

# The tradeoff between mortgage prepayments and tax-deferred retirement savings<sup>☆</sup>

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## Abstract

Many households face the tradeoff between paying an extra dollar off the remaining mortgage on their house and saving that extra dollar in tax-deferred accounts (TDAs) used for retirement. We show that, under certain conditions, it becomes a tax arbitrage to reduce mortgage prepayments and to increase TDA contributions because of the tax deductibility of mortgage interest and tax-exemption of qualified retirement savings. Using data from the Survey of Consumer Finances, we document that a significant number of households that are accelerating their mortgage payments instead of saving in TDAs forgo a profitable tax arbitrage opportunity. Finally, we show empirically that this inefficient behavior is unlikely to be driven by liquidity or other financial constraints. Rather, the observed behavior can be attributed to a certain extent to the reluctance of many households to participate in financial markets as either lenders or borrowers.

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“Neither a borrower nor a lender be;

For loan oft loses both itself and friend,

And borrowing dulls the edge of husbandry.”

— William Shakespeare

## 1. Introduction

Many households are reluctant to participate in financial markets either as lenders or as borrowers. According to the 2001 Survey of Consumer Finances (SCF), nearly half of U.S. households do not own stocks and more than one-third of the households eligible for employer-sponsored retirement plans do not contribute at all to such plans. Furthermore, some households are also averse to carrying debt. At a first glance, this runs counter to stylized facts on the proliferation of consumer borrowing, especially in unsecured credit markets. Yet, a surprising number of households accelerate paydowns of their mortgage loans, which account for a larger share of their debt. We show that these choices generate substantial monetary costs for a significant number of households.

This paper focuses on two of the most important financial decisions of households: retirement savings and home ownership borrowing. Many households, at one time or another, face the tradeoff between paying an extra dollar off the remaining mortgage on their house and saving that extra dollar in tax-qualified retirement accounts. In a world without frictions, paying off mortgage loans early and investing in retirement accounts would be equivalent saving decisions. In reality, however, taxes and transaction costs play a key role in the determination of the effective borrowing and lending rates. We show that, under certain conditions, it becomes a tax arbitrage to reduce mortgage prepayments and to increase contributions to tax-deferred accounts (TDAs).<sup>3</sup>

Mortgage interest payments are deductible from taxable income for households that itemize their deductions, while investment income in retirement accounts remains effectively tax-exempt.<sup>4</sup> Hence, households earn pre-tax returns ( $r_L$ ) in their retirement accounts and pay after-tax rates  $(1 - \tau)r_B$  on their mortgage borrowing. Although the borrowing rate ( $r_B$ ) on the mortgage is likely higher than the investment rate ( $r_L$ ) for an asset with similar risk properties, we show that, as long as  $r_L > (1 - \tau)r_B$ , households are generally better off saving in a TDA instead of prepaying their mortgage. Given the simplicity of this strategy, it is reasonable to ask whether and to what extent households recognize this tradeoff in their personal decisions.

Using data from the Survey of Consumer Finances, we investigate household choices between mortgage prepayments and retirement account contributions. While it is not surprising that some households are not making the right choice, the magnitude of the overall inefficiency is striking. On the margin, at least 38% of households that prepay their mortgages could benefit from our proposed arbitrage strategy. Depending on the choice of the investment asset in the TDA, the average annual consumption gain from such a reallocation ranges between 11 and 17 cents per

<sup>3</sup> Throughout the paper, we use the term “mortgage prepayment” to denote extra payments on an existing mortgage (which is commonly known as “curtailment” in the industry) or taking out a mortgage with a maturity shorter than the standard 30 years. Short maturity mortgages carry higher periodic payments, which can be considered committed prepayments in the same sense as writing extra checks to the mortgage company. We do not include mortgage refinancing in our definition of “prepayments,” although this interpretation is common in the industry.

<sup>4</sup> Consider, for example, a Roth account where households pay income tax when they contribute and no more tax is owed upon withdrawal. Also, when tax rates are constant over time, investing in a tax-deferred account is equivalent to investing in a Roth account.

dollar of “mis-allocated savings” or between 252 and 385 dollars per household. In the aggregate, correcting this inefficient behavior could save U.S. households about 1.5 billion dollars per year. The finding that a significant number of households make substantial mistakes in their financial decisions echoes the conclusions of [Campbell \(2006\)](#).

There are arguably numerous rational reasons for households either to prepay their mortgages or not to contribute to their retirement accounts—among them interest rate risks, liquidity and default risks, and credit constraints. However, we argue that none of these reasons obviates the tax arbitrage opportunity that exists for the majority of households that are prepaying without maximizing their TDA contributions.

Rather, these households seem to be influenced by an aversion to participate in financial markets either as lenders or borrowers.<sup>5</sup> Empirically, debt aversion and risk aversion explain to some extent the household preference for reducing their debt obligations in spite of incurring considerable monetary losses in the process. The propensity of debt-averse households to forgo tax arbitrages is related to the findings in [Graham \(2000\)](#), who shows that many corporations give up substantial tax benefits by holding too little debt.

Our paper is most closely related to the recent literature on the optimal asset location choice that considers the tradeoff between savings in taxable vs. tax-deferred accounts. [Dammon et al. \(2004\)](#), [Shoven and Sialm \(2004\)](#), [Poterba et al. \(2004\)](#), [Huang \(2006\)](#), and [Garlappi and Huang \(2006\)](#) show theoretically that, in order to maximize the tax benefit of retirement accounts, highly taxed assets should generally be located in tax-deferred accounts and that lightly taxed assets should be located in taxable accounts. The actual behavior of individuals investing in taxable and tax-deferred accounts is analyzed by [Barber and Odean \(2003\)](#), [Bergstresser and Poterba \(2004\)](#), and [Amromin \(2004\)](#). These papers find that many households have significant amounts of money in both accounts and that a large proportion of them do not appear to take advantage of the potential benefits of optimal asset location. Similar to this literature, we theoretically compare the tax efficiency of two forms of savings choices, and then document actual household behavior and evaluate the extent of losses relative to the theoretical benchmark. Our main contribution is to introduce mortgage payments as an additional investment option in the tax arbitrage framework.

There is also a vast literature on both retirement savings decisions<sup>6</sup> and mortgage choices.<sup>7</sup> Our paper contributes to this literature by linking these two strands of research and considering retirement contributions and mortgage payments as two alternative forms of household savings decisions.

The paper is structured as follows. Section 2 describes the tax arbitrage strategy in detail and Section 3 discusses its robustness to a number of alternative assumptions. Section 4 describes the data and Section 5 provides summary statistics for TDA contribution and mortgage payment behavior. Section 6 calculates the cost of choosing the suboptimal saving strategy. Section 7 looks at possible explanations for why households may forgo the tax arbitrage, and Section 8 provides concluding remarks.

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<sup>5</sup> The limited participation of households in asset markets has been discussed by [Mankiw and Zeldes \(1991\)](#) and [Vissing-Jorgensen \(2002\)](#). The reluctance to participate in tax-qualified retirement plans has been described in a voluminous literature, summarized recently by [Bernheim \(2002\)](#), [Poterba \(2002\)](#), and [Bernheim and Rangel \(in press\)](#).

<sup>6</sup> For example, [Poterba et al. \(1995\)](#), [Madrian and Shea \(2001\)](#), [Choi et al. \(2002\)](#), [Agnew et al. \(2003\)](#), [Choi et al. \(2005\)](#), [Mitchell et al. \(2005\)](#), [Duflo et al. \(2006\)](#), [Huberman and Jiang \(2006\)](#), [Brown et al. \(2006\)](#), and [Poterba et al. \(2006\)](#) consider the determinants of individual TDA participation and portfolio choice.

<sup>7</sup> For example, [Dunn and Spatt \(1985, 1999\)](#), [Green and Shoven \(1986\)](#), [Stanton and Wallace \(1998\)](#), [Quigley \(2002\)](#), [Campbell and Cocco \(2003\)](#), [Hurst and Stafford \(2004\)](#), and [Kojien et al. \(2007\)](#) study mortgage choices, including contract types, refinancing, and prepayment decisions.

## 2. Tax arbitrage strategy

This section describes the tax arbitrage strategy between tax-deferred retirement account contributions and mortgage prepayments. We consider a household that contributes less than the statutory maximum to a TDA and that also makes additional mortgage payments at the same time. Households that make such payments have already chosen to save some of their income. We analyze the marginal tradeoff between contributing to a TDA and building up home equity to determine whether these households would be better off reallocating their savings.

There exist several different types of retirement accounts. Because of data limitations, we restrict our attention to traditional employer-sponsored TDAs, such as 401(k) and 403(b) plans that allow contributions on a before-tax basis. These contributions grow tax-deferred until withdrawal when the household pays taxes both on its original contribution amount and on the cumulative investment returns.

The household is assumed to have a constant tax rate  $\tau$  over time, and faces a penalty  $\kappa_t$  on TDA withdrawals at time  $t$ . Currently, withdrawals by individuals younger than  $59\frac{1}{2}$  years of age generally face a 10% penalty. Hence,  $\kappa_t = 10\%$  if  $t < 59\frac{1}{2}$  and  $\kappa_t = 0$  otherwise.

To derive our main result, we make the following simplifying assumptions. First, the household has a fixed-rate mortgage with a rate  $r_B$  and earns a constant rate of return  $r_L$  on its tax-deferred savings. Second, the household itemizes deductions and can therefore effectively subtract mortgage interest from taxable income. Third, under the current prepayment schedule, the mortgage has a fixed remaining horizon  $T$ , which means that the household never defaults or pays off the entire mortgage for moving or refinancing purposes. Fourth, each dollar of prepayment in the current year affects only year  $T$  cash flow and reduces the after-tax mortgage payment by  $(1+(1-\tau)r_B)^T$  dollars. Fifth, households can withdraw funds from retirement accounts prior to reaching  $59\frac{1}{2}$  after paying a 10% early withdrawal penalty. These assumptions are useful for illustrating the tax arbitrage strategy. We discuss their robustness in Section 3.

Under these assumptions, we propose a simple tax arbitrage strategy where the household makes the following perturbation to its current savings strategy: (i) decreases the mortgage prepayment by one dollar; (ii) contributes an additional

$$X \equiv \frac{1}{1-\tau-\kappa_T} \left( \frac{1+(1-\tau)r_B}{1+r_L} \right)^T \quad (1)$$

dollars to the tax-deferred account that earns a return of  $r_L$ ; (iii) receives an immediate tax credit of  $\tau X$  dollars for the additional contribution; and (iv) withdraws  $X(1+r_L)^T$  dollars from the tax-deferred account in year  $T$ .

Since the additional contribution  $X$  to the tax-deferred account grows to  $X(1+r_L)^T$  by the end of year  $T$ , exactly offsetting the withdrawal amount, the new strategy yields the same wealth in the tax-deferred account as the current strategy. Moreover, the total proceeds from the withdrawal are  $X(1+r_L)^T(1-\tau-\kappa_T) = (1+(1-\tau)r_B)^T$ , where  $\tau$  is the tax rate and  $\kappa_T$  is the penalty upon withdrawal.<sup>8</sup> At the same time, we have assumed that reducing the current mortgage prepayment by one dollar increases the mortgage obligation by  $(1+(1-\tau)r_B)^T$  dollars in year  $T$ . Hence, the withdrawal proceeds exactly offset the additional mortgage liability resulting from the reduced prepayment of the mortgage loan. Finally, the combination of steps (i)–(iv) implies that the household can walk away with a net profit of  $1+\tau X - X$  in the taxable account, which can

<sup>8</sup> Note that the household receives  $(1-\tau-\kappa_T)$  dollars for each dollar withdrawn rather than  $(1-\tau)(1-\kappa_T)$  since the penalty is not tax-deductible under the current tax code.

be consumed immediately. We simplify its expression and call it the “Marginal Arbitrage Profit” (MAP),

$$MAP \equiv 1 + \tau X - X = 1 - \frac{1 - \tau}{1 - \tau - \kappa_T} \left( \frac{1 + (1 - \tau)r_B}{1 + r_L} \right)^T. \quad (2)$$

For any household, as long as the MAP measure is positive, it is better off following the arbitrage strategy of reducing its prepayments and increasing its TDA contributions. Inspecting Eq. (2) yields the following intuitive results. First, the arbitrage profit decreases with  $r_B$  and increases with  $r_L$ . A higher mortgage borrowing rate  $r_B$  makes it less profitable to stop prepaying, while a higher investment return  $r_L$  makes it more attractive to invest in the tax-deferred account. Second, the arbitrage benefit increases with the investment horizon  $T$  as long as  $r_L > (1 - \tau)r_B$ , since the money grows tax-deferred for a longer period of time. Finally, this arbitrage strategy is always feasible, since it is “self-financed”. The only cash outflow implied by the strategy is the additional mortgage payment on the terminal date, which is exactly covered by the future withdrawal from the tax-deferred account. As a result, the household never needs to put in additional money after pocketing the arbitrage profit.

If households continue to save in the future, this self-financing requirement yields conservative estimates of the arbitrage profit. In particular, if  $\kappa_T > 0$ , our strategy requires households to pay withdrawal penalties in order to meet the additional mortgage obligation at time  $T$ . However, if they can use other funds in their taxable accounts or can reduce their future contributions to retirement accounts to satisfy these obligations, they will be able to delay the withdrawal and avoid the penalty. Even when the penalty is zero, delaying the withdrawal allows households to shelter assets from taxation for a longer time period, and hence improves the arbitrage profit.

The MAP expression further underestimates the benefit of the tax arbitrage strategy if a household does not consume the arbitrage profit immediately. In particular, its current wealth level is increased by the MAP amount. Without reducing its current consumption level or altering any part of its remaining portfolio, a household can contribute an additional amount (up to the MAP measure) to its TDA. This additional contribution allows it to further enjoy the benefit of tax-deferred savings. The proposed arbitrage transaction also ignores employer matches and deductibility of TDA contributions from state income taxes, both of which increase its profitability.

The proposed strategy may also have an indirect benefit of reducing fixed participation costs as discussed by [Vissing-Jorgensen \(2002\)](#) and encouraging equity market participation. Moving mortgage prepayments to employer-sponsored TDA accounts introduces some households to an environment with lower equity participation costs, either because of employer subsidies or simplified investment options.

### 3. Discussion

We now discuss the robustness of the tax arbitrage strategy by relaxing the assumptions in the previous section.

#### 3.1. Stochastic interest rates

In our derivation of the tax arbitrage strategy in Section 2, both the mortgage borrowing rate ( $r_B$ ) and the tax-deferred investment return ( $r_L$ ) are assumed to be constant over time. Since we

restrict our empirical investigation to households with fixed rate mortgages, the assumption of constant  $r_B$  is violated only when the mortgage is refinanced at a time  $S < T$ . As long as the refinancing decision is driven purely by interest rate considerations, the new mortgage rate  $r'_B$  is less than  $r_B$ , reducing the required future mortgage payments. Hence, the arbitrage profit in this case is increased after the refinancing.

The assumption of fixed lending rates does not hold in cases where TDA contributions are invested in pass-through instruments such as mortgage-backed securities (MBS), which pool individual mortgages. MBS have a variable maturity because of prepayment and default risks. Yields on MBS investments also vary over time, since they are typically sold through mutual funds that change their asset composition frequently. In this setting, households are trading off a fixed mortgage liability for an asset with variable rate of return and maturity, both of which are affected by general movements in interest rates.

Still, we expect our estimation of the arbitrage profit to be conservative, as movements in the lending rate  $r_L$  have an *asymmetric* impact on its profitability. When  $r_L$  increases, households gain, since the newly invested amount earns a higher return than the corresponding liability. On the other hand, when  $r_L$  goes down, households are more likely to exercise their option to refinance, reducing the downside risk of the arbitrage strategy.

### 3.2. Moving-related prepayment risks

In addition to falling interest rates, households may pay off their entire mortgages early when they sell their existing homes, because of relocations or other changes in housing needs. If interest rates stay constant over time, the arbitrage strategy remains valid as long as households are able to carry their mortgage debt over to the new house.

When both interest rate and moving risks are present, our tax strategy is no longer a risk-free arbitrage. While households are better off if they choose to move when the interest rate goes down, it is also possible that they may need to move when the new mortgage borrowing rate increases. As a result, the extra mortgage obligation would exceed the potential withdrawal from the tax-deferred saving. In this case, however, the overall loss from replacing a lower-rate mortgage is substantially greater than the change in the value of the tax strategy. To the extent that moving decisions are somewhat endogenous, households may postpone their actions when the interest rate environment is not favorable.<sup>9</sup> Thus, it is reasonable to conclude that, although the combination of moving and interest rate risks makes the tax strategy risky, its impact on the expected profitability of the strategy is likely to be small.

### 3.3. Liquidity risks

We also assume households never face large liquidity needs that require them to take out additional home equity loans. At first glance, paying down a mortgage improves household borrowing capacity almost dollar for dollar by enabling higher home equity lines of credit (HELOC). Thus, concerns for future liquidity needs may prompt households to accelerate home equity build-up and forgo implementing the arbitrage strategy.

However, a comparison of relative liquidity characteristics of HELOCs and TDAs is far from straightforward. Most HELOCs are re-evaluated annually and may indeed be cancelled in the event of job loss, making them a poor source of liquidity when needed. On the other hand, many

<sup>9</sup> Quigley (2002) finds that households do, in fact, delay relocating when interest rates are rising.



households can borrow up to 50% of their TDA assets (up to the \$50,000 limit) and can in worst-case scenarios (e.g., job loss or financial hardship) access TDA assets by paying a 10% penalty. Furthermore, the tax burden on these hardship withdrawals tends to be low, since households would often be in relatively low tax brackets under these circumstances.

Moreover, the fluctuation in housing prices makes mortgage prepayments a less effective means to provide liquidity when needed. In particular, if the house price appreciates, the amount of home equity is likely to be sufficient to meet any liquidity needs even without mortgage prepayments. On the other hand, if the house price falls significantly, most of the home equity will be wiped out even if the household has been prepaying. In this case, had the household followed our tax strategy to invest in the tax-deferred account instead, the funds would still be available for liquidity-related withdrawals.

### 3.4. Default risks

Default risks are extraordinary liquidity events that force households to default on mortgage payments. A household may choose to pay off its mortgage in order to reduce the risk of ever losing the house. Although reasonable on the surface, we show that this argument might not justify forgoing the tax-arbitrage either.

First, following the tax-arbitrage strategy is unlikely to increase the probability of default for a household, since borrowing or withdrawing from the tax-deferred account is generally as effective as prepaying the mortgage in meeting any liquidity needs. Second, in the unfortunate event of personal bankruptcy, households are generally better off had they followed the tax-arbitrage. As a federal policy, employer-sponsored retirement savings are exempt from personal bankruptcy. On the other hand, homestead exemptions vary by state, with some states (e.g., Florida) allowing nearly unlimited exemptions and others (e.g., Pennsylvania) only a token amount. Hence, our tax arbitrage strategy provides households with the additional option of defaulting on the house and claiming bankruptcy while at the same time retaining their extra TDA savings. While the psychological costs of losing a house may be large, this free option increases the benefit of the tax arbitrage strategy from a pure monetary point of view, especially for residents of states with stringent homestead exemptions.<sup>10</sup>

### 3.5. Tax environments

We have also made several simplifying assumptions regarding tax environments, the most significant one being the constant tax rate over time. This assumption excludes the possibilities of either changing tax laws or changing tax brackets over a household's lifetime.<sup>11</sup> Although it is hard to predict the direction of tax law changes, the assumption of a constant tax rate is likely conservative for estimating the benefits of our arbitrage strategy. The tax rate for a given household is generally lower during retirement, since the taxable income is often lower. According to the 1995–2001 SCF data, 41% of households are in the top four tax brackets (i.e., at or above 28%) before retirement while only 18% of households are in these top brackets after retirement. Households can also optimally time their TDA withdrawals to minimize the effective tax burden. Hence, tax-deductible contributions are made when rates are relatively high and

<sup>10</sup> See, for example, White (1998) and Fay et al. (2002) for a discussion of the household bankruptcy decision.

<sup>11</sup> See, for example, Sialm (2006) for a discussion of historical tax rates on investment income between 1926 and 2004.

taxable withdrawals are made when rates are relatively low, increasing the tax arbitrage profit. To gauge the sensitivity of the arbitrage strategy to changes in tax rates, we evaluate a number of alternative tax scenarios in Section 6.3.

In this section we have argued that relaxing the assumptions of Section 2 is unlikely to eliminate gains from the strategy. However, whether households use similar reasoning in practice is an open question. For example, they may have a different *perception* of relative liquidity of the two savings choices; they might not be aware of differences in their bankruptcy treatments; or they may not treat these two saving vehicles as substitutes because of behavioral biases such as narrow framing.<sup>12</sup> We return to this question in our empirical analysis of Section 7.

#### 4. Data sources

We use the 1995, 1998, and 2001 Surveys of Consumer Finances to analyze the actual savings behavior of households with mortgage debt and with the opportunity to save in employer-sponsored tax-deferred retirement accounts. The surveys are conducted by the Board of Governors of the Federal Reserve System and cover a substantial cross-section of U.S. households. The surveys collect data on many aspects of households' financial situation — their financial, real estate, and pension assets; portfolio composition; availability and price of credit; and sources of earnings.<sup>13</sup>

The surveys over-sample wealthy households, since these households own a disproportionate fraction of financial assets. We use a set of sampling weights from the SCF to compute distributions of survey variables in the population. Unless otherwise noted, all descriptive statistics utilize population weights.

Since our analysis focuses on evaluating the tradeoff between contributing to retirement accounts and making additional mortgage payments, SCF data on real estate holdings, financing, and tax-deferred savings choices are of particular interest. We know whether a household owns its home and, if so, whether it still has an outstanding mortgage. We know the key characteristics of mortgages such as the current interest rate, the mortgage term, the remaining as well as original balance, and the type (e.g., adjustable rate or balloon).

We identify two ways in which households can pay off their mortgages early. First, they can make payments in addition to their required mortgage obligations at regular or irregular intervals. We identify these “discretionary prepayments” from household responses to the SCF question on whether they are ahead, behind, or on time with their mortgage payments.<sup>14</sup> Since the SCF does not ask prepaying households for the exact amount or the frequency of prepayments, we estimate the additional annual mortgage payments by contrasting the

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<sup>12</sup> The behavioral finance literature is surveyed thoroughly in [Hirshleifer \(2001\)](#) and [Barberis and Thaler \(2003\)](#). Two strands of this literature are particularly relevant for our paper. One of them focuses on “narrow framing”, discussed in [Tversky and Kahneman \(1981\)](#) and [Shefrin and Thaler \(1988\)](#), which posits that investors mentally frame assets as belonging to various accounts and view these accounts as less-than-perfectly interchangeable. The other strand studies how behavioral biases relate to households' failure to take advantage of certain features of the tax code. A specific example of such behavior, considered in [Odean \(1998\)](#), [Grinblatt and Keloharju \(2001\)](#), and [Ivkovich et al. \(2005\)](#), is related to household propensity to sell stocks with accrued capital gains and desire to hold on to stocks with accrued capital losses (the so-called “disposition effect”).

<sup>13</sup> See [Kennickell and Starr-McCluer \(1994\)](#) for a description of the SCF data set.

<sup>14</sup> Using this method, we classify about 16% of households with 30-year fixed-rate mortgages as “discretionary prepayers”. This number is very similar to the 14% incidence of accelerated repayments reported by [Fu et al. \(1997\)](#) on the basis of administrative records of Citibank mortgage holders between 1995 and 1997.



respondents' expected date of full repayment with the original mortgage term and by assuming a constant prepayment schedule.<sup>15</sup>

The second method of prepayment is choosing a mortgage with a term shorter than 30 years. We call these “short-mortgage prepayments” and define the amount of prepayments as the difference between the required payment on the existing mortgage and the payment on a hypothetical 30-year mortgage that the household could have taken out on the origination date. Specifically, we derive the *average* mortgage rates from the Freddie Mac series of the initial contract rate on new commitments for 15- and 30-year conventional fixed-rate mortgages with 80% loan-to-value ratios. For each household with a 15-year mortgage, for example, we define its “quality spread” as the difference between *its* mortgage rate and the average rate on 15-year mortgages taken on the same date. Assuming that this quality spread is independent of the mortgage term, we can add it to the average 30-year mortgage rate to construct the rate on a hypothetical 30-year mortgage.

In order to evaluate possible benefits of saving in a TDA, we need to identify TDA-eligible households and estimate the extent to which they can increase their contributions. An accurate measure of eligibility can be constructed from a number of responses to questions about features of employment-related pension coverage. We follow the methodology in Pence (2002) to identify households that are eligible for high-limit employer-sponsored defined contribution retirement plans. A significant number of SCF respondents are self-employed, and under the current tax code, they have the right to open tax-deferred accounts with high contribution limits and nearly unrestricted investment choices. However, since the actual TDA contributions by the self-employed are unknown, we choose to restrict the definition of eligibility to households with at least one member that can participate in an employer-sponsored plan. We also ignore Individual Retirement Accounts (IRAs), since the SCF has no data on actual IRA contributions. Both of these choices are conservative as they limit the universe of households that can potentially benefit from modifying their savings choices.

For each eligible household, we define the “TDA contribution gap” as the difference between the actual and the maximum “allowed” contribution. Household contributions to employer-sponsored TDA plans are reported separately in the SCF for each household member. However, the annual contribution limit for each household member is less straightforward, since the SCF has no information on employer-specific TDA plan features. In general, each TDA participant faces an annual IRS statutory limit of \$9,240, \$10,000, and \$10,500 in 1995, 1998 and 2001, respectively. In addition, the sum of employee and employer contributions is subject to an additional restriction of the lesser of \$35,000 or 25% of compensation (IRC 415(c) limit). Finally, many plans impose their own limits on employee contributions in order to make it easier to pass non-discrimination tests. We approximate the contribution limit for each household member by the lesser of the annual statutory limit and 10% of the reported wage. We then sum up contribution gaps calculated for each household member to measure the extent to which the household can increase its TDA contributions.

Unfortunately, we do not know the specific investment options offered in TDAs. In our analysis, we consider two TDA investment scenarios that involve holding either mortgage-backed securities or Treasury bonds with the same maturity as the remaining mortgage horizon. The yield

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<sup>15</sup> We also investigate alternative discretionary prepayment measures, which are based on the comparison of the *reported* current mortgage balance with the balance expected if only required payments were made. If the former is smaller, a household is effectively ahead of its mortgage repayment schedule. Our results remain qualitatively similar if we use this alternative prepayment measure.

on Treasury bonds of various maturities is linearly interpolated between the 10- and the 30-year yields reported by Bloomberg for each of the three survey years. The MBS yields at different maturities are linearly interpolated using yields on 15- and 30-year current coupon agency MBS (Fannie Mae and Freddie Mac) as reported by Bloomberg. Note that the average yield on Treasury bonds is substantially lower than the average mortgage rate in our sample, primarily because Treasury bonds do not have default and prepayment risks as individual mortgages do. The average investment rate on MBS assets is also lower than the average mortgage borrowing rate, because of the transaction costs of processing mortgages and constructing MBS assets. Investing in Treasury securities provides a lower bound on the tax arbitrage profit, while investing in MBS provides a better estimate of the magnitude of the tax benefit. We do not consider additional asset classes (e.g., equities) in our main results, because we do not want to change the aggregate risk level of the portfolio.

In addition to the variables that describe mortgage characteristics and TDA savings choices, we include a number of controls that reflect household wealth, income, demographics, measures of financial savvy, liquidity constraints, self-reported reasons for savings, and levels of risk and debt aversion. All of these variables are available in the SCF. Finally, our estimates of households marginal tax rates (MTR) are derived from TAXSIM calculations based on SCF income data.<sup>16</sup>

## 5. Summary statistics

Homeowners with mortgage debt face the decision of whether to save first by repaying their mortgage early or by contributing to a tax-deferred retirement account. As discussed in Section 2, this decision depends on numerous individual characteristics, such as the mortgage interest rate, the investment opportunities, the effective tax rate, the saving horizon, and additional liquidity and borrowing constraints facing a household. In this section we divide households into distinct groups on the basis of their TDA and mortgage prepayment decisions and provide a comparison of key characteristics of these groups to set the stage for the subsequent analysis of their choices.

### 5.1. Household characteristics by eligibility and home ownership

Table 1 summarizes the characteristics of households according to their savings opportunities. The three columns display characteristics of all households (column 1), of households that are eligible to contribute to employer-sponsored retirement accounts (column 2), and of those eligible households that own houses and have fixed-rate mortgage debt (column 3).<sup>17</sup> Our complete sample over the three survey years includes 13,046 observations that are based on an average of 102.7 million households per year using the population weights given in the SCF. Slightly less than half of the households are eligible to contribute to an employer-sponsored TDA. Slightly less than half of these eligible households have a fixed-rate mortgage on their homes. Thus, there is on average 22.8 million households per survey facing the TDA–mortgage prepayment tradeoff.

<sup>16</sup> We are very grateful to Kevin Moore and Dan Feenberg for computing these marginal tax rates. Additional information on this microsimulation model can be found in Feenberg and Coutts (1993).

<sup>17</sup> In our sample, 89% of households with mortgage debt have a fixed-rate mortgage. We focus on fixed-rate mortgages because we do not know the exact adjustment pattern and frequency for adjustable-rate mortgages. However, households using adjustable-rate mortgages can also use similar arbitrage strategies as the ones described in our paper if they use floating-rate bonds instead of fixed-rate bonds.

Table 1  
Characteristics of all households

Variable	All households	All eligible households	All eligible households with fixed mortgage
Number of observations	13,046	8569	2684
Number of households	102.7 M	46.6 M	22.8 M
Age	48.7 [35 – 61]	42.5 [34 – 50]	43.6 [37 – 50]
Proportion married (in %)	59.2	71.9	82.4
Proportion with college (in %)	32.8	43.4	49.0
Proportion with high school (in %)	83.2	93.0	95.1
Proportion that are debt averse (in %)	39.2	40.6	37.9
Risk-aversion score	3.2 [3 – 4]	2.9 [2 – 4]	2.8 [2 – 3]
Proportion liquidity-constrained (in %)	28.9	29.7	22.4
Liquid financial wealth	85,276 [870 – 36,720]	78,061 [2100 – 40,800]	81,399 [4200 – 58,000]
Retirement wealth	36,216 [0 – 18,100]	54,075 [80 – 43,000]	66,673 [2200 – 65,000]
Net worth	280,689 [9700 – 205,600]	285,841 [24,600 – 222,980]	314,458 [58,080 – 287,800]
Normal income	54,211 [19,267– 61,675]	71,887 [34,949– 79,149]	85,174 [45,069– 92,512]
Federal tax bracket	16.5 [15 – 28]	22.2 [15 – 28]	24.1 [15 – 28]
Credit card balance	1699 [0 – 1300]	2362 [0 – 2650]	2572 [0 – 3100]

This table summarizes characteristics of households from the 1995, 1998, and 2001 Surveys of Consumer Finances. The first column summarizes the characteristics of all households, the second column summarizes the characteristics of households that are eligible to contribute to an employer-sponsored retirement account, and the third column summarizes the characteristics of households that are eligible to contribute to an employer-sponsored retirement account and that currently have a fixed-rate mortgage outstanding. The number in the first row of each characteristic corresponds to the weighted mean, where the weights are the population weights provided by the Survey of Consumer Finances. The numbers in brackets correspond to the inter-quartile ranges of the characteristics.

To describe the distribution of household characteristics, we summarize the mean and the inter-quartile ranges of the variables. Households that are eligible to contribute to an employer-sponsored retirement account tend to be younger primarily because retirees do not have the opportunity to save in TDAs. Eligible households are better educated: 43.4% of eligible households have a college degree, while only 24.0% of non-eligible households have one. This difference occurs because retirement plans tend to be more prevalent in companies where a large fraction of employees are professionals. Eligible households receive significantly higher incomes and are in higher tax brackets than non-eligible households.

Comparing the second and the third columns indicates that eligible homeowners with outstanding mortgage debt tend to have higher income and wealth levels than all eligible households. The following sections focus on this last group of households that have the choice of saving by building up home equity or retirement assets.<sup>18</sup>

<sup>18</sup> In unreported analysis, we have divided our sample into the three waves of the Survey of Consumer Finances. Most household characteristics and our main results remain the same over the time periods. Consequently, we do not differentiate among the survey years in the remainder of the paper.

Table 2  
 Characteristics of households according to prepayment and contribution behavior

Variable	No contributions		Contributions	
	No prepay	Prepay	No prepay	Prepay
<i>Panel A: Prepayment and contribution behavior</i>				
Number of observations	482	425	867	908
Number of households	4.5 M	3.4 M	7.8 M	7.1 M
Contribution			4966	5506
			[1680 – 6400]	[1800 – 7400]
Contribution gap	5257	6149	2770	2864
	[3000 – 6700]	[3400 – 8600]	[180 – 4200]	[200 – 4260]
Total prepayments		2712		3345
		[728 – 2782]		[858 – 3386]
Discretionary prepayments		953		1735
		[0 – 826]		[0 – 1271]
Short mortgage prepayments		1759		1610
		[0 – 1947]		[0 – 2107]
<i>Panel B: Wealth levels and income flows</i>				
Liquid financial wealth	60,775	90,051	67,515	105,348
	[2101 – 32,500]	[5000 – 72,650]	[3600 – 42,000]	[8000 – 87,700]
Retirement wealth	22,943	56,101	71,344	94,393
	[0 – 11,000]	[0 – 36,000]	[7000 – 73,000]	[12,500–105,000]
Home equity	61,593	93,190	63,464	90,580
	[16,000 – 77,000]	[28,000 – 113,000]	[17,000 – 75,000]	[31,000 – 111,000]
Net worth	210,508	363,152	265,282	411,311
	[35,300 – 163,800]	[65,200 – 367,600]	[51,200 – 258,400]	[91,350 – 387,240]
Annual income	69,006	86,383	81,087	96,121
	[37,521 – 78,121]	[41,116 – 92,512]	[45,634 – 92,186]	[51,396 – 102,791]
<i>Panel C: Mortgage characteristics (in %)</i>				
Mortgage rate	8.00	7.81	7.87	7.59
	[7.00 – 8.50]	[7.00 – 8.30]	[7.00 – 8.50]	[6.95 – 8.00]
Mortgage rate spread (30–15 yr at origination)	0.44	0.45	0.43	0.44
	[0.38 – 0.48]	[0.44 – 0.48]	[0.34 – 0.48]	[0.38 – 0.48]
Loan-to-value ratio	58.5	45.9	61.8	50.1
	[35.6 – 80.0]	[25.7 – 64.1]	[45.4 – 80.0]	[32.3 – 68.4]
Federal tax bracket	21.7	23.8	24.2	25.7
	[15 – 28]	[15 – 28]	[15 – 28]	[15 – 28]
<i>Panel D: Households with credit card debt</i>				
Proportion with debt	53.0	44.7	52.8	43.9
Median balance	2400	2000	3000	3000
Median interest rate	14.3	12.0	14.0	12.5
Median liquid assets	3000	3700	3200	4500

This table summarizes characteristics of households from the 1995, 1998, and 2001 Surveys of Consumer Finances according to their prepayment and contribution behavior. The sample consists of households that have fixed-rate mortgages and are eligible for employer-sponsored TDAs. The number in the first row of each characteristic corresponds to the weighted mean, where the weights are the population weights provided by the Survey of Consumer Finances. The numbers in brackets correspond to the inter-quartile ranges of the characteristics.

## 5.2. Household characteristics by saving behavior

We sort the sample of eligible households with fixed-rate mortgage debt into four different groups according to their TDA contribution and mortgage prepayment behavior. [Table 2](#) summarizes the characteristics of these four groups. The first sorting criterion depends on the contribution to the employer-provided retirement account. We observe that 34.6% of eligible households with fixed-rate mortgages (7.9 million households per year) do not contribute at all. On average, non-contributing households could put an additional \$5640 in their TDAs, while contributing households could increase their TDA savings further by \$2814 before reaching the contribution limit.

These results indicate that many households do not take full advantage of the tax-qualified retirement savings opportunities, possibly relinquishing substantial tax benefits and matching contributions of their employers. This fact is particularly puzzling as many of these households own substantial financial assets, which they could effectively transfer to their retirement accounts. Non-contributing households in our sample own, on average, taxable financial assets with a total value of \$73,375. This average financial wealth level is skewed to the right as a small number of households own very large portfolios. Still, 53.9% of these non-contributing households own liquid financial assets exceeding \$10,000.

The second sorting criterion depends on whether a household accelerates its mortgage payoff either by making additional discretionary payments or by choosing a short-term mortgage. Aggregating over different contribution groups, we find that 46.1% of eligible households with fixed-rate mortgages (10.5 million households) accelerate their payments. Pre-paying households make, on average, total prepayments of \$3140 per year, where average discretionary prepayments amount to \$1482 and additional prepayments from short-term mortgages amount to \$1658.

Combining the findings between the mortgage prepayment and the non-contribution decisions, we have identified a substantial group of households that face the TDA-prepayment tradeoff. It is particularly interesting to compare the characteristics of the households in columns 2 (prepay and not contribute) and 3 (contribute and not prepay) of [Table 2](#). These households tend to save similar amounts through prepayments and TDA contributions. However, the characteristics of these two groups differ substantially. As shown in Panel B, the prepayers tend to be in better financial shape than the contributors, which makes liquidity and other concerns identified in Section 3 less relevant and their decision to forgo the tax arbitrage all the more puzzling.

Panel C summarizes mortgage characteristics of the households. The mortgage rate tends to be slightly lower for prepayers, because some prepayers have short-term mortgages that tend to have lower interest rates. Not surprisingly, the prepayers tend to have lower loan-to-value ratios, as past prepayments reduced outstanding mortgage balances for many such households.

Finally, Panel D provides information on household credit card balances. While there exists a statistically significant difference in the share of prepayer and non-prepayer households with revolving balances, credit card debt is still quite common among prepayers. Among households in column 2 (prepay and not contribute) that carry credit card debt, the median balance is \$2000 and the median annual interest rate is 12%. These households would clearly benefit from curtailing prepayment of lower-interest (and often tax-deductible) mortgage debt and using the funds to pay off their credit cards. They could do even better by using some of their highly liquid funds invested in low-yielding assets such as savings and money market accounts. This puzzle, highlighted by [Gross and Souleles \(2002\)](#), is intriguing, but remains outside the scope of our paper.

## 6. Gains from the tax arbitrage strategy

In this section, we compute the gains that households may achieve by following the proper tradeoff between mortgage prepayments and contributions to tax-deferred accounts.

### 6.1. Marginal benefits of the tax-arbitrage strategy

The marginal tradeoff between accelerating mortgage payments and saving for retirement is given by the MAP measure, which is derived in Eq. (2). We use the actual mortgage rates of the households for  $r_B$  and the interest rates on mortgage-backed securities or Treasury bonds at the time of the surveys for the investment rates  $r_L$ . Mortgage interest is assumed to be deductible only if the household currently itemizes deductions. The investment horizon  $T$  equals the remaining maturity of the current mortgage. Finally, TDA withdrawals face a penalty of 10% if the retirement account holder is younger than  $59\frac{1}{2}$  years.

Table 3 summarizes the measure of MAP for households in our sample. Panel A assumes that the retirement account is invested in MBS with a remaining maturity equal to that of the mortgage. We demonstrate that a significant share of prepaying households would benefit from our proposed tax arbitrage (i.e., have  $MAP > 0$ ). For example, 43.4% of eligible households that make prepayments and do not contribute to TDAs exhibit positive arbitrage gains. The mean arbitrage gain from switching \$100 from a mortgage prepayment to a retirement account amounts to \$17.20 for this group. The distribution of the benefits is relatively broad and the inter-quartile range varies between \$7.70 and \$23.70. We can interpret the MAP measure as the extra return that households can earn on their savings by simply choosing the proper savings channel.

We obtain similar results for households that make discretionary prepayments and contribute to their employer-sponsored retirement accounts, as long as they do not reach the contribution limit. Of the 3.5 million households with positive MAPs, 2.5 million are not bound by the contribution limit and can benefit from the proposed tax arbitrage. The mean marginal gain for such households equals 16.6%. Panel B summarizes the distribution of the tax benefits if the retirement account is invested in Treasury bonds instead. It is comforting that we still obtain a MAP of about 11% for those households that prepay.

Overall, we find that about 38% of households that prepay their mortgages could benefit from our proposed arbitrage strategy. However, this result does not necessarily imply that 62% of households are making the right decision. Because of our conservative assumptions in deriving the arbitrage gains (e.g., excluding employer matches, imposing early withdrawal penalties, and allowing only investments in safe fixed income securities), it is likely that we are underestimating the number of households that would benefit from reducing prepayments and increasing TDA contributions. Furthermore, even if a reshuffling of assets between accounts does not represent a risk-free arbitrage opportunity, it might increase the welfare of households as long as they are sufficiently risk tolerant.

### 6.2. Total benefits of the tax-arbitrage strategy

To quantify the Total Arbitrage Profit (TAP) for each household, we multiply the MAP by the minimum of the total prepayment and the contribution gap:

$$TAP_i = \max(0, MAP_i) \times \min(\text{Prepayment}_i, \text{Contribution Gap}_i). \quad (3)$$

The TAP is thus positive only if the household is prepaying and not contributing the maximum possible to the TDA, while having a positive MAP.



Table 3  
Forgone arbitrage opportunities

	No contributions		Contributions	
	No prepay	Prepay	No prepay	Prepay
<i>Panel A: Using MBS rate for TDA investments</i>				
Number of households with MAP>0	2.2 M	1.5 M	4.5 M	3.5 M
Proportion of households with MAP>0 (in %)	48.9	43.4	58.2	48.8
MAP (in %)	21.4	17.2	22.9	16.6
	[10.0 – 31.2]	[7.7 – 23.7]	[11.9 – 33.7]	[7.9 – 24.8]
Number of households with TAP>0	0	1.5 M	0	2.5 M
TAP from all prepayments		394		375
		[77 – 403]		[54 – 471]
TAP from discretionary prepayments		265		280
		[0 – 223]		[0 – 326]
TAP from short mortgage		151		107
		[0 – 156]		[0 – 137]
Aggregate TAP:1.528 billion				
<i>Panel B: Using T-bond rate for TDA investments</i>				
Number of households with MAP>0	1.1 M	0.9 M	2.7 M	2.1 M
Proportion of households with MAP>0 (in %)	26.3	28.6	35.1	30.0
MAP (in %)	16.0	10.9	14.6	10.4
	[6.9 – 25.0]	[2.3 – 14.8]	[6.2 – 20.9]	[4.4 – 14.9]
Number of households with TAP>0	0	0.9 M	0	1.6 M
TAP from all prepayments		281		240
		[28 – 338]		[41 – 289]
TAP from discretionary prepayments		188		164
		[0 – 93]		[0 – 210]
TAP from short mortgage		112		82
		[0 – 116]		[0 – 83]
Aggregate TAP:0.637 billion				

This table summarizes the marginal arbitrage profits (MAP) and the total arbitrage profits (TAP) for households that have positive MAPs based on the 1995, 1998, and 2001 Surveys of Consumer Finances. The number in the first row of each characteristic corresponds to the weighted mean, where the weights are the population weights provided by the Survey of Consumer Finances. The two numbers in brackets correspond to the inter-quartile ranges of the characteristics. Panels A and B correspond to the MAP and TAP computed using the investment rates from mortgage-backed securities and from Treasury bonds, respectively.

In Table 3, we show that, on average, prepaying households that contribute nothing to their TDA forgo a TAP of \$394 per year (with a median TAP of \$179.) For prepaying households that already contribute to a retirement account the forgone TAP is, on average, slightly smaller at \$375 per year (with a median of \$191.) With a total of about 4 million positive TAP households, we calculate an aggregate annual consumption gain of about \$1.5 billion from following our tax strategy.

Households do not have an option to replace a short-term mortgage with a long-term mortgage without refinancing. On the other hand, it is relatively easy to simply discontinue the discretionary prepayments. Therefore, we also report the TAP separately for gains that occur from discretionary prepayments and short-term mortgages. Since a small number of households prepay in both manners and face binding contribution constraints, the total TAP is slightly smaller than the sum of the two individual TAPs.

Table 4  
Alternative scenarios for evaluating forgone arbitrage opportunities

Scenario	Households with MAP>0	Mean MAP with MAP>0 (in %)	Mean TAP with MAP>0	Aggregate
(1) Base case scenario	3.9 M	17.2	385	1.53 B
(2) 25% increase in tax rates at retirement	2.7 M	14.7	321	0.87 B
(3) 25% decrease in tax rates at retirement	5.3 M	19.8	447	2.36 B
(4) 50% increase in tax rates at retirement	1.5 M	12.9	275	0.40 B
(5) 50% decrease in tax rates at retirement	6.3 M	22.8	513	3.23 B
(6) Including employer match for households reporting match	5.6 M	38.1	468	2.64 B
(7) Excluding early withdrawal penalty	5.5 M	16.3	365	2.01 B
(8) Including state tax deductibility for itemizers	5.6 M	19.4	421	1.93 B

This table summarizes the marginal arbitrage profit (MAP) and the total arbitrage profit (TAP) under a number of alternative scenarios. The sample is limited to households that have not exhausted their allowed TDA contributions. In scenarios (2)–(5), we assume that only the marginal tax rate at withdrawal is affected; the current tax rates are used in valuing the tax deduction from additional TDA contributions and deductibility of mortgage interest payments for tax itemizers. In the “employer match” scenario, we assume an employer contribution of 50 cents per each \$1 in TDA contributions, up to 6% of total salary. In the state tax deductibility scenario, we use a uniform 5% state tax for itemizers, since we do not know the states in which households reside.

In Panel B of Table 3, we assume that the TDA is invested in Treasury bonds. In this case, 2.5 million households have positive TAPs leaving an aggregate of \$637 million per year on the table.

### 6.3. Alternative scenarios

In this subsection, we calculate the forgone arbitrage gains using alternative assumptions about future tax rates, employer matches, withdrawal penalties, and state taxes. The first row of Table 4 repeats the forgone arbitrage profits and the number of affected households for our base-case scenario described in Table 3. Rows (2) to (5) assume that marginal tax rates at the time of withdrawal will increase or decrease by 25% or 50% for all tax brackets. These tax changes affect the profitability of the tax arbitrage by driving a wedge between the marginal tax rates at retirement and during the contribution period. Row (6) includes a typical employer match of 50% applied to contributions up to 6% of total salary. This matching schedule mimics the most common practice of U.S. employers (Engelhardt and Kumar, 2006). The table also reports scenarios that eliminate the early withdrawal penalty of 10% and that allow the deductibility of TDA contributions and mortgage interest payments from state taxes. Since the public SCF data do not include information on the households’ state of domicile, we cannot include state taxes in our computations. However, row (8) evaluates a hypothetical case of mortgage interest and TDA deductions from a uniform 5% state tax. The number of households with profitable arbitrage opportunities and the forgone arbitrage gains remain significant in all of these various scenarios.

### 6.4. Characteristics of losers and winners from arbitrage

To set the stage for further analysis on why households forgo tax arbitrages, we summarize the characteristics of households that prepay but do not exhaust their TDA limits based on whether

Table 5  
 Characteristics of households which prepay the mortgage

Variable	No contributions		Partial contributions	
	Gain	Loss	Gain	Loss
<i>Panel A: Main determinants of forgone benefits</i>				
Number of households	1.5 M	1.9 M	2.5 M	3.0 M
Mortgage rate (in %)	7.22 [6.75 – 7.50]	8.26 [7.25 – 9.00]	7.20 [6.75 – 7.58]	7.97 [7.00 – 8.50]
Mortgage spread (in %)	-0.19 [-0.80 – 0.43]	0.84 [-0.20 – 1.45]	-0.10 [-0.64 – 0.49]	0.52 [-0.25 – 1.01]
Federal tax bracket (in %)	27.3 [28 – 31]	21.1 [15 – 28]	27.3 [28 – 28]	23.1 [15 – 28]
Age	48.3 [41 – 54]	44.5 [37 – 52]	44.6 [38 – 51]	41.0 [34 – 48]
<i>Panel B: Financial characteristics</i>				
Liquid financial wealth	142,063 [13,000 – 144,700]	51,609 [2,970 – 41,500]	92,145 [11,420 – 78,000]	56,980 [4,750 – 56,400]
Retirement wealth	93,869 [0 – 98,000]	27,151 [0 – 15,000]	87,401 [12,650 – 102,000]	58,091 [6500 – 64,000]
Home equity	125,490 [42,000 – 151,000]	68,463 [25,000 – 79,000]	93,058 [34,000 – 113,000]	72,056 [23,000 – 100,000]
Loan-to-value ratio (in %)	48.9 [30.5 – 66.1]	43.5 [22.3 – 63.3]	53.6 [37.9 – 71.7]	48.8 [30.0 – 70.5]
Net worth	551,529 [117,480 – 510,850]	220,216 [46,410 – 203,820]	371,231 [97,200 – 381,790]	250,537 [60,800 – 275,000]

This table summarizes the characteristics of households in the 1995, 1998, and 2001 Surveys of Consumer Finances that accelerate mortgage repayment but do not maximize TDA contributions. The households are separated depending on whether they have positive or negative MAPs. Prepayments include both discretionary prepayments and prepayments due to a short-term mortgage. The number in the first row of each characteristic corresponds to the weighted mean, where the weights are the population weights provided by the Survey of Consumer Finances. The numbers in brackets correspond to the inter-quartile ranges of the characteristics.

they benefit or lose from our proposed arbitrage. Panel A of Table 5 summarizes the characteristics of households. Households that gain from our proposed arbitrage tend to be slightly older, primarily because older households are less likely to face the 10% early withdrawal penalty. Also, the arbitrage winners have lower mortgage interest rates, lower mortgage spreads, and higher tax brackets than arbitrage losers.

Panel B summarizes the wealth characteristics of winners and losers. Given their characteristics in Panel A, it is not surprising that arbitrage winners are wealthier on average. In particular, they have more than \$90,000 in liquid financial wealth, which indicates that it is unlikely that a large fraction of the winners face substantial liquidity constraints. In unreported analysis, we also find that only 10% of these households have current loan-to-value ratios exceeding 80%, which might result in additional mortgage insurance premia.

## 7. Empirical analysis

Our goal in this section is to provide an explanation for why a significant number of households fail to make wealth-maximizing decisions with respect to two of their most

significant assets — housing wealth and tax-deferred retirement accounts. We focus on three non-exclusive possibilities: (a) households are constrained by their liquidity and consumption needs; (b) information required for making a proper choice is limited or costly; and (c) household choices are distorted by specific preferences over the form of saving and perceived differences in risk and liquidity characteristics between the two savings habitats. A particular form of preferences in (c) is referred to as “debt aversion”. For example, debt-averse households may find mortgage repayment that directly reduces their debt a more appealing savings choice, even though it may result in lower net worth than TDA contributions.

The intuition for each of these classes of explanations is straightforward. Not having enough resources may curtail the ability of some households to make decisions on the infra-marginal level. Moreover, liquidity-constrained households would put greater emphasis on accessibility of saved assets, and would thus favor savings habitats that they perceive as more liquid. Limited information may preclude an objective cost–benefit analysis of the tradeoff.

Turning to preferences, more risk-averse households may choose to forgo an increase in expected wealth since the proposed exchange of a mortgage dollar for a TDA dollar is risky when the latter is invested in, say, an MBS fund. Finally, being motivated by a “socially acceptable” savings goal like debt-free home ownership may eliminate other savings vehicles from the set of alternative investment choices.

Our empirical analysis is structured as follows. First, we consider the determinants of each of the savings choices — having a short maturity mortgage, making discretionary mortgage prepayments, and contributing to TDA. We next look at the relative preference for retirement savings, by analyzing the share of total TDA and mortgage savings that is attributable to TDA contributions. In particular, we test the hypothesis that households understand the tradeoff between these two forms of savings and tilt their choice towards TDA contributions when it is more beneficial to do so. We further test whether the hypothesized relationship between MAP and the TDA-mortgage savings decision varies with household preferences and knowledge.

### 7.1. Estimation model and variable definitions

Throughout this section, we will be using a vector of explanatory variables based on the discussion in the preceding subsection. Taking the choice to hold a short mortgage as an example, we estimate the following probit regression:

$$\begin{aligned} \text{Short Mortgage}_i = & \beta_1 \text{MAP Components}_i + \beta_2 \text{Liquidity Constraints}_i + \beta_3 \text{Information}_i \\ & + \beta_4 \text{Preferences}_i + \beta_5 \text{Demographics}_i + u_i \end{aligned} \quad (4)$$

Regressors that make up the vector of MAP components include (a) the spread between the existing mortgage rate and the MBS rate at the time of the survey, interpolated over the remaining mortgage term ( $r_B - r_L$ ), (b) the federal tax bracket in the year preceding the survey, (c) an indicator variable for households that itemize deductions, (d) an indicator variable for households that are not subject to the TDA early withdrawal penalty because they are older than 59½ at the time of the survey, (e) the employer match rate on TDA contributions, (f) an indicator variable for whether households pay private mortgage insurance (PMI), and (g) an indicator variable for whether households reside in “High Homestead Exemption” states.

Although variables (e)–(g) do not enter the expression for MAP in Eq. (2) directly, they influence the relative attractiveness of TDA savings and mortgage prepayments. In particular, employer matching contributions make TDA savings significantly more attractive.<sup>19</sup> As described in Section 3.4, households in high homestead exemption states may choose to build up their home equity as a means to shelter assets in the event of bankruptcy.<sup>20</sup> Similarly, households may be accelerating repayment to bring their loan-to-value ratios below the 80% threshold, thereby obtaining an option to eliminate PMI payments. About 19% of households in our sample reside in a high homestead exemption state and about 22% report carrying PMI.

We define liquidity constraints by combining information from several survey questions. Liquidity-constrained households are defined as those that satisfy at least one of the following conditions: (i) they were turned down for credit at least once during the past five years, (ii) they were not able to obtain this credit later or were discouraged from applying again, or (iii) they have credit card balances in excess of 75% of their total credit card borrowing limit. Household wealth is another indicator of liquidity constraints, measured by the logarithm of household net worth.

We use two binary variables to gauge how easy it is to acquire and to analyze information necessary for making financial decisions. The first is an indicator variable for having a college degree. The second takes on a value of one for households that consult a professional in “making savings and investment decisions”. The list of suitably knowledgeable professionals includes accountants, bankers, brokers, and financial planners. About 49% of households in our sample relied on advice from such professionals.

One of the measures of preference heterogeneity is the self-reported willingness to take on financial risk, which ranges from 1 to 4, with the value of 4 indicating “unwillingness to take any financial risks”. Our measure of household tolerance for debt is based on reported behavior with respect to paying off credit card debt. This binary variable is set to 1 for those who report paying off their balances in full “always or almost always”. We interpret this variable as an indicator of “debt aversion”, as it reflects the household’s determination to restrict its spending to what it can afford.<sup>21</sup>

The vector of regressors is rounded out by several demographic characteristics. The vector of demographic characteristics contains the number of children in the household, as well as age and marital status. Finally, we also include survey year and mortgage origination year dummies, where the latter control for exogenous changes in the structure of mortgage markets.

## 7.2. Determinants of prepayment and contribution behavior

From the outset, we limit the sample to home owners with outstanding fixed-rate mortgages who are eligible to participate in employer-sponsored tax-deferred plans. These households face an active choice between prepayment and TDA contributions.

<sup>19</sup> The SCF measures employer matches by the ratio of employer matching contributions to wages for a household. In particular, the measure of matching contributions is defined as the max(head of household’s employer contributions/head of household’s wages, spouse’s employer contributions/spouse’s wages).

<sup>20</sup> High homestead exemption states include FL, IA, KS, OK, SD, and TX, which have no limits, and AZ, MA, MN, NV, and RI, which have exemptions above \$100,000. Restricting high exemption states to those with no limits does not affect the results. We are indebted to Kevin Moore of the Board of Governors for estimating regressions with state-specific variables using internal SCF data.

<sup>21</sup> Arguably, such payment behavior may also reflect the household’s ability to pay. To the extent that we have controlled for both liquidity constraints and various measures of wealth in our regressions, we believe that this variable primarily captures household’s tastes rather than its ability to pay.

Table 6 presents the results of estimating probit regressions (4) for each of the three savings choices separately. Column 1 of Table 6 shows the estimated marginal effects of the regressors on the choice of a short-maturity mortgage. We find that variables pointing to a higher MAP are associated with a lower likelihood of prepayment, as suggested by the argument in Section 2. In particular, the likelihood of holding a short-term mortgage decreases as the borrowing–lending spread shrinks. A lower spread implies that it is more attractive to decrease monthly mortgage payments by switching to a 30-year mortgage and to invest the difference in a TDA. Of the two tax variables, itemization (which is a necessary condition for writing off mortgage interest expense) has a strong negative effect, with itemizers being 8 percentage points less likely to hold a short mortgage. In a similar vein, we find that households making PMI payments are less likely to take out short-term mortgages. On the other hand, there is no evidence that residing in a high-exemption state affects the term of the mortgage significantly.

Taking out a short mortgage requires a commitment to higher monthly cash payments. Consequently, we find strong effects for variables that indicate availability of financial resources. In particular, liquidity-constrained households are found to be 9 percentage points less likely to have a short mortgage. Household net worth is another key factor behind this decision. The estimated coefficient suggests that each percentage point increase in net worth leads to about 5% rise in the probability of prepayment via a short mortgage.

We further find that more risk-averse households are marginally more likely to hold short mortgages. One of the frequently told explanations for mortgage prepayment is the desire to be “free of debt”, even if it entails sacrificing current consumption to achieve this goal. Thus, we would expect households that strive to be debt-free to make natural candidates for committed prepayment in the form of a short mortgage. Consistent with this conjecture, we find that debt-averse households are more likely to choose short mortgages (and, as shown later, make discretionary prepayments).<sup>22</sup>

In sum, the decision to have a short-maturity mortgage is affected by a number of variables that conform to rational models of financial decision-making. There is some evidence that households making such choice have less to gain from the interest rate deduction and have the financial wherewithal for higher payments (higher net worth and no liquidity constraints).

It is more difficult to find influence of such rational factors on the decision to make discretionary prepayments, however. As shown in column 2 of Table 6, few factors have statistically significant explanatory power for the household choice to write additional checks to their mortgage company. We still find that being subject to liquidity constraints serves as a barrier to mortgage prepayments, even when such prepayments do not require the commitment associated with short-maturity mortgages. Also, debt aversion substantially increases the likelihood of discretionary prepayments. However, there is no evidence that a household’s financial position (whether in the form of net worth or current income as proxied by the tax variables) plays a role in this decision. Nor is there much support for the motive to eliminate PMI or build up more home equity for possible bankruptcy. Moreover, the estimated coefficient on the borrowing–lending spread is negative, implying that households for whom the current investment

<sup>22</sup> One could make a case for the endogeneity of our measure of debt aversion, since the decision to pay off a credit card and make an extra mortgage payment are made simultaneously. However, as argued earlier, paying off credit card balances in full is an indicator of household consumption and savings tastes. As such, this variable provides useful information of what otherwise would be an omitted measure of household heterogeneity, and it is kept in reported regression specifications. For robustness, we re-estimated all regressions without this variable. Omitting debt aversion makes the effect of net worth more positive and raises its statistical significance. There are no qualitative changes in any of the other coefficients.



Table 6  
Determinants of prepayment and contribution behavior

	Short mortgage	Discretionary prepayments	Retirement contributions
Mortgage spread (in ppt)	8.78*** (1.02)	-1.59** (0.73)	-0.76 (0.80)
Federal tax bracket (in ppt)	0.08 (0.16)	0.03 (0.13)	0.34** (0.14)
Itemize deductions	-8.29*** (2.93)	1.03 (2.26)	6.55*** (2.72)
Not subject to TDA penalty	-9.04** (4.36)	2.62 (3.92)	-8.70* (4.60)
Employer TDA match (in ppt)	0.13 (0.20)	-0.08 (0.16)	2.20*** (0.39)
Mortgage insurance	-8.19*** (2.39)	-1.76 (1.89)	1.19 (2.24)
High homestead exemption	0.01 (2.57)	1.52 (2.05)	3.05 (2.33)
Liquidity-constrained	-9.11*** (2.80)	-6.16*** (2.14)	-5.32*** (2.71)
Log of net worth	4.72*** (0.91)	0.19 (0.65)	0.05 (0.82)
College education	-3.71 (2.29)	-0.71 (1.82)	1.13 (2.11)
Use professional advice	-0.78 (2.04)	1.85 (1.62)	-2.27 (1.95)
Risk aversion	2.39* (1.35)	-1.60 (1.06)	-5.40*** (1.28)
Debt aversion	6.06*** (2.31)	8.82*** (1.79)	0.10 (2.19)
Age (in years)	0.83*** (0.15)	-0.23** (0.11)	-0.44*** (0.14)
Number of children	1.57* (0.90)	-1.71** (0.70)	-1.30 (0.85)
Married	2.90 (2.98)	-0.40 (2.41)	0.94 (2.79)
Year 1995	15.33*** (3.18)	-4.36* (2.31)	-2.52 (2.93)
Year 1998	6.91** (2.79)	-4.61** (2.00)	0.33 (2.56)
Number of observations	2647	2647	2647
Pseudo R-squared	0.095	0.045	0.077

This table summarizes the determinants of the prepayment and contribution behavior for households from the 1995, 1998, and 2001 Surveys of Consumer Finances. The dependent variables are indicator variables of (1) whether households have a short mortgage, (2) whether they make discretionary prepayments, and (3) whether they contribute to a TDA. The table reports the marginal effects of the probit regressions. The regressions also include unreported mortgage origination year fixed effects. The changes in the probabilities are expressed in percent. The standard errors are adjusted for heteroskedasticity and are summarized in parentheses. The significance levels are abbreviated with asterisks: ‘\*\*\*’, ‘\*\*’, and ‘\*’ correspond to a 1%, 5%, and 10% confidence levels, respectively.

opportunities are poor (high spread) are nevertheless *less* likely to pay off their expensive mortgage obligations.

For completeness, we also estimate the factors that determine whether households contribute to a TDA. The estimation results are shown in column 3 of Table 6. We find that households in high tax

brackets and those itemizing tax deductions are more likely to contribute. Once again, we find evidence of the importance of liquidity constraints, as liquidity-constrained households shy away from making TDA contributions.<sup>23</sup> There is also a strong negative cohort effect in TDA participation.

Interestingly, more risk-averse households are less likely to contribute to TDAs, although risk aversion affects the prepayment decision only marginally. Debt aversion, on the other hand, fails to show up in TDA contributions, even though it features prominently in prepayment decisions. The contribution decision is also strongly positively affected by the size of the employer match, which plays no role in the prepayment decision.

### 7.3. Relative preference for contributions vs. prepayments

This subsection investigates the relative preference for retirement savings. The variable *TDA Fraction* captures the fraction of relevant savings that is directed towards tax-deferred contributions rather than prepayments:

$$\text{TDA Fraction} \equiv \frac{\text{TDA Contribution}}{\text{Prepayment} + \text{TDA Contribution}},$$

where *TDA Contribution* is defined as the total dollar contribution of all household members and *Prepayment* is either (i) the imputed prepayment from holding a short mortgage, or (ii) the discretionary prepayment. *TDA Fraction* is continuous by construction, with values ranging from 0 to 1.

We proceed to estimate a variant of Eq. (4) using *TDA Fraction* as the dependent variable and modifying the vector of explanatory variables in two ways. First, we replace *MAP* components that appear in Eq. (2) with the *MAP* itself. Since we are now looking explicitly at the relative taste for TDA contributions vs. prepayments, *MAP* is the proper measure for capturing the influence of “rational” factors, in spite of its inherent non-linearity.

In other words, if households are aware of the tax-arbitrage strategy, the *MAP* measure should explain part of the cross-sectional differences in *TDA Fraction*.

Recall that *MAP* is the marginal benefit that households can derive from the hypothetical conversion of a dollar from mortgage prepayments to TDA contributions. It is possible that the degree to which households relate *MAP* to this tradeoff varies with certain household characteristics. For instance, debt-averse households may be pre-occupied by the motive to reduce mortgage debt and thus pay less attention to *MAP*, leading to a weaker positive relationship between *MAP* and *TDA Fraction*. To test this, we add interactions of *MAP* with preference and information variables to the vector of regressors.

Note that *TDA Fraction* cannot be defined for households that make no TDA contributions and no mortgage prepayments. The resulting sample truncation opens up the possibility of selection bias. Therefore, prior to estimating the model, we test for sample selection using a standard Heckman two-step estimator (Heckman, 1976). We use self-reported saving habits as instruments for identifying the choice to make at least one of the two savings decisions and thus to be excluded from the group that neither prepays nor contributes. We find that households that save regularly are indeed more likely to make prepayments or TDA contributions.<sup>24</sup> However, the estimated

<sup>23</sup> A similar result is found in Engelhardt and Kumar (2006), using the HRS data.

<sup>24</sup> Saving “regularly” is defined on the basis of responses to SCF questions X3015–X3020. These instruments have strong statistical significance. The two dummies identifying households that save regularly and those that do not save are jointly significant at the 1% level, and they raise the pseudo- $R^2$  of the probit regression from 0.068 to 0.083.

inverse Mills ratio is not statistically different from zero, and we therefore proceed to estimate regressions for TDA Fraction on the truncated sample without making further adjustments for sample selection.

In our estimation we take into account the fact that the dependent variable is censored. The first form of censoring derives from non-negativity restrictions on contributions and prepayments, which censor TDA Fraction at 0 and 1, respectively. In addition, households that reach the statutory contribution limit are also right-censored, as their observed TDA Fraction values are likely lower than what they would be in the absence of regulatory constraints. Moreover, the censoring levels of these households will differ depending on the magnitude of their prepayments.<sup>25</sup>

Table 7 presents the results for both definitions of prepayments. Since higher MAP values indicate larger tax benefits for replacing mortgage prepayments with TDA contributions, the estimated coefficient of MAP should be positive if households understand this tradeoff and tilt their saving decisions accordingly. While the result for prepayments through holding short-maturity mortgages confirms this hypothesis, the estimated coefficient is of the wrong sign for discretionary prepayments. The results indicate that, when choosing between a traditional 30-year and a shorter-term mortgage, households are likely to take into account the economic tradeoff between mortgage payments and retirement savings and make the right choice. But they are much less likely to do the formal calculation when putting aside extra savings each month. This result is consistent with our findings on the determinants of various saving decisions in Table 6.

Specifications in columns (2) and (4) further decompose the effects of MAP on this tradeoff. In the case of short mortgage prepayments, having access to better financial information (either through a financial advisor or through better education) substantially increases the likelihood of making the correct choice, as both MAP interaction terms on these variables are strongly positive. However, we fail to detect any moderating effect of better information on making the correct choice in the case of discretionary prepayments. For both types of prepayments, we find little evidence that household preferences influence the mortgage–TDA tradeoff through MAP. There is also no measurable difference for households not subject to TDA withdrawal penalties, for whom TDA savings have few drawbacks. In the case of discretionary prepayments, this means that non-penalized households are just as likely to be forgoing the arbitrage, reminiscent of the results in Choi et al. (2005).

Similar to the results in Table 6, we find that characteristics other than MAP influence households' relative preferences towards mortgage prepayment or TDA savings. As argued earlier in Section 3.3, it is difficult to claim that home equity is unambiguously more liquid than TDA assets. The results in Table 7 are consistent with this view. In particular, the liquidity-constrained households are not found to have different relative preferences in any of the specifications. Notwithstanding the relative strength of the effects of liquidity constraints on prepayments and TDA contributions (see Table 6), both of these forms of savings appear to be negatively affected by liquidity considerations. This suggests that liquidity-constrained households may prefer to first build up wealth in liquid taxable accounts instead.

Preference heterogeneity shows up repeatedly in each of the specifications. We find that households that are more risk- and debt-averse generally favor mortgage prepayments over TDA contributions, and that these preferences do not influence the savings choice through MAP. The

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<sup>25</sup> We carry out the estimation with a censored-normal regression model that allows censoring points to vary with each observation. Due to the fact that a relatively small number of households reach TDA contribution limits, we obtain results that are qualitatively similar to those from a standard Tobit model that allows for left-censoring at zero and right-censoring at one.

Table 7  
Determinants of the relative propensity to contribute vs. prepay

	Prepayments are defined as:			
	Short mortgage	Discretionary prepayments		
MAP	1.04*** (0.19)	0.86** (0.44)	-0.33** (0.17)	-1.33** (0.65)
MAP*Risk aversion		-0.14 (0.16)		0.26 (0.20)
MAP*Debt aversion		0.31 (0.38)		0.51* (0.31)
MAP*College		0.87** (0.36)		0.15 (0.32)
MAP*Prof. advice		0.76*** (0.29)		-0.11 (0.31)
MAP*No TDA penalty		0.23 (0.55)		0.03 (0.76)
Not subject to TDA penalty	-0.05 (0.15)	0.05 (0.16)	-0.44** (0.21)	-0.41* (0.23)
Employer TDA match (ppt)	0.04*** (0.01)	0.03*** (0.01)	0.06*** (0.01)	0.06*** (0.01)
Mortgage insurance	0.12 (0.08)	0.15** (0.07)	0.07 (0.11)	0.09 (0.11)
High homestead exemption	0.10 (0.08)	0.05 (0.08)	0.04 (0.11)	0.04 (0.11)
Liquidity-constrained	0.13 (0.10)	0.12 (0.09)	0.20 (0.14)	0.19 (0.14)
Log of net worth	-0.06*** (0.02)	-0.06*** (0.02)	0.05 (0.03)	0.05 (0.03)
College education	0.08 (0.07)	0.14** (0.07)	0.08 (0.10)	0.10 (0.10)
Use professional advice	0.04 (0.07)	0.01 (0.06)	-0.07 (0.09)	-0.06 (0.09)
Risk aversion	-0.14*** (0.05)	-0.15*** (0.04)	-0.08 (0.06)	-0.09 (0.06)
Debt aversion	-0.13* (0.08)	-0.12* (0.07)	-0.33*** (0.10)	-0.36*** (0.11)
Age (in years)	-0.02*** (0.005)	-0.04*** (0.005)	0.007 (0.006)	0.003 (0.006)
Number of children	-0.06** (0.03)	-0.07*** (0.03)	0.02 (0.04)	0.02 (0.04)
Married	-0.06 (0.10)	-0.11 (0.10)	0.01 (0.13)	-0.01 (0.13)
Number of observations	2078	2078	1924	1924
Number of non-limit observations	462	462	286	286
Pseudo <i>R</i> -squared	0.111	0.123	0.032	0.034

This table summarizes the determinants of the relative preference for retirement contributions relative to mortgage prepayments for households from the 1995, 1998, and 2001 Surveys of Consumer Finances. The dependent variables are ratios of contributions to the sum of prepayments and contributions. The prepayments are defined as: (1) the difference between the actual payment on short mortgage and that on a 30-year mortgage, and (2) dollar amount of discretionary prepayments. The table summarizes the estimated coefficients of censored-normal regressions where the standard errors (reported in parentheses) are adjusted for heteroskedasticity. The regressions also include unreported survey and mortgage origination year fixed effects. The significance levels are abbreviated with asterisks: '\*\*\*', '\*\*', and '\*' correspond to a 1%, 5%, and 10% confidence levels, respectively.

finding that debt-averse households focus on paying off their debt obligations is consistent with the hypothesis that preferences for specific forms of wealth may override the goal of maximizing the overall wealth level.

## 8. Conclusion

We characterize the optimal tradeoff between contributing an extra dollar of savings toward accelerating mortgage payments and saving that extra dollar in tax-qualified retirement accounts. We show that it is often a tax arbitrage to reduce prepayments and increase TDA contributions. We document actual household behavior using data from the Survey of Consumer Finances, and conclude that at least 38% of households who prepay their mortgages could benefit from our proposed arbitrage strategy. Depending on the choice of the investment asset in the TDA, the median gain from such a reallocation ranges between 11 and 17 cents per dollar of “mis-allocated savings”. In the aggregate, correcting this inefficient behavior could save U.S. households about 1.5 billion dollars per year. Finally, we show empirically that this inefficient behavior is unlikely to be driven by liquidity or other constraints, and that many households are reluctant to participate in financial markets either as borrowers or as lenders.

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