, one needs to consider them jointly with those for the TDA portfolio choice in order to test model predictions.

Portfolio Choice in TDA The estimated parameters for TDA portfolio allocations are shown in panel B of table 1.7. The estimates provide qualified support for the precautionary savings channel of moving households away from Tepper-Black tax efficiency.

The share of wealth held in TDA is estimated to have a strong positive effect on TDA equity allocations. This result is particularly important given the finding of an opposite relationship between equity share and location in the taxable account. Such differential relationship between location and allocation choices in the two account types is a distinguishing feature of the precautionary portfolio model that is able to generate tax-inefficient behavior.[25] Another key result is that being subject to early withdrawal penalties increases TDA equity shares (p-value of 0.066). Even though the coefficient estimate of this regressor in panel A is not statistically significant, the opposite signs of the effects of TDA penalties on equity shares in the two account types are consistent with the precautionary model. Similarly, positive effects of conditional standard deviation of the log of wages on TDA equity share are in contrast to their negative relationship with the share of taxable account held in equities (again, the estimate is only marginally significant, with a p-value of 0.09). However, the effects of other measures of household labor income risk and of housing wealth are not statistically significant. In general, the precision of coefficient estimates of the TDA portfolio choice is markedly lower than that in the taxable portfolio choice. This can be at least partially attributed to the necessity to impute TDA portfolio composition from a small set of discrete responses. As can be seen in figure 1.1, there is much less dispersion along the x-axis that captures TDA portfolio allocations. Such agglomeration of TDA portfolio choices masks important cross-sectional heterogeneity that could be used to identify the effects of individual regressors.

Finally, the bivariate tobit procedure estimates a strong positive correlation between the two error terms. One explanation for this is the presence of zero-limit (or no-equity) households—unobserved factors that influence household participation in equity markets are likely to work in the same direction in both habitats. For example, households

that already incurred the costs of learning about the stock market are more likely to own equities in both accounts. Taken together, the empirical estimates of the determinants of equity shares in the two account types suggest that precautionary savings motives play an active role in household portfolio choices and contribute to frequent departures from the Tepper-Black standard of tax efficiency.

1.6 Conclusion

Observed portfolio choices in taxable and tax-deferred account habitats are inconsistent with the theoretical predictions of Tepper-Black dual-habitat models. Although Bergstresser and Poterba (2004) show that the extent of deviations from the Tepper-Black optimum is fairly limited, the fact that households effectively leave money on the table is puzzling. One possible explanation for observing relatively safe but high-tax-burden assets like bonds in households' taxable accounts derives from limited TDA accessibility, which makes it costly to smooth bad income shocks by tapping one's retirement savings. This chapter presents empirical evidence from the SCF suggesting that precautionary considerations can help to explain existing patterns of asset allocation within and between TDA and taxable accounts. These findings augment the existing empirical literature on portfolio effects of precautionary motives by focusing on account-specific responses to limited liquidity and uninsurable risk.

The chapter also highlights the importance of distinguishing between account habitats in future studies of household financial decision-making. Existing institutional differences in accessibility and tax treatment—as well as distinct savings motives for each of the two account types—may be helpful in resolving several empirical puzzles. Indeed, the dramatic differences in age profiles of equity participation and portfolio composition in the two account types could provide insight into reasons for nonparticipation in equity markets or to assess the degree of responsiveness to various tax incentives like the step-up in basis at death.

Finally, this chapter is relevant for evaluating several policy questions pertaining to the rules that govern tax-deferred savings plans and possible behavioral responses to changes in these rules. In particular, it may help to enrich the structure of budget forecasting models by identifying factors that affect household location and allocation choices in taxable and tax-deferred accounts. In particular, the results suggest that relaxing early withdrawal penalties may lead to more tax-efficient TDA allocations, lowering tax revenues and affecting flows into and out of tax-

deferred accounts. As demographic changes necessitate an ever more important role for self-directed retirement savings in national pension systems throughout the industrialized world, improving the understanding of household choices in this arena is likely to remain an important item on the agenda of policymakers and researchers alike.

Appendix A

Estimation of Non-Financial Income Moments from PSID

The methodology for estimating conditional moments of non financial income is very similar to Vissing-Jørgensen (2002) and Carroll and Samwick (1998). The income process of household is a product of a permanent component and a transitory shock: $Y_t = P_t\varepsilon_t$, where log permanent shock follows a random walk with a drift. Switching to log notation, we obtain:

$$y_t = p_t + \varepsilon_t; \quad p_t = g_t + p_{t-1} + u_t; \quad \varepsilon_t \sim N(0, \sigma_\varepsilon^2); \quad u_t \sim N(0, \sigma_u^2), \tag{1}$$

where both u_t and ε_t are i.i.d. and are mutually uncorrelated at all leads and lags. The drift term (g_t) is predictable on the basis of information available at time $t-1$—that is, $g_t = f(Z_{t-1})$.

Differencing of the log income produces:

$$y_t - y_{t-1} = g_t + u_t + \varepsilon_t - \varepsilon_{t-1}; \tag{2}$$

$$y_t - y_{t-2} = g_t + g_{t-1} + u_t + u_{t-1} + \varepsilon_t - \varepsilon_{t-2}. \tag{3}$$

The d-year conditional variance of the log of income, $V(y_t \mid y_{t-1}, \ldots, y_{t-d}, Z_{t-1}, \ldots, Z_{t-d})$, is then given by $v_d = d\sigma_u^2 + 2\sigma_\varepsilon^2$.

In order to remove the predictable drift component, I regress detrended first difference of log non financial income on a vector of variables known at time $t-1$: age of household head, age-squared, occupation and industry dummies, number of children, as well as race, marital, and education category dummies. The resulting residuals are then used to construct sample one- and two-year conditional variances of the log of labor income for each household: v_1 and v_2. With these estimates in hand, one can theoretically separate sample variances of permanent and transitory shock components. However, this is not attempted here, and an estimate of one-year conditional variance is used as a regressor.

For estimation, 1985–1993 PSID data is used—restricting the sample to households that remained intact over the entire sample period and

provided complete responses in each of the survey years. Further, households in poverty and Latino subsamples are also excluded. The resulting sample consists of 2,404 households, each of which has nine observations. When estimating the predictable component of labor income growth rate, records which show unemployment spells of more than four weeks as well as records with suspiciously low nonfinancial income relative to household sample average (<10%) are excluded. Sample variances are computed for all households that did not have unemployment spells in any of the nine sample years. These variances are regressed on a vector of education and occupation dummies, and the resulting coefficient vector is used to impute labor income volatility for SCF respondents.

Appendix B

Econometric Model

As described in section 1.5, an analysis of tax-efficiency of portfolio choices that allows for the simultaneity of the overall location decision requires econometric models of limited dependent variables with endogenous regressors. In the case of the extensive margin choice (whether to be tax efficient), the dependent variable is binary. In the case of the intensive margin choice (the degree of tax efficiency), the two dependent variables are given by the share of each of the two account types invested in equities, restricted to the [0,1] range. The resulting econometric model has a common structure given by:

$$y_i^* = \beta_1 + \beta_2 M_i + \beta_3 W_i + \beta_4 L_i + \beta_5 H_i + \beta_6 D_i + u_i, i = 1, \ldots, N, \quad \text{(B1)}$$

where for the extensive margin choice the observed dependent variable is defined as:

$$y_i = 1 \text{ if } y_i^* > 0, 0 \text{ otherwise}, \quad \text{(B2)}$$

and for the intensive margin choice the observed dependent variables specialize to:

$$y_{i,k} = y_{i,k}^* \text{ if } y_{i,k}^* \in (0,1); \quad \text{(B3)}$$

$$y_{i,k} = 0 \text{ if } y_{i,k}^* \leq 0; y_{i,k} = 1 \text{ if } y_{i,k}^* \geq 1; k \in \{\text{TDA, taxable}\}.$$

In both cases, one of the key explanatory variables—the share of wealth held in TDA (*swlth*TDA)—is an endogenously determined proxy of lo-

cation choice (and of liquidity constraints). The endogenous variable *swlth*TDA is assumed to be related to a vector of instruments (X_1 X_2), where X_1 denotes variables that are included in equation (B1). In contrast, X_2 contains variables that affect the dependent variable(s) in equation (B1) only through their correlation with *swlth*TDA and are thus excluded from equation (B1):

$$swlth\text{TDA}_i = \Pi_1 X_{i1} + \Pi_2 X_{i2} + \varepsilon_i, (u, \varepsilon) \sim \text{MVN}(\mu, \Sigma). \quad \text{(B4)}$$

The set of explanatory variables is broken into several subsets for convenience. Variable *M* is a subset of variables that proxy for illiquidity of household wealth due to its TDA holdings—share of wealth in TDA and an indicator of being subject to the early withdrawal penalty. Variable *W* consists of financial and housing wealth. Variable *L* contains estimates of the conditional volatility of the log of labor income by occupation and education, derived from PSID data. The regressors in *L* also include the probability of unemployment estimated for the same demographic groups using CPS data and a dummy variable for households with two or more income earners. Variable *H* contains additional indicators of the extent to which a household may be subject to precautionary motives. These binary variables capture whether the main self-reported motive for savings is precautionary, whether all members of household are covered by health insurance, and whether the household has enough liquid assets to satisfy self-reported liquidity needs. Finally, *D* represents a subset of demographic variables—education category dummies and a quadratic in age.

The model in (B1)–(B4) is estimated on the basis of Newey's (1987) estimator for limited dependent variable models with endogenous explanatory variables—which is a variant of Amemiya's (1978) generalized least squares (AGLS). In Newey's estimator, parameters of the limited dependent variable equation (such as equation (B1)) are estimated by maximum likelihood after substituting for the endogenous variable with a reduced form equation (such as equation (B4)). The structural parameters of equation (B1) are then backed out via a generalized least squares approach.

An additional complication of the model in (B1)–(B4) is that the regressors in *L* are themselves generated on the basis of household labor income characteristics obtained from additional data sources—the Current Population Survey and the Panel Study of Income Dynamics. To account for sampling error in the generated regressors, I restate the AGLS estimator in the GMM framework for multistep estimators

(Hansen 1982).[26] The details of estimation are available on request, but two points can be made here. The first is that most of the moment conditions in the estimator can be assumed to be mutually independent, since they are computed using data from three different surveys. Since it is unlikely that same people were chosen for participation in these surveys, the assumption of independence is not unreasonable. As a result, the complexity of the estimator is greatly reduced. The second point is that all information from PSID and CPS data needed to correct the variance-covariance matrix of structural coefficients β is contained in consistent estimators of $\mathrm{Var}(\theta)$, where θ is a vector of coefficients from regressions of labor volatility measures on occupation and education dummies. The size of these estimated $\mathrm{Var}(\theta)$ matrices is one of the key determinants of the magnitude of corrections for generated regressors. Both of the other data samples—PSID and CPS—are rather large.[27] Given their size and the nature of parameter vectors (simple demographic cell means), it is not surprising that both θ-vectors are very precisely estimated. Consequently, the correction to standard errors that is due to the presence of generated regressors is very small. While accounting for the effect of such regressors remains an important theoretical concern, its practical implications are quite limited in the current application.

The extensive margin of tax-efficiency is, thus, modeled as a probit variant of (B1)–(B4) with the dependent variable given by (B2). The intensive margin decision is described by portfolio allocations in *both* accounts, which are modeled jointly to account for simultaneity of such choices. The resulting econometric model in (B1)–(B4) specializes to a bivariate tobit model with correlated error structure, where error terms in each equation (u_i^{TDA}, u_i^{taxable}) include unobserved or omitted household-specific factors. The bivariate vector of dependent variables in this model is defined by (B3). The results for the two margins of tax-efficiency are summarized in table 1.6 and 1.7, respectively, with Newey's asymptotically efficient estimates of structural coefficients.

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Notes

1. For example, Dammon, Spatt, and Zhang (2004) estimate utility costs of tax-inefficient allocations to be up to fifteen percent of total investable wealth for young households.

2. These data are from the U.S. Flow of Funds, tables L.118.c and L.225.i. Self-directed retirement accounts include employer-sponsored defined contribution plans such as 401(k) and 403(b), similar plans for the self-employed such as Keogh and SEP-IRA, and individual retirement savings accounts such as Regular and Roth IRA.

3. For the remainder of this paper, tax efficiency of portfolio allocations is defined in the narrow sense of Tepper-Black. An allocation is said to be tax-efficient if a strict pecking order is observed—the highest-taxed asset is always located in the tax-preferred habitat before any lower-taxed assets can be placed there. Relative to this benchmark, any allocation that violates this pecking order is labeled tax inefficient.

4. Other recent papers have also attempted to address the discord between theory and data in a variety of ways. For example, Huang (2001) uses lumpy expenditure needs that are unavoidable at certain points over the lifecycle, while Dammon, Spatt, and Zhang (2004) add uncertain labor income and lumpy consumption shocks. These models are discussed in detail in Amromin (2003).

5. Garlappi and Huang (2006) offer an alternative and novel mechanism for generating non-Tepper-Black portfolios. Starting with the premise that Tepper-Black tax efficiency maximizes the tax subsidy inherent in TDA savings (Poterba 2004), they show that risk-averse households facing borrowing constraints are concerned not only with the level of such tax subsidy, but also with its *volatility*. Consequently, they may opt to reduce the volatility of the subsidy by placing both bonds and stocks in each of the two account types. Although Garlappi and Huang (2006) contains interesting empirical predictions, they cannot be readily tested with available data.

6. However, if TDA access is unrestricted, the precautionary motives can be satisfied by assets in either habitat and tax efficiency of allocations need not be violated. This should be the case with the Canadian system, which openly treats tax-favored registered retirement savings plans (RRSP) as just another means to smooth consumption.

7. An especially popular formulation of this test has been to look for a negative relationship between the share of equities in household portfolio and the level of its labor income risk, as shown numerically in Cocco, Gomes, and Maenhout (2005) and Viceira (2001). Vissing-Jørgensen (2002) and Heaton and Lucas (2000a) find strong effects, but Guiso, Jappelli, and Terlizzesse (1996) conclude that labor income risk has small effects on portfolio choice, while Hochguertel (2003) finds that the sign of these effects may even occasionally be positive in his sample of Dutch households. Bertaut and Haliassos (1995) also find that those in high-risk occupations (defined as occupations with higher and more variable unemployment rates) are less likely to own any stocks.

8. Although the empirical analysis is carried out using U.S. data, the same paradigm would hold true in any country that (1) imposes accessibility restrictions on tax-favored accounts, and (2) has lower tax burdens on equities, as compared with less risky bonds. One prominent example of such setting is the United Kingdom.

9. A detailed definition of low- and high-tax assets is provided in section 1.4.

10. As noted in the footnote to table 1.1, investable financial wealth includes financial assets outside of checking accounts, as well as assets in self-directed individual retirement savings plans. The choice of which assets should be considered investable and which investment choices should be regarded as tax-efficient will be addressed in detail in the next section. Furthermore—in order to account for likely measurement error—the definition of tax-efficiency is relaxed to allow for a 10 percent interval around the tax-efficient frontier as indicated by dotted lines in figure 1.1.

11. These proportions pertain only to households with positive financial wealth in both account types. As seen in table 1.1, the share of such households in the United States has been growing rapidly from only 33 percent in 1995 to nearly 46 percent in 2001, largely as a result of increasing popularity of tax-deferred retirement accounts.

12. Here, τ corresponds to the marginal tax rate (and the tax rate on bond holdings), while τ_{st} is the effective tax rate on stocks. Intuitively, since taxable equities are less risky than equities contained in TDA, risk-preserving tax-efficient rebalancing produces higher after-tax equity holdings: $\$(1-\tau)/(1-\tau_{st})$ as compared to $\$(1-\tau)$.

13. Haliassos and Michaelides (2003) provide a detailed analysis of household portfolio choice under liquidity constraints. The illiquidity of TDA accounts potentially has an even stronger effect on the ultimate location and allocation choice in the presence of firm consumption commitments such as housing. Chetty and Szeidl (forthcoming) and Fratantoni (2001) study the effect of such commitments on household portfolio choice and conclude that they may explain low (or non existent) equity holdings of households.

14. Precautionary savings are commonly defined as the incremental savings that a liquidity-constrained household makes when it faces labor income risk, compared to the certain income scenario. Carroll, Dynan, and Krane (2003) empirically confirmed the existence of such savings, although the results were somewhat sensitive to measures of savings.

15. Simulation results indicate that under plausible specifications of stochastic income processes, buffer stocks need to be not only liquid but also include safe assets like bonds. Still, stronger theoretical results are needed to establish conditions under which buffer stocks necessarily contain riskless assets.

16. The model in Amromin (2003) can directly accommodate only a few avenues for increasing precautionary savings motives, such as the share of wealth in illiquid TDA accounts, degree of their illiquidity (early withdrawal penalty), and probability of unemployment shocks. The empirical analysis will extend to additional measures of precautionary concerns, such as housing equity and volatility of labor income.

17. Both exemptions became law in 1997 as a part of The Taxpayer Relief Act. Education withdrawals can apply towards tuition, as well as room and board, and they can be taken out for oneself, one's children, or grandchildren. There is not a fixed dollar limit on such withdrawals and as long as all of it goes toward qualified education expenses no penalties are due. The housing exemption applies to first-time homebuyers and is capped at ten thousand dollars for each of the partners. First-time is defined as not having owned a primary residence for the past 2 years.

18. Some recent studies (Flavin and Yamashita, 2002) focus on the role of housing wealth, which serves an important role in relaxing liquidity constraints through home equity loans and lines of credit. I control for housing wealth in empirical work but it does not enter the definition for investable wealth. Heaton and Lucas (2000b) demonstrated that proprietary business holdings are an important component of household portfolios. Such holdings are typically less liquid and more volatile than purely financial assets. Although the current version of the paper excludes these holdings, it would be useful to conduct robustness checks on the definition of wealth in the future.

19. Self-reported liquidity needs were determined from responses to the following question: "About how much do you think you (and your family) need to have in savings for emergencies and other unexpected things that may come up?" A household that has enough liquid non investment assets to satisfy these needs would be more likely to have a tax-efficient investment portfolio.

20. Another concern about using firm size, is that larger firms are more likely to provide matching TDA contributions in the form of company stock. Indeed, a recent survey conducted by The Profit Sharing/401k Council of America indicates that while 37 percent of corporations with more than five thousand employees match with company stock, only 3 percent of companies with less than five hundred employees do the same. This difference is also due to the fact that smaller firms rarely have publicly traded stocks and, thus, are much less likely to offer company stock as an investment option (13.5% as compared with 76.7%).

21. Even though eligibility is a direct measure of the extent of TDA saving opportunities (as opposed to firm size), it is also not an ideal instrument because of its relationship with the underlying household preferences (Weisbenner 2002; Pence 2002) for a detailed discussion of selection and education effects. Similar concerns can also be raised with respect to the size of employer match.

22. There are several such accounts—Keogh, SEP-IRA, etc.—all of which have high contribution limits. For example, Keogh plans allow one to save up to forty thousand dollars per year in combined employee and employer contributions.

23. In order to correct for extreme skewness in distribution of financial and housing wealth, I use the inverse hyperbolic sine function advocated by Carroll, Dynan, and Krane (2003). This transformation is described by $\gamma(W, \theta) = \ln[\theta W + (\theta^2 W^2 + 1)^{0.5}]/\theta$, where θ controls the degree to which large values are downweighted. Unlike log transform, γ-transform can handle negative and zero observations as well.

24. In an unreported exercise, I test for sample selection bias produced by restricting the regression sample to households that have positive wealth in both account types. The likelihood ratio test of independence of the selection and tax-efficiency equations in the Heckman sample selection probit model cannot be rejected at the 10 percent confidence level.

25. Recall that in models that generate Tepper-Black tax-efficient outcomes, *swlth*TDA has a positive relationship with equity shares in *both* account types.

26. The set of moments for GMM estimation consists of the first order conditions of the log-likelihood function for equation (B1), the OLS estimator of equation (B4), and the two moments from OLS estimation of coefficient vectors used to impute the probability of unemployment and standard deviation of labor income in the SCF. The first moment condition is based on the conditional log-likelihood functions for probit and bivariate tobit in cases (B2) and (B3), respectively (Greene 1999). Details are available upon request.

27. The PSID panel used for estimation of θ^{PSID} consists of 1,396 households, with 9 observations per household. The CPS sample used for estimation of θ^{CPS} has 120,477 observations.

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