The Tradeoff between Mortgage Prepayments and Tax-Deferred Retirement Savings

Gene Amromin* Jennifer Huang† Clemens Sialm‡

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Abstract

We show that a significant number of households can perform a tax arbitrage by cutting back on their additional mortgage payments and increasing their contributions to tax-deferred accounts (TDA). Using data from the three latest Surveys of Consumer Finances, we show that about 38% of U.S. households that are accelerating their mortgage payments instead of saving in tax-deferred accounts are making the wrong choice. For these households, reallocating their savings can yield a mean tax benefit of 11 to 17 cents per dollar, depending on the choice of investment assets in the TDA. In the aggregate, these misallocated savings are costing U.S. households as much as 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 self-reported debt aversion and risk aversion variables explain to some extent the preference for paying off debt obligations early and hence the propensity to forgo our proposed tax arbitrage.

*Federal Reserve Bank of Chicago, Email: gamromin@frbchi.org, Phone: (312) 322-5368.

†Department of Finance, B6600, McCombs School of Business, University of Texas at Austin, Austin, TX 78712. Email: jennifer.huang@mccombs.utexas.edu, Phone: (512) 232-9375.

‡Stephen M. Ross School of Business, University of Michigan, Ann Arbor, MI 48109-1234. Email: sialm@umich.edu, Phone: (734) 764-3196

1 Introduction

Many households, at one time or another, face the trade-off between paying an extra dollar off the remaining mortgage on the 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 (TDA).[1]

Mortgage interest payments are deductible from taxable income for households that itemize their deductions, while investment income in retirement accounts remains effectively tax-exempt.[2] 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) in an asset with similar risk properties, we show that, as long as $r_L > (1-\tau)\, r_B$, investors are generally better off saving in the TDA instead of prepaying their mortgage. Given the simplicity of this strategy, it is reasonable to ask whether and to what extent investors recognize this tradeoff in their personal decisions.

Using data from the three latest Surveys 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

[1] Throughout the paper, we use the term "mortgage prepayment" to denote extra payments on an existing mortgage 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 consider mortgage refinancing separately and do not include it in our definition of "prepayments," although this interpretation is common in the industry.

[2] Consider, for example, a Roth account where investors 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 401(k) account is equivalent to investing in a Roth account.

of the overall inefficiency is striking. On the margin, 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 mean gain from such a reallocation ranges between 11 and 17 cents per dollar of "misallocated savings." In the aggregate, correcting this inefficient behavior could save U.S. households as much as 1.5 billion dollars per year. The finding that a significant number of households make substantial mistakes in their financial decisions is consistent with Campbell (2006).

To identify rational reasons for investors to forgo this substantial tax benefit, we consider the robustness of our proposed strategy to different assumptions. We show that interest rate risks, liquidity and default risks, and other potential constraints are unlikely to explain this inefficient behavior. Rather, investors seem to be influenced by an aversion to take on debt. Empirically, self-reported debt aversion and risk aversion variables 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 arbitrage is related to the findings in Graham (2000), who shows that many corporations forgo substantial tax benefits by holding too little debt.

Our paper is most closely related to the recent literature on the optimal asset location choice which considers the tradeoff between savings in taxable vs. tax-deferred accounts. Dammon, Spatt, and Zhang (2004), Huang (2004), Shoven and Sialm (2004), Poterba, Shoven, and Sialm (2004), and Garlappi and Huang (2005) 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 Bodie and Crane (1997), Barber and Odean (2003), Bergstresser and Poterba (2004), and Amromin (2004). These papers find that many investors 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 investor 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 the retirement savings decisions[3] and the mortgage choices of households[4]. To the best of our knowledge, this is the first paper to consider retirement contributions and mortgage payments as two alternative forms of household savings decisions.

Our finding is also consistent with the explanation that investors may not treat these two forms of saving decisions as substitutes. Hoynes and McFadden (1997) find little substitution between retirement savings and other forms of personal financial asset saving and housing wealth, and Poterba, Venti and Wise (1995) find that even similar saving vehicles like 401(k)s and IRAs are not close substitutes.

The paper is structured as follows. Section 2 introduces the tax-arbitrage strategy. Section 3 describes the data and Section 4 provides summary statistics for TDA contribution and mortgage payment behavior. Section 5 calculates the certainty equivalent wealth cost when investors choose the wrong saving strategy, and Section 6 looks at possible explanations for why households may forgo the tax arbitrage. The robustness of our tax arbitrage strategy is considered in Section 7, and Section 8 concludes.

[3]For example, Benartzi and Thaler (2001), Madrian and Shea (2001), Choi, Laibson, Madrian, and Metrick (2002), Cunningham and Engelhardt (2002), Agnew, Balduzzi, and Sunden (2003), Duflo and Saez (2003), Choi, Laibson, and Madrian (2004, 2005), Mitchell, Utkus, and Yang (2005), Duflo, Gale, Liebman, Orszag, and Saez (2006), Huberman and Jiang (2006), and Brown, Liang, and Weisbenner (2006) consider the determinants of individual TDA participation and portfolio choice.

[4]For example, Quigley (2002), Campbell and Cocco (2003), and Hurst and Stafford (2004) study mortgage choices including type of contract, refinancing, and prepayment decisions.

2 The Tax Arbitrage Strategy

This section considers a household whose TDA contributions are less than the statutory maximum and who at the same time makes additional mortgage payments. We analyze the marginal trade-off between these two forms of savings decisions. Households that make additional mortgage payments have effectively chosen to save some of their income. Thus, we simply investigate whether these households would be better off by saving through different channels.

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 which 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 the cumulative investment returns.

The investor is assumed to have a constant tax rate τ over his life time. He faces a penalty κ_t on TDA withdrawals at age t. Under the current tax rules, 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 investor has a fixed-rate mortgage with a rate r_B and earns a constant rate of return r_L on his tax-deferred savings. Second, the household itemizes deductions and can therefore effectively subtract mortgage interest from taxable income. Third, the investor never defaults, takes out additional home equity loans (for liquidity reasons), or pays off the entire mortgage for moving or refinancing purposes. As a result, the mortgage has a fixed remaining horizon T. Fourth, each dollar of prepayment in the current year affects only year T cash flow and reduces the after-tax mortgage payment by $\$(1+(1-\tau)r_B)^T$. We relax these assumptions in section 7, but they are useful for exposition purposes in deriving a

simple tax arbitrage strategy.

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

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

dollars to the tax-deferred account that grows at the rate r_L; and (iii) 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 τ is the tax rate and κ_T is the penalty upon withdrawal.[5] At the same time, we have assumed that reducing 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 due to the reduced prepayment of the mortgage loan. Finally, since the investor effectively receives τX in tax reductions for his $\$X$ contributions to tax-deferred account this year, he can walk away with a net profit of $1+\tau X - X$ in the taxable account. We simplify its expression and term it the "Marginal Arbitrage Profit" (MAP),

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

For any investor, as long as the MAP measure is positive, he is better off following the arbitrage strategy of reducing his prepayment and increasing his TDA contributions.

[5]Note that the investor receives $\$(1-\tau-\kappa_T)$ for each dollar withdrawn rather than $(1-\tau)(1-\kappa_T)$ since the penalty is not tax-deductible under the current tax code.

Inspection of equation (1) 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 investor never needs to put in additional money after pocketing the arbitrage profit (MAP).

If investors 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 investors to withdraw and pay 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 investors to shelter assets from taxation for a longer time period, and hence improves the arbitrage profit.

The MAP further underestimates the benefit of the tax arbitrage strategy if an investor does not consume the arbitrage profit immediately. In particular, his wealth level is increased by the MAP amount. Without reducing his current consumption level or altering any part of his remaining portfolio, he can contribute an additional amount (up to the MAP measure) to his TDA. This additional contribution allows him to further enjoy the benefit of tax-deferred savings. Finally, we also ignore the fact that employers often match their employees' TDA contributions, which substantially increases the profitability of the proposed arbitrage transaction. The proposed strategy may also have an indirect benefit

of 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.

Although our MAP measure is derived under rather restrictive assumptions, we show in Section 7 that it is generally a conservative measure of the total benefits of replacing mortgage prepayments with tax-deferred contributions.

3 Data Sources

We use the 1995, 1998, and 2001 Surveys of Consumer Finances (SCF) 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. They collect data on virtually every aspect of households' financial situation–their financial, real estate, and pension assets, portfolio composition, availability and price of credit, and sources of earnings.[6]

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 trade-off between saving in retirement accounts and through additional mortgage payments, SCF data on real estate holdings, financing, and on tax-deferred savings choices are of particular interest. For each household in the sample, the SCF collects exhaustive information on home ownership status and financing characteristics. Thus, we know whether a household owns its home and if so, whether it still has an outstanding mortgage. We know the key characteristics of

[6]See Kennickell and Starr-McCluer (1994) for a description of the SCF data set.

mortgages such as their current interest rate, mortgage term, remaining as well as original balance, and whether a mortgage is an adjustable rate or a balloon mortgage. Moreover, we know whether a household is actively pre-paying its mortgage, sticking to the original payment schedule, or is falling behind scheduled payments.

We distinguish between two different methods of pre-payments: discretionary prepayments and prepayments due to short mortgages. Discretionary prepayments occur if households make payments in addition to their required mortgage obligations at regular or irregular intervals. We identify discretionary prepayments from household responses to the SCF question on whether they are ahead, behind, or on time with their mortgage payments. Unfortunately, the SCF does not ask prepaying households for the exact amount or the frequency of discretionary prepayments. However, they are asked for an expected date of full repayment. By contrasting this date with the original mortgage term and assuming a constant prepayment schedule, we are able to estimate the additional annual mortgage contribution that could be channeled into a TDA.[7] We define prepayments due to short mortgages as the difference between the required payment on the existing mortgage and a required payment 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 TDA contributions. An accurate measure of eligibility can be constructed from a number of sequential responses to questions about features of employment-related pension coverage. We follow the methodology in Pence (2001) to identify households that are eligible for (but don't necessarily participate in) employer-sponsored defined contribution retirement plans.

Household contributions to employer-sponsored TDA plans are reported separately for each household member. However, annual limits on household TDA contributions are less

[7] 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.

straightforward, as they are determined by the individual's wage income and employer policies. In 2001, each TDA participant was limited to a before-tax contribution of $10,500 (IRC 402(g) limit). 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). This means that employees that earn less than $42,000 cannot reach the 402(g) limit even in the absence of any employer match. Moreover, many plans impose their own limits on employee contributions in order to make it easier to pass non-discrimination tests. Since the SCF has no information on employer-specific TDA plan features, we choose a conservative approach and define the contribution limit in 2001 for each household member as the lesser of $10,500 or 10% of their reported wages. For 1995 and 1998, we use the corresponding IRC 402(g) limits. Next, we compute the "TDA contribution gap" by differencing the actual contribution and the imputed limit for each eligible household member. Summing up these "gaps" for all household members gives us a measure of the extent to which a given household can use its TDA for investment of funds created by the elimination of mortgage prepayments.

A significant number of SCF respondents are self-employed and, under the current tax code, they have the right to open IRA-type accounts with high contribution limits and nearly unrestricted investment choices.[8] 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 the role of IRAs in defining TDA eligibility. Although IRAs are broadly available, their contribution limits are small and the SCF has no data on actual IRA contributions. Both of these choices limit the universe of households that can potentially benefit from modifying their savings choices and are likely to bias the contribution gaps

[8]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 $40,000 per year in combined employee and employer contributions.

towards zero.

For investments in the TDA we assume that investors hold either mortgage-backed securities (MBS) or Treasury bonds with the same maturity as the remaining mortgage horizon. The MBS security enables a household to invest in a diversified mortgage pool and has similar default and prepayment options as an individual mortgage. On the other hand, Treasury securities do not match the default and prepayment options of mortgages but provide a risk-free investment option. Thus, using Treasury bond investments gives a lower bound on the tax-arbitrage profit.

In our analysis, we set the investment rate r_L to be either equal to the Treasury bond rate or the average rate earned on MBS of corresponding maturity. Note that the average investment rate on MBS assets is still lower than the average mortgage borrowing rate, due to the transaction costs of processing mortgages and constructing MBS assets. The data on MBS returns are proxied by yields on 15- and 30-year current coupon agency MBS (Fannie Mae and Freddie Mac) as reported by Bloomberg. Data on *average* mortgage rates, which are used for computing the prepayment amounts implicit in short mortgages, are derived from the Freddie Mac series on average initial contract rate on new commitments for 15- and 30-year conventional fixed-rate mortgages with 80% loan-to-value ratios.[9] 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.

[9]To illustrate, for each household with a 15-year mortgage, we compute the difference between *its* interest rate and the average rate on 15-year mortgages taken on the same date. Assuming that this quality spread is independent of mortgage term, we can add it to the average 30-year mortgage rate to construct the rate on a hypothetical 30-year mortgage. This gives us enough information to compute the required payment on such a mortgage.

Finally, our estimates of households marginal tax rates (MTR) are derived from TAXSIM calculations based on SCF income data.[10]

4 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 high-level comparison of key characteristics of these groups to set the stage for subsequent analysis of their choices.

4.1 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 homeowners that are eligible to contribute to such accounts and that have fixed rate mortgage debt (column 3). 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 home. Thus, the average sample of households that face the TDA-mortgage prepayment tradeoff contains 22.8 million

[10] 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).

households per survey.

To describe the distribution of household characteristics in our paper, we summarize the mean and the inter-quartile ranges of the corresponding variables. Households that are eligible to contribute to an employer-sponsored retirement account tend to be younger primarily because retired households will usually not have the opportunity to save in retirement accounts. Eligible households are better educated than non-eligible households. 43.4% of eligible households have a college degree, while only 24.0% of non-eligible households have a college degree. 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.

The income and wealth distribution is highly skewed to the right, resulting in significantly higher means than medians. For example, the mean normal household income level for the three survey years is $54,211, while the median income level is just $35,977. The differences are much more pronounced for wealth levels. The mean household net worth in the SCF sample is $280,689, which exceeds the 75 percentile of $205,600. These results confirm the well-known observation that the aggregate wealth is concentrated among a relatively small fraction of the population.[11]

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 which have the choice of saving by building up home equity or retirement assets.[12]

Table 2 divides our sample of eligible households with a fixed rate mortgage into

[11] See Poterba (2000) for a description of the wealth concentration in the U.S.

[12] 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.

the three waves of the Survey of Consumer Finances and demonstrates that the nominal income and the wealth variables increase substantially over the time period. Although the home equity also increases substantially over time, the loan-to-value ratio stays relatively constant. The mortgage rate is slightly lower in 2001 than in 1995, reflecting the change in the interest rate environment.

4.2 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 contributions and mortgage prepayment behavior. Table 3 summarizes the characteristics of households for 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 and only 14.9% (3.3 million households per year, not shown) contribute the maximum amount.

To economize on space, we average over prepaying and non-prepaying households to report household characteristics by their contribution decisions. On average, non-contributing households could contribute an additional $5,640 to their TDAs. Furthermore, contributing households save, on average, $5,223 annually in TDAs and they could increase their contributions further by $2,814 before reaching the contribution limit.

These results indicate that many households do not take full advantage of the tax-qualified retirement savings opportunities. These households might relinquish 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 of liquid financial assets. However, 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. We quantify both types of prepayments using the methodology described in the preceding section. Aggregating over different contribution groups, we find that 46.1% of eligible households with fixed-rate mortgages (10.5 million households) accelerate their payments. Prepaying households make, on average, total prepayments of $3,140 per year, where average discretionary prepayments amount to $1,482 and additional prepayments due to short-term mortgages amount to $1,658.

It is particularly interesting to compare the characteristics of the households in columns two (prepay and not contribute) and three (contribute and not prepay) of Table 3 . These households tend to save similar amounts through prepayments and retirement account contributions. However, the characteristics of these two groups of households differ substantially. The prepayers tend to be in better financial shape than the partial contributors, as shown in Panel B.

Panel C summarizes the 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.

5 Gains from the Tax Arbitrage Strategy

This section computes the gains that investors may achieve by following the proper trade-off between prepayment and contribution to tax-deferred accounts. These computations are normative in nature, as they identify households that make "suboptimal" choices and impute the magnitudes of likely losses. We show that many households make costly errors

with respect to two of their most common financial decisions - saving in a tax-deferred account and building equity in their home.

The data in Table 3 shows that many households face the TDA-mortgage prepayment tradeoff. An open question is whether these households could be made better off by decreasing their prepayments and increasing their contributions to the retirement account. As households differ substantially in their underlying characteristics (available mortgage rate, investment opportunities, effective tax burden, time horizon, etc.) such reshuffling of savings choices will not be optimal for all households. However, we can estimate the fraction of households that would be better off by changing their saving strategy.

5.1 Benefits of The Tax-Arbitrage Strategy

We first focus on the marginal tradeoffs between paying off their mortgage loan early and saving for retirement in the tax-deferred account. Specifically, we estimate the magnitude of the MAP measure as derived in equation (1). We use the actual borrowing rates for the households for r_B and the current interest rates on mortgage-backed securities or Treasury bonds for the investment rates r_L. Mortgage interest is assumed to be deductible at the tax rate τ only if the households currently itemize deductions. For non-itemizing households we assume that mortgage interest is not deductible. 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 4 summarizes the measure of MAP for households in our sample. Panel A assumes that the retirement account is invested in mortgage-backed securities with a remaining maturity equal to the remaining maturity of the mortgage of the investor. The yield on mortgage-backed securities for various maturities is linearly interpolated between the 15-year yield and the 30-year yield for each of the three survey years. The yield on mortgage backed securities is generally lower than the mortgage rate because of the

transactions costs involved in creating such assets and because some fixed-rate mortgages were originated when interest rates were considerably higher than those in the survey years. As a robustness check, we also report in Panel B the value of MAP by assuming that the retirement account is invested in Treasury bonds with a remaining maturity equal to that of the mortgage. The yield on Treasury bonds for various maturities is also interpolated between the 10- and the 30-year yield for the three survey years. The average yield on Treasury bonds is substantially lower than the average mortgage rate in our sample, primarily because Treasury bonds generally do not have the same prepayment options as residential mortgages.

Panel A demonstrates that a significant share of prepaying households would benefit from our proposed tax arbitrage by transferring the prepayments to mortgage-backed securities in their retirement accounts. For example, 43.4% of eligible households that make prepayments and do not contribute exhibit positive arbitrage gains. The mean arbitrage gain from switching $1 from a mortgage prepayment to a retirement account amounts to 17.20 cents for this group, indicating the potential magnitude of the consumption gain from such reallocation of savings. The distribution of the benefits is relatively broad and the inter-quartile range varies between 7.7 and 23.7 cents.

We obtain very similar results for households that make discretionary prepayments and contribute to their employer-sponsored retirement account. Note, however, that of the 3.5 million households with positive MAPs in this group, only 2.5 million that are not bound by the contribution limit would benefit from the proposed tax arbitrage. The mean marginal gain for such households equals 16.6%.

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

$$TAP_i = MAP_i \times \min(Prepayments_i, ContrGap_i). \tag{2}$$

Households with positive MAPs that prepay and do not contribute forgo an average TAP of $394 per year. Not surprisingly, the TAP measures are, on average, smaller for prepaying households that already contribute to a retirement account. Overall, an average contributing household forgoes a TAP of $375 per year.

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 mortgage prepayments. Therefore, we also report the TAP separately between the gains that occur from discretionary prepayments and short-term mortgages. Since a small number of households prepay in both manners and face binding constraints, the total TAP is slightly smaller than the sum of the two individual TAPs. We find that the average TAP from discretionary prepayments is larger than the average TAP from short-term mortgages.

Panel B summarizes the distribution of the gains if the retirement account is invested in Treasury bonds instead. Unlike MBS, zero-coupon Treasury strips are not subject to prepayment and reinvestment risks. However, Treasury bonds pay significantly lower interest rates, reducing the benefits of our alternative savings strategy. Still, 2.5 million households that currently prepay their mortgages and that do not max out their TDA contributions would benefit from savings reallocation. The average gains amount in this case to 10.6% of misallocated savings.

In the last row of each panel, we report the aggregate TAP across all U.S. households, which can be calculated by multiplying the number of households that prepay and have positive TAPs with the average TAP. We find that households leave $1.528 billion per year on the table by not contributing to the maximum extent if we use the MBS rate as the investment rate. Using the Treasury bond rates still results in the aggregate TAP of $637 million. We believe that this TAP provides a lower bound for the total welfare losses, because of our various conservative assumptions. In particular, the gains would

be significantly higher if households obtain matching contributions from their employers, if they avoid withdrawing TDA funds early both to eliminate the 10% early withdrawal penalty and to allow a longer tax-deferred investment period, and if they itemize their deductions because of higher mortgage values. The aggregate gains would be higher still if self-employed households or households without employer-sponsored retirement plans were included in the sample.

Table 5 summarizes the TAP for each survey year. We find that, in each survey year, there is a large number of households that forgo a significant amount of TAP by prepaying their mortgage debt aggressively. The aggregate TAP is lower in 1998 relative to 1995 and 2001, as both the proportion of households that would benefit from our suggested arbitrage and the average TAP are lower.

5.2 Characteristics of Losers and Winners from Arbitrage

Table 6 summarizes the characteristics of households that benefit or lose from our proposed arbitrage. Panel A summarizes the main determinants of the gains from such a savings reallocation. Households that gain from this strategy tend to be slightly older, primarily because older households are less likely to face the 10% early withdrawal penalty. It is not surprising that the winners have lower mortgage interest rates and lower mortgage spreads than the losers. Finally, the winners tend to be in higher tax brackets than the losers.

Panel B summarizes the wealth characteristics of the winners and the losers. The households that currently do not contribute to an employer-sponsored retirement account and that would gain from our proposed strategy have an average net worth of $551,529, and more than 75% of these households have a total net worth exceeding $100,000. A significant fraction of this net worth is held in liquid non-retirement assets and in home equity. The average non-retirement liquid wealth equals $142,063. Moreover, only 10%

of households have loan-to-value ratios exceeding 80%, which might result in additional mortgage insurance premia. We obtain very similar results if we focus on households that make partial contributions to their retirement accounts. This indicates that it is unlikely that a large fraction of these households face substantial liquidity constraints.

6 An Empirical Analysis of Prepayment and Retirement Saving Decisions

Our goal in this section is to provide some explanation for the seemingly inefficient behavior documented earlier. We will focus on three 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". Since housing is typically a highly leveraged investment, saving in the form of mortgage prepayments directly reduces one's debt. In contrast, TDA contributions affect net worth while leaving housing debt unchanged, which may be less appealing to debt-averse households.

The intuition for each of these three classes of explanations is straightforward. Not having enough current resources may curtail the ability of some households to make decisions on the infra-marginal level. Moreover, households that face liquidity constraints 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. Since the proposed exchange of a mortgage dollar for a TDA dollar is risky when the latter is invested in, say, MBS, more risk averse households may choose to forgo an increase in expected wealth. Finally, being motivated by a "socially acceptable" savings goal like 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 making positive TDA contributions. We next look at the relative preference for mortgage prepayment, by analyzing the share of total TDA-mortgage savings that is attributable to prepayments. Finally, we estimate the relative importance of explanatory factors for the two groups of households making diametrically opposite savings choices – those that contribute to TDA but make no mortgage prepayments and those who prepay but do not contribute.

6.1 What Influences 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.

We first consider the household mortgage prepayment choice. As discussed earlier, the decision to accelerate mortgage repayment depends, among other things, on the difference between borrowing and lending rates faced by the household, the extent of the benefits it derives from tax-deductibility of mortgage interest, and household investment horizon. All of these factors feature prominently in MAP. However, since for the moment we are looking at prepayment choice in isolation and not relative to TDA savings, we keep these components separate, without assuming a specific functional form implied by MAP.

Savings choices of a household are also thought to be influenced by its demographic characteristics, by its ability to tap external credit markets or to rely on its existing stock of wealth, as well as by its tastes towards risk and indebtedness. For each savings choice, we estimate a probit regression.

$$SavingsChoice_{i,j} = \beta_1 MAPComponents_i + \beta_2 LiquidConstr_i + \beta_3 Wealth_i \quad (3)$$
$$+\beta_4 Preferences_i + \beta_5 EmployerMatch_i + \beta_6 Demographics_i + u_{i,j}$$

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 ($r_B - r_L$), interpolated over the remaining mortgage term, (b) the federal tax bracket in the year preceding the survey, and (c) an indicator variable for households that itemize deductions.

We define liquidity constraints by combining information from several survey questions. Liquidity-constrained households are defined as those that satisfy 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 form applying again, or (iii) they have credit card balances in excess of 75% of their total credit card borrowing limit. Household wealth is measured by the logarithm of household net worth.

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". We also construct an index of "debt aversion". Its value is defined as a sum of affirmative responses to a series of questions on "whether it's all right for someone like yourself to borrow money for ..." The possible options range from "fur coat and jewelry", which gets approved by less than 9% of the households in our regression sample, to "educational expenses", which gets a nod from 88%. Our second measure of household tolerance for debt is based on reported behavior with respect to paying off credit card debt. Households that report paying off their balances in full "always or almost always" are judged to display little taste for carrying revolving debt. Arguably, such payment behavior reflects not only the household's ability to pay but also its determination to restrict its spending to what it can afford. Consequently, we interpret

this variable as another indicator of debt aversion.

We also include a variable that captures the employer match on TDA contributions in each of the three savings choice probits. We would expect this variable to affect mortgage prepayment choice only if this form of savings is a substitute or a complement of TDA contributions.[13] The vector of demographic characteristics contains the number of children in the household, as well as dummies for age deciles and marital status. Household educational attainment status is set to one if the head of the household has a college degree. Assuming that financial decisions are made by the head of the household, this variable serves as a proxy for how easy it is to acquire and analyze information necessary for making such decisions. We also include survey year and mortgage origination year dummies, where the latter control for exogenous changes in the structure of mortgage markets. Table 7 contains the moments and the correlations between explanatory variables.

Table 8 presents the results of estimating (3) for each of the three savings choices separately. The leftmost column 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 mortgage increases with the borrowing-lending spread. A higher spread implies that it is more attractive to pay down the high-yield mortgage debt instead of investing through other means. 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.

Liquidity constraints play an important role in the prepayment decisions, as liquidity-constrained households are found to be 9 percentage points less likely to have a short mortgage. Not surprisingly, household net worth is one of the key factors behind the

[13] We also conduct a more formal test of independence between the mortgage prepayment and TDA contribution decisions, which is discussed later in this section.

decision to have a short mortgage, which requires a commitment to higher monthly cash payments. The estimated coefficient suggests that each percentage point increase in net worth leads to about a 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 more commonly told stories for prepaying mortgages is the stated desire to be "free of debt", even if it entails sacrificing current consumption to achieve this goal. Presumably, households that dislike borrowing more intensely would make natural candidates for committed prepayment in the form of a short mortgage. Yet, we find no evidence that our index of debt aversion has any statistically measurable effect on this decision. In contrast, short mortgage ownership is much more likely for households that customarily pay off their credit card debt in full.[14]

Short mortgages have a hump-shaped age profile, peaking for the 50-59 age group, which could be trying to pay off their mortgage debt before retirement. Interestingly for our analysis of the mortgage-TDA tradeoff, these households are also near the expiration of early withdrawal penalties on TDA funds, which should make all forms of mortgage prepayment less prevalent for them, ceteris paribus.[15]

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, have the financial wherewithal for higher payments (higher net worth and no liquidity constraints), and are at least somewhat more risk- and debt-averse.

[14]One could make a case for endogeneity of revolving 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 in Tables 8-10 without this variable. Omitting aversion to revolving debt makes the effect of net worth more positive and raises its statistical significance. There are no qualitative changes in any of the other coefficients.

[15]Parenthetically, mortgage origination year effects are quite strong as shorter-term mortgage products gained acceptance in the marketplace in the early 1990's.

It is more difficult to find influence of such "rational" factors on the decision to make discretionary prepayments, however. As shown in the middle column of Table 8, 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 making mortgage prepayments, even when such prepayments do not require the commitment associated with short maturity mortgages. Also, the aversion to carrying revolving debt 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. Moreover, the estimated coefficient on the borrowing-lending spread is negative, implying that households for whom the current investment opportunities are poor (high spread) are nevertheless less likely to pay off their expensive mortgage obligations.

For completeness, we model the TDA contribution decision as a function of the same set of factors. The estimation results are shown in the rightmost column of Table 8. We find that households with high current income (i.e. those 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. Furthermore, more risk averse households are less likely to contribute to TDAs. Interestingly, credit card payment behavior (or revealed aversion to revolving debt) which featured prominently in prepayment decisions fails to show up in TDA contributions. There is also a strong negative cohort effect in TDA participation.

The TDA contribution decision is strongly positively affected by the size of the employer match. The employer match played no role in the prepayment decision, raising the possibility that the two types of decisions are somewhat separable. A better way to assess this hypothesis is to evaluate the likelihood of prepayment and TDA contributions jointly, by allowing the error terms of these decisions to be correlated. There may well be

some unobserved factors that influence each of these decisions, biasing the single-equation coefficients. To account for this possibility, we estimate a bivariate probit model of contribution and prepayment decisions (not shown). Each equation contains one unique regressor to help with identification. The size of TDA match is excluded from the prepayment equation and a dummy variable for households with loan-to-value (LTV) ratios above 80% is excluded from the contribution equation. By bringing the LTV ratio below 80%, households can eliminate mortgage insurance payments, which may serve as an additional motive to prepay but is not likely to have a direct effect on TDA contribution.

We cannot reject the hypothesis of independence between the two savings decisions regardless of the way mortgage repayment is defined. Indeed, both prepayments and TDA contributions are influenced by similar factors. Having enough wealth or income makes each prepayment choice more likely, as does not being subject to liquidity constraints. Each savings choice is also made more likely by at least some measure of higher risk and/or debt aversion. This suggests that households may compartmentalize these decisions, counter to the implicit tradeoff implied by the MAP measure. To check whether the relative magnitudes of these effects still allow for some tradeoff between prepayment and TDA contributions, we turn to the analysis of the composition of total TDA-mortgage prepayment savings in the next section.

6.2 Relative Preference for Prepayment

The dependent variable in this subsection, $PrepayFraction$, captures the fraction of relevant savings that is directed towards prepayments rather than tax-deferred contributions.

$$PrepayFraction \equiv \frac{Prepayment}{Prepayment + TDAContribution},$$

It is continuous by construction, with values ranging from 0 to 1.

We proceed to estimate a variant of equation (3) using $PrepayFraction$ as the dependent variable where $Prepayment$ is defined first as the imputed prepayment from holding

a short mortgage, then as the discretionary prepayment, and finally as the sum of the two prepayment measures. The only change in the vector of regressors is the replacement of MAP components with the MAP itself. Since we are now looking explicitly at the relative taste for prepayments (i.e. the tradeoff between TDA and home equity build-up), MAP is the proper measure for capturing the influence of "rational" factors, in spite of its inherent nonlinearity. In other words, if investors are aware of the tax-arbitrage strategy, the MAP measure should explain part of the cross-sectional differences in $PrepayFraction$.

Note that $PrepayFraction$ cannot be defined for households that make no TDA contributions and no mortgage prepayments (henceforth, 0-0 households). The resulting sample truncation opens up the possibility of selection bias. Therefore, prior to estimating a variant of (3) for $PrepayFraction$, 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 0-0 group. We find that households that save regularly are indeed more likely to make prepayments or TDA contributions. However, the estimated inverse Mills ratio is not statistically different from zero, and we therefore proceed to estimate regressions for $PrepayFraction$ on the truncated sample without making adjustments for sample selection bias.

Table 9 presents the results for all three definitions of prepayments. The comparison of estimated MAP coefficients across the three columns is quite jarring. Recall that the intuition for MAP was derived from a hypothetical conversion of a dollar in discretionary prepayments to a dollar in TDA contributions. Yet, although the tradeoff between discretionary prepayments and TDA contributions is ideally suited to be made on the basis of MAP, the estimated coefficient is of the wrong sign. In a way, this result is a necessary consequence of the earlier finding of substantial forgone gains from tax arbitrage. It is still somewhat surprising that, on average, households for whom it is more advantageous

to channel discretionary prepayments into TDA contributions do precisely the opposite. In contrast, the revealed taste for prepayment through short mortgages is substantially smaller for households with high MAP values. The same holds true in the rightmost column, where prepayments aggregate extra flows from short mortgages and discretionary payments.

Arguably, liquidity-constrained households put greater emphasis on accessibility of assets, and would thus favor savings habitats that are at least perceived as more liquid. At a first glance, paying down a mortgage improves household borrowing capacity almost dollar-for-dollar by enabling higher home equity lines of credit. In contrast, borrowing from TDAs is generally limited to 50% of available assets. Moreover, in the event of job loss, all TDA loans have to be repaid in full or be subject to the 10% early withdrawal penalty. Both of these suggest that liquidity-constrained households might favor prepayments, *conditional* on being able to prepay and contribute to a TDA. Yet, the only statistically significant effect of liquidity constraints (in the first column) has the opposite sign. Notwithstanding the relative strength of the effects of liquidity constraints on prepayments and TDA contributions (see Table 8), both of these forms of savings are estimated 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 consistently in each of the specifications. We find that households that are more risk- and debt-averse (at least according to one of our measures) generally favor mortgage prepayments over TDA contributions. The 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.

We are unable to identify any effects of education in these regressions. For an alter-

native test of the hypothesis that information required for making a "proper" choice is limited or costly, we split the sample into more- and less-informed households on the basis of whether they 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.

On balance, we do not find any qualitative differences across these two subgroups in explaining the relative propensity for prepayments. The group that relied on professional advice has somewhat stronger and more precisely identified effects of MAP on its decisions. However, the signs of these effects remain the same. This means that for discretionary prepayments the "more-informed" group makes greater errors, while the relationship between MAP and prepayment propensity is not statistically significant for the "less-informed" group.

6.3 A Study of Contrasts: Prepayers vs. Contributors

As our last exercise, we look at differences in factors explaining household membership in one of the four groups defined by their prepayment and TDA contribution choices. These groups are: (1) neither prepay nor contribute, (2) prepay but do not make any contributions, (3) make TDA contributions but do not prepay, and (4) both contribute and prepay. We estimate a multinomial logit model of membership in these four groups, with explanatory variables drawn from equation (3). We designate the (contribute only) group to serve as the base group. Consequently, the estimated coefficients tell us whether corresponding explanatory variables explain membership in group j *relative* to the (contribute only) group.

Table 10 presents the estimation results.[16] In particular, we are interested in compar-

[16]For regressions in Table 10, prepayments are defined as discretionary mortgage payments.

ing two groups with diametrically opposite savings choices – those who prepay but do not contribute and those who contribute but do not prepay, which is shown in the leftmost column of Table 10.

Lower employer matches on TDA contributions clearly push households towards being in the prepayments-only group. Extra 5 percentage points in employer match increases the probability of being in the (contribute only) group instead of the (prepay only) group by half (or by 3 percentage points, from the base level of 6%). More interestingly, both higher risk aversion and debt aversion push households towards making mortgage prepayments (at least in comparison with those making only TDA contributions). This serves as another corroboration of the earlier finding that mortgage prepayments attract households that shy away from financial risk and dislike being in debt.

7 Discussion

We now discuss the robustness of our tax arbitrage strategy by extending our main assumptions.

7.1 Stochastic Interest Rates

In our description of the tax arbitrage strategy in Section 2, both the mortgage borrowing rate (r_B) and the tax-deferred investment return (r_L) were assumed to be constant over time. These assumptions work well in the case of a household with a fixed-rate mortgage that never refinances and that buys and holds to maturity Treasury bonds term-matched to the remaining lifetime of its mortgage. While this scenario appears restrictive, we argue that deviations from these assumptions will likely not have substantial welfare losses for households following our proposed savings strategy.

Consider first the case in which a fixed-rate mortgage is refinanced in year $S < T$ by an investor who has followed the arbitrage strategy up to that point. Barring for the

moment the possibility of changes in the term of the mortgage, the new mortgage rate r'_B is typically less than r_B which allows the investor to complete the original arbitrage strategy at T with higher profits. One complication of the arbitrage strategy is that it requires refinancing of a somewhat larger mortgage principal at S.[17]

Next, we allow TDA contributions to be invested in a pass-through security like MBS, which has variable maturity due to prepayment and default risks. MBS yields also vary over time since they are typically sold through mutual funds, which change their asset composition each year. In this setting, households are trading off a fixed mortgage liability for an asset with a variable rate of return and maturity, both of which are affected by general movements in interest rates. Yet, we expect our estimation of the gains not to be affected significantly, since interest rates have an asymmetric impact on the benefit of the tax arbitrage strategy. When rates go up, investors gain since the newly invested amount earns higher rates than the corresponding liability. On the other hand, when rates go down, investors are more likely to exercise their option to refinance, reducing the downside risk of the savings strategy.

So far we have focused only on risks induced by changing interest rates. There are also other risks that may trigger changes in the mortgage horizon and the resulting arbitrage profits. We consider the impact of moving-related prepayment risks, liquidity, and default risks in the next subsections.

7.2 Moving-Related Prepayment Risks

In addition to falling interest rates, investors may choose to pay off their entire mortgages early when they sell their existing houses, either because of job-related relocations or simply because of changes in tastes and housing needs. If interest rates stay constant over

[17] As shown earlier in Table 3, prepaying households generally have both large liquid financial wealth and large home equity values, which indicate that they would likely be able to increase their mortgage borrowing.

time, the perturbation specified by the arbitrage strategy remains valid for an exogenous moving shock, as long as households are able to roll over their mortgage debt into the new house.

When both the interest rate and moving risks are present, our tax strategy is not a risk-free arbitrage. While investors are probably 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 interest rate goes up and the new mortgage borrowing rate becomes $r'_B > r_B$. As a result, in our previous perturbation, the extra mortgage obligation $(1 + (1 - \tau)r_B)^S(1 + (1 - \tau)r'_B)^{T-S}$ is larger than the potential withdrawal from the tax-deferred saving $(1 + (1 - \tau)r_B)^T$, making it suboptimal to follow our strategy. Of course, in this case, 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 endogenous and investors may delay their moving and prepayment decisions when the interest rate environment is not favorable, 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.

7.3 Liquidity Risks

Our arbitrage strategy also assumes that investors never face large liquidity needs that may require them to take out additional home equity loans. It may appear plausible that accelerating the mortgage payments builds up more equity in the house and allows investors to take out more home equity loans when necessary, hence, concerns for future liquidity needs may prevent investors from implementing the arbitrage strategy.

However, liquidity considerations are unlikely to affect our tax-arbitrage strategy substantially. The tax-arbitrage strategy only affects the availability of funds through the different transaction costs involved in borrowing against home equity and in withdrawing

from the tax-deferred account. Home equity loans are not costless since they usually carry higher interest rates than the original mortgage.[18] On the other hand, investors can always withdraw from the tax-deferred account after paying a 10% penalty. So the maximum difference in the ex-post transaction costs is 10% of the withdrawal amount. As long as the probability q of a liquidity event is low enough, the ex-ante expected cost ($q \times 10\%$) is small relative to the expected arbitrage profit, which is in the range of 11-17% (as is shown in Section 5). Moreover, nearly all 401(k) plans allow investors to borrow against their 401(k) savings, which effectively removes the 10% penalty and further improves the benefit of the arbitrage strategy.

7.4 Default Risks

Default risks are extraordinary liquidity needs in the future that may force investors to default on mortgage payments and hence lose their homes. An investor may prefer to pay off his mortgage before saving in retirement accounts so that he can reduce the risk of ever losing his house. Although reasonable on the surface, we argue 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 significantly. Consider the case when the large liquidity event happens after the investor would have paid off his mortgage had he followed his accelerated payment schedule. By construction, our tax arbitrage strategy is "self-financed" in the sense that once the original plan would have paid off the mortgage, investors rely solely on the withdrawal from the tax-deferred account to pay for the remaining mortgage. Hence, following the arbitrage strategy does not cause extra defaults in this case.

If, on the other hand, the liquidity event happens before the investor would have paid off his mortgage even under the accelerated schedule, the discussion in the previous

[18] In our data set, the home equity loan has a mean interest rate of 9.3%, while the same households have an average mortgage rate of 7.6%.

section shows that borrowing or withdrawing from the tax-deferred account can mitigate the impact of such liquidity needs.

Second, in the unfortunate event of personal bankruptcy, households might be 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. In the event of large liquidity shocks, our tax arbitrage strategy provides investors with the additional option of defaulting on the house and claiming bankruptcy while at the same time retaining their extra TDA savings.[19] 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.[20]

7.5 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 an investor's lifetime. The proposed arbitrage strategy becomes less attractive if the marginal tax rates are higher during the withdrawal period than during the contribution period. Although it is hard to predict the direction of tax law changes, the assumption of a constant tax rate is probably conservative for estimating the tax benefits of our arbitrage strategy. The tax rate for a given investor is generally lower during retirement since the taxable income is usually lower. The investor can also optimally time the withdrawals from his retirement account to minimize the effective tax burden. Hence, tax-deductible contributions are

[19]The treatment of assets in IRA and rollover IRA accounts varies by state, but such assets are also generally sheltered in personal bankruptcy proceedings.

[20]See, for example, White (1998) and Fay, Hurst, and White (2002) for a discussion of the household bankruptcy decision.

made when tax rates are relatively high and taxable withdrawals are made when tax rates are relatively low, increasing the tax arbitrage profit. Moreover, the tax rate during retirement is more dependent on the investment income, and is more likely lower when the return on investments is lower. Lower tax rates yield higher after-tax withdrawals in these states, providing an additional hedge against return risks and increasing the benefit of the tax-arbitrage strategy.

8 Conclusion

We characterize the optimal tradeoff between contributing an extra dollar of savings towards 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 three latest Surveys of Consumer Finances, and conclude that about 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 "misallocated savings". Finally, we show empirically that this inefficient behavior is unlikely to be driven by liquidity or other constraints, and that self-reported debt aversion and risk aversion variables explain to some extent the household preference for paying off their debt obligations early and hence the propensity to forgo our tax arbitrage.

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Table 1: **Characteristics of All Households**

This table summarizes some 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 two numbers in brackets correspond to the interquartile ranges of the characteristics.

Variable	All Households	All Eligible Households	All Eligible Households with Fixed Mortgage
Number of Observations	13,046	8,569	2,684
Number of Households	102.7M	46.6M	22.8M
Age	48.7	42.5	43.6
	[35 - 61]	[34 - 50]	[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
Risk Aversion Score	3.2	2.9	2.8
	[3 - 4]	[2 - 4]	[2 - 3]
Debt aversion Score	2.7	2.5	2.5
	[2 - 3]	[2 - 3]	[2 - 3]
Proportion with Liquidity Constraints	28.9	29.7	22.4
Normal Income	54,211	71,887	85,174
	[19,267 - 61,675]	[34,949 - 79,149]	[45,069 - 92,512]
Federal Tax Bracket	16.5	22.2	24.1
	[15 - 28]	[15 - 28]	[15 - 28]
Liquid Financial Wealth	85,276	78,061	81,399
	[870 - 36,720]	[2,100 -40,800]	[4,200 - 58,000]
Retirement Wealth	36,216	54,075	66,673
	[0 - 18,100]	[80 - 43,000]	[2,200 - 65,000]
Credit Card Balance	1,699	2,362	2,572
	[0 - 1,300]	[0 - 2,650]	[0 - 3,100]
Net Worth	280,689	285,841	314,458
	[9,700 - 205,600]	[24,600 - 222,980]	[58,080 - 287,800]

Table 2: **Characteristics of Eligible Households with Fixed Mortgages by Year** This table summarizes some characteristics of households that are eligible to contribute to an employer-sponsored retirement account and that currently have a fixed-rate mortgage outstanding. Each column corresponds to one of 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 interquartile ranges of the characteristics.

Variable	1995	1998	2001
Number of Observations	840	877	967
Number of Households	20.2M	22.6M	25.5M
Age	42.9	43.9	43.9
	[35 - 49]	[37 - 51]	[37 - 50]
Proportion Married (in %)	81.8	83.0	82.3
Proportion with College (in %)	43.5	48.2	54.1
Proportion with High School (in %)	93.6	96.1	95.5
Risk Aversion Score	3.0	2.7	2.8
	[3 - 4]	[2 - 3]	[2 - 3]
Debt Aversion Score	2.5	2.6	2.5
	[2 - 3]	[2 - 3]	[2 - 3]
Proportion with Liquidity Constraints	26.4	22.9	18.8
Normal Income	70,671	78,055	100,281
	[39,947 - 81,943]	[44,619 - 88,225]	[51,396 - 113,070]
Federal Tax Bracket	23.6	24.0	24.6
	[15 - 28]	[15 - 28]	[15 - 28]
Liquid Financial Wealth	47,825	83,259	106,337
	[2,530 - 33,400]	[5,400 - 73,000]	[4,940 - 72,500]
Retirement Wealth	45,395	62,293	87,398
	[0 - 35,000]	[3,000 - 70,000]	[5,000 - 90,200]
Credit Card Balance	2,384	2,779	2,538
	[0 - 3,000]	[0 - 3,500]	[0 - 3,000]
Net Worth	212,995	289,270	417,090
	[45,000 - 185,000]	[61,420 - 283,000]	[76,100 - 387,200]
Home Equity	58,703	66,183	98,172
	[18,000 - 73,000]	[20,000 - 80,000]	[27,500 - 112,000]
Loan-to-Value Ratio	54.6	56.6	54.2
	[31.4 - 77.9]	[36.7 - 76.5]	[35.7 - 73.8]
Mortgage Rate	8.25	7.82	7.43
	[7.25 - 9.00]	[7.00 - 8.30]	[6.85 - 7.90]

Table 3: **Characteristics of Household According to Prepayment and Contribution Behavior**
This table summarizes some 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 two numbers in brackets correspond to the interquartile ranges of the characteristics.

Variable	No Contributions		Contributions	
	No Prepay	Prepay	No Prepay	Prepay
Panel A: Prepayment and Contribution Behavior				
Number of Observations	482	425	867	908
Number of Households	4.5M	3.4M	7.8M	7.1M
Contribution			4,966	5,506
			[1,680 - 6,400]	[1,800 - 7,400]
Contribution Gap	5,257	6,149	2,770	2,864
	[3,000 - 6,700]	[3,400 - 8,600]	[180 - 4,200]	[200 - 4,260]
Total Prepayments		2,712		3,345
		[728 - 2,782]		[858 - 3,386]
Discretionary Prepayments		953		1,735
		[0 - 826]		[0 - 1,271]
Short Mortgage Prepayments		1,759		1,610
		[0 - 1,947]		[0 - 2,107]
Panel B: Wealth Levels				
Liquid Financial Wealth	60,775	90,051	67,515	105,348
	[2,101 - 32,500]	[5,000 - 72,650]	[3,600 - 42,000]	[8,000 - 87,700]
Retirement Wealth	22,943	56,101	71,344	94,393
	[0 - 11,000]	[0 - 36,000]	[7,000 - 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]
Panel C: Mortgage Characteristics				
Mortgage Rate (in %)	8.00	7.81	7.87	7.59
	[7.00 - 8.50]	[7.00 - 8.30]	[7.00 - 8.50]	[6.95 - 8.00]
Loan-to-Value Ratio (in %)	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 (in %)	21.7	23.8	24.2	25.7
	[15 - 28]	[15 - 28]	[15 - 28]	[15 - 28]

Table 4: **Forgone Arbitrage Opportunities**
This table summarizes the marginal (MAP) and the total arbitrage profits (TAP) for households which 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 interquartile 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.

	No Contributions		Contributions	
	No Prepay	Prepay	No Prepay	Prepay
Panel A: Using MBS Rate for TDA Investments				
Number of Households with MAP>0	2.2M	1.5M	4.5M	3.5M
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	1.5M	0	2.5M
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				
Panel B: Using T-Bond Rate for TDA Investments				
Number of Households with MAP>0	1.1M	0.9M	2.7M	2.1M
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	0.9M	0	1.6M
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				

Table 5: **Forgone Arbitrage Opportunities by Year**
This table summarizes the marginal (MAP) and the total arbitrage profit (TAP) of households according to their prepayment and contribution behavior for each of 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 interquartile ranges of the characteristics. Panels A, B, and C correspond to the three different survey years. TDA contributions are invested in MBS.

	No Contributions		Contributions	
	No Prepay	Prepay	No Prepay	Prepay
Panel A: 1995 Survey				
Number of Households with MAP>0	2.4M	1.4M	3.9M	3.4M
Proportion of Households with MAP>0 (in %)	47.9	46.7	59.7	61.4
MAP (in %) 24.3	21.9	26.7	17.0	
	[9.5 - 39.0]	[8.5 - 30.5]	[14.1 - 40.2]	[6.4 - 26.3]
Number of Households with TAP>0	0	1.4M	0	2.7M
TAP from All Prepayments		435		294
		[83 - 495]		[37 - 378]
TAP from Discretionary Prepayments		277		158
		[0 - 204]		[0 - 232]
TAP from Short Mortgage		159		144
		[0 - 212]		[0 - 211]
Aggregate TAP = $1.403 Billion				
Panel B: 1998 Survey				
Number of Households with MAP>0	1.9M	1.1M	3.9M	3.0M
Proportion of Households with MAP>0 (in %)	43.3	37.8	49.3	40.6
MAP (in %)	17.6	12.3	20.2	14.5
	[3.7 - 29.1]	[5.9 - 17.5]	[10.7 - 29.1]	[7.3 - 20.1]
Number of Households with TAP>0	0	1.1M	0	1.9M
TAP from All Prepayments		260		337
		[79 - 215]		[71 - 529]
TAP from Discretionary Prepayments		172		247
		[0 - 122]		[0 - 392]
TAP from Short Mortgage		107		107
		[0 - 119]		[0 - 148]
Aggregate TAP = $0.940 Billion				
Panel C: 2001 Survey				
Number of Households with MAP>0	2.3M	1.8M	5.8M	4.0M
Proportion of Households with MAP>0 (in %)	56.1	44.9	65.1	47.5
MAP (in %)	21.7	16.4	22.1	17.8
	[15.2 - 27.9]	[7.7 - 23.9]	[11.9 - 31.4]	[8.6 - 26.8]
Number of Households with TAP>0	0	1.8M	0	2.9M
TAP from All Prepayments		441		476
		[75 - 593]		[55 - 626]
TAP from Discretionary Prepayments		311		414
		[0 - 284]		[0 - 524]
TAP from Short Mortgage		171		71
		[0 - 180]		[0 - 82]
Aggregate TAP = $2.174 Billion				

Table 6: **Characteristics of Households Which Prepay Mortgage**
This table summarizes the characteristics of households from the 1995, 1998, and 2001 Surveys of Consumer Finances depending on whether they have positive or negative MAP. 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 two numbers in brackets correspond to the interquartile ranges of the characteristics.

Variable	No Contributions		Partial Contributions	
	Gain	Loss	Gain	Loss
Panel A: Main Determinants of Total Benefits				
Number of Households	1.5M	1.9M	2.5M	3.0M
Age	48.3	44.5	44.6	41.0
	[41 - 54]	[37 - 52]	[38 - 51]	[34 - 48]
Mortgage Rate (in %)	7.22	8.26	7.20	7.97
	[6.75 - 7.50]	[7.25 - 9.00]	[6.75 - 7.58]	[7.00 - 8.50]
Mortgage Spread (in %)	-0.19	0.84	-0.10	0.52
	[-0.80 - 0.43]	[-0.20 - 1.45]	[-0.64 - 0.49]	[-0.25 - 1.01]
Federal Tax Bracket (in %)	27.3	21.1	27.3	23.1
	[28 - 31]	[15 - 28]	[28 - 28]	[15 - 28]
Panel B: Financial Characteristics				
Liquid Financial Wealth	142,063	51,609	92,145	56,980
	[13,000 - 144,700]	[2,970 - 41,500]	[11,420 - 78,000]	[4,750 - 56,400]
Retirement Wealth	93,869	27,151	87,401	58,091
	[0 - 98,000]	[0 - 15,000]	[12,650 - 102,000]	[6,500 - 64,000]
Home Equity	125,490	68,463	93,058	72,056
	[42,000 - 151,000]	[25,000 - 79,000]	[34,000 - 113,000]	[23,000 - 100,000]
Loan to Value Ratio (in %)	48.9	43.5	53.6	48.8
	[30.5 - 66.1]	[22.3 - 63.3]	[37.9 - 71.7]	[30.0 - 70.5]
Net Worth	551,529	220,216	371,231	250,537
	[117,480 - 510,850]	[46,410 - 203,820]	[97,200 - 381,790]	[60,800 - 275,000]

Table 7: **Correlations Between Explanatory Variables**
This table summarizes the means, standard deviations, and the correlations between the main explanatory variables of mortgage prepayments and retirement account contributions.The significance levels are abbreviated with asterisks: '***' corresponds to a 1% confidence level; '**' corresponds to a 5% confidence level; and '*' corresponds to a 10% confidence level.

Variable	Mean	Std. Dev.	Correlation (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) Mortgage Spread	1.41	1.29	1											
(2) Federal Tax Bracket	26.77	8.58	−0.11***	1										
(3) Itemize Deductions	0.82	0.38	−0.12***	0.29***	1									
(4) Liquidity Constrained	0.18	0.39	0.13***	−0.23***	−0.15***	1								
(5) Log of Net Worth	12.38	2.31	−0.09***	0.55***	0.28***	−0.31***	1							
(6) Risk Aversion Index	2.74	0.80	0.12***	−0.25***	−0.17***	0.12***	−0.21***	1						
(7) Debt Aversion Index	2.57	0.99	−0.02	0.00	−0.01	−0.08***	0.05***	0.04**	1					
(8) Aversion to Revolving Debt	0.56	0.50	−0.15***	0.32***	0.17***	−0.35***	0.40***	−0.16***	0.12***	1				
(9) Employer TDA match	3.50	5.14	−0.02	0.07***	0.02***	−0.03	0.07***	−0.06***	0.02	0.04**	1			
(10) College Education	0.58	0.49	−0.13***	0.37***	0.23***	−0.18***	0.33***	−0.21***	−0.03	0.27***	0.04**	1		
(11) Age	45.08	9.83	0.13***	0.26***	0.13***	−0.12***	0.36***	0.05**	0.11***	0.13***	−0.03	0.12***	1	
(12) Number of Children	1.25	1.20	−0.04**	−0.08***	0.00	0.09***	−0.02	0.02	−0.05***	−0.06***	−0.01	−0.02	−0.26***	1
(13) Married	0.85	0.35	−0.03	0.12***	0.11***	−0.07***	0.17***	−0.02	−0.01	0.09*	0.04*	0.03	−0.01	0.23***

Table 8: **Determinants of Prepayment and Contribution Behavior**
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 summarizes the marginal effects of the probit regressions. The changes in the probabilities are expressed in percent. The robust standard errors are summarized in parentheses. The significance levels are abbreviated with asterisks: '***', '**', and '*' correspond to a 1%, 5%, and 10% confidence levels, respectively. Significance levels for mortgage origination year effects are from F-tests of joint significance.

Variable	Short Mortgage	Discretionary Prepayments	Retirement Contributions
Mortgage Spread (in ppt)	8.81***	−1.58**	−0.86
	(1.02)	(0.73)	(0.80)
Federal Tax Bracket (in ppt)	0.07	0.03	0.31**
	(0.16)	(0.13)	(0.15)
Itemize Deductions	−8.20***	0.77	6.16**
	(2.93)	(2.29)	(2.70)
Liquidity Constrained	−8.98***	−6.12***	−5.13*
	(2.79)	(2.15)	(2.72)
Log of Net Worth	4.97***	0.34	−0.28
	(0.90)	(0.65)	(0.82)
Risk Aversion	2.25*	−1.69	−5.47***
	(1.35)	(1.06)	(1.29)
Debt Aversion Index	1.20	0.06	−1.49
	(1.03)	(0.81)	(1.02)
Aversion to Revolving Debt	5.56**	8.75***	−0.03
	(2.32)	(1.81)	(2.23)
Employer TDA match (in ppt)	0.11	−0.08	2.19***
	(0.20)	(0.16)	(0.39)
Age in the 30s	1.40	3.78	−1.63
	(5.36)	(4.23)	(4.69)
Age in the 40s	11.29**	−1.84	−3.14
	(5.36)	(3.97)	(4.68)
Age in the 50s	19.24***	−2.63	−9.19*
	(5.60)	(4.02)	(5.09)
Age in the 60s	18.00***	−2.79	−18.09***
	(6.65)	(4.70)	(6.47)
Age in the 70s	22.01*	−1.26	−54.56***
	(11.43)	(8.37)	(7.16)
Number of Children	1.58*	−1.76**	−1.52*
	(0.93)	(0.73)	(0.88)
Married	2.40	0.06	1.51
	(3.00)	(2.43)	(2.80)
College Education	−3.69	0.73	1.06
	(2.30)	(1.82)	(2.12)
Year 1995	15.45***	−4.39*	−1.78
	(3.17)	(2.30)	(2.93)
Year 1998	6.70**	−4.84**	0.95
	(2.79)	(2.00)	(2.57)
Mortgage Origination Dummies	Yes***	Yes***	Yes
Number of Observations	2,647	2,647	2,647
Pseudo R-Squared	0.092	0.046	0.080

Table 9: **Determinants of the Relative Propensity to Prepay vs. Contribute**
This table summarizes the determinants of the relative preference for mortgage prepayments for households from the 1995, 1998, and 2001 Surveys of Consumer Finances. The dependent variables are ratios of mortgage prepayments to the sum of prepayments and TDA contributions. The prepayments are defined as: (1) the difference between the actual payment on short mortgage and that on a 30-year mortgage, (2) dollar amount of discretionary prepayments, and (3) the sum of (1) and (2). The table summarizes the estimated coefficients of tobit regressions, with robust standard errors in parentheses. The significance levels are abbreviated with asterisks: '***', '**', and '*' correspond to a 1%, 5%, and 10% confidence levels, respectively.

Variable	Short Mortgage	Discretionary Prepayments	All Prepayments
MAP	-1.01^{***}	0.25^{**}	-0.49^{***}
	(0.08)	(0.12)	(0.07)
Liquidity Constrained	-0.15^{**}	-0.14	-0.08
	(0.07)	(0.10)	(0.06)
Log of Net Worth	0.07^{***}	0.01	0.04^{***}
	(0.01)	(0.02)	(0.01)
Risk Aversion	0.09^{***}	0.05	0.08^{***}
	(0.03)	(0.04)	(0.02)
Debt Aversion Index	0.05^{**}	0.03	0.02
	(0.02)	(0.03)	(0.02)
Aversion to Revolving Debt	0.11^{**}	0.32^{***}	0.14^{***}
	(0.05)	(0.08)	(0.04)
Employer TDA match (ppt)	-0.02^{***}	-0.03^{***}	-0.02^{***}
	(0.004)	(0.01)	(0.01)
Age in the 30s	0.22^{*}	0.10	0.17^{*}
	(0.11)	(0.15)	(0.09)
Age in the 40s	0.46^{***}	-0.10	0.24^{***}
	(0.11)	(0.16)	(0.09)
Age in the 50s	0.72^{***}	-0.05	0.43^{***}
	(0.12)	(0.16)	(0.10)
Age in the 60s	0.87^{***}	0.08	0.59^{***}
	(0.14)	(0.20)	(0.12)
Age in the 70s	1.49^{***}	1.12^{***}	1.32^{***}
	(0.29)	(0.44)	(0.25)
Number of Children	0.04^{**}	-0.02	0.03^{*}
	(0.02)	(0.03)	(0.02)
Married	0.01	-0.04	0.03
	(0.07)	(0.10)	(0.06)
College Education	-0.07	-0.10	-0.06
	(0.05)	(0.07)	(0.04)
Year 1995	0.43^{***}	-0.13	0.22^{***}
	(0.07)	(0.10)	(0.06)
Year 1998	0.08	-0.14^{*}	-0.02
	(0.06)	(0.09)	(0.05)
Mortgage Origination Dummies	Yes***	Yes***	Yes
Number of Observations	2,098	1,943	2,200
Number of Non-limit Observations	675	401	908
Pseudo R-Squared	0.129	0.037	0.084

Table 10: **Multinomial Logit Results for Contribution and Prepayment Behavior**

This table summarizes the multinomial logit results for subgroups of households from the 1995, 1998, and 2001 Surveys of Consumer Finances, formed according to their contribution and prepayment behavior. These groups are: (neither contribute nor prepay), (prepay only), (contribute only), and (both contribute and prepay). The (contribute only) group is taken to be the base and hence the coefficients below measure effects relative to this group. The standard errors are summarized in parentheses. The significance levels are abbreviated with asterisks: '***', '**', and '*' correspond to a 1%, 5%, and 10% confidence levels, respectively.

Variable	Prepay only vs Contribute only	Neither vs Contribute only	Both vs Contribute only
Employer TDA match (ppt)	-0.16^{***}	-0.13^{***}	-0.01
	(0.03)	(0.01)	(0.01)
Risk Aversion	0.23^{**}	0.23^{***}	-0.16^{**}
	(0.11)	(0.06)	(0.08)
Debt Aversion Index	0.11	0.08	-0.03
	(0.08)	(0.05)	(0.06)
Aversion to Revolving Debt	0.49^{**}	0.06	0.63^{***}
	(0.20)	(0.11)	(0.14)
Liquidity Constrained	0.01	0.18	-0.56^{***}
	(0.25)	(0.13)	(0.21)
Log of Net Worth	0.04	-0.03	0.02
	(0.06)	(0.03)	(0.04)
Mortgage Spread (ppt)	-0.09	0.04	-0.08
	(0.07)	(0.03)	(0.05)
Federal Tax Bracket	0.01	-0.02^{**}	-0.01
	(0.01)	(0.01)	(0.01)
Itemize Deductions	-0.12	-0.31^{**}	0.01
	(0.24)	(0.13)	(0.18)
Age in the 30s	0.67	-0.06	0.12
	(0.50)	(0.24)	(0.27)
Age in the 40s	0.33	0.07	-0.18
	(0.50)	(0.23)	(0.27)
Age in the 50s	0.35	0.42^{*}	-0.18
	(0.52)	(0.24)	(0.29)
Age in the 60s	0.70	0.79^{***}	-0.19
	(0.58)	(0.29)	(0.36)
Age in the 70s	2.46^{***}	2.52^{***}	0.45
	(0.92)	(0.68)	(0.95)
Number of Children	-0.01	0.05	-0.14^{***}
	(0.08)	(0.04)	(0.06)
Married	-0.02	-0.04	-0.01
	(0.25)	(0.14)	(0.18)
College Education	-0.26	0.01	0.08
	(0.19)	(0.11)	(0.13)
Year 1995	-0.22	0.19	-0.17
	(0.21)	(0.12)	(0.14)
Year 1998	-0.04	-0.08	-0.28
	(0.20)	(0.12)	$(0.14)^{**}$
Number of Observations	2,693		
Pseudo R-Squared	0.067		