Prepay or Defer: An Analysis of the Tradeoff between Mortgage Prepayment and Tax-Deferred Retirement Savings

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Introduction

Two major sources of wealth for most households, especially those approaching retirement, can be found in accumulated retirement assets and housing equity. Ironically, along the lifecycle prior to retirement a household also faces challenging decisions on where to most effectively save their limited excess income, especially as it relates to either prepaying their mortgage and building home equity or accumulating tax-deferred retirement assets. Rules surrounding tax-deferred retirement savings vehicles can be somewhat complex and one would expect having access to a financial planner would help households better understand the tradeoffs between prepaying a mortgage and investing in a tax-deferred retirement vehicle.

The purpose of this paper is to (1) model the quantitative tradeoff between prepaying a mortgage or contributing to a tax-deferred retirement (TDR) account, and then after controlling for several of these quantitative variables, to (2) study the influence of qualitative factors, such as access to a financial planner, on the decision to prepay a mortgage or contribute to a TDR savings vehicle.

Theoretical Framework

Expected Utility Tradeoff

Expected Utility Framework

Amromin, Huang, and Sialm (2007) present a simple tax mathematical model which helps explain the tradeoff a household faces in using savings to either pay down mortgage debt or contribute to tax-deferred employer provided retirement accounts, such as a 401(k) or 403(b) plans. Their model included key variables related to this tradeoff, including current tax rate, annual tax rate until anticipated withdrawal period, future tax rate at withdrawal (including any possible 10% early penalty), mortgage rate, and investment rate within tax-deferred account. We expand their model by also including possible employer matching in a TRD account, vested percentage in employer contributions in a TDR account, and the weight or percentage allocated between equity appreciating assets (e.g. stocks) and income generating assets (e.g. bonds) for the up-front tax savings generated from contributions to a TDR account assumed invested in a taxable brokerage account. Including these additional variables, we model the decision to use available household savings to prepay a mortgage or contribute to a TDR account as follows:

$$E\left(U\left(W_{RET}\right)\right) > E\left(U\left(W_{MORT}\right)\right) \quad (1)$$

where $E\left(U\left(W_{RET}\right)\right)$ is the expected utility from wealth generated from contributing to employer provided tax-deferred retirement vehicle and $E\left(U\left(W_{MORT}\right)\right)$ is the expected utility from wealth generated from prepaying a mortgage. Based on this, as long as the expected utility of wealth at withdrawal from the TDR is greater than the expected utility of future savings from prepaying a mortgage, a household should use limited savings to contribute to a TDR.

Constant Relative Risk Aversion

The constant relative risk aversion model (CRRA) (Samuelson, 1990) assumes an individual's utility from wealth, $U(W)$, is a function of wealth (*W*) and a constant relative risk aversion (*RRA*= -percentage change in marginal utility/percentage change in wealth) that is derived as follows:

$$U(W) = \frac{W^{1-RRA}}{1-RRA} \quad \text{, where } RRA > 0. \quad (2)$$

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[1] In the special CRRA case where *RRA* approaches 1, *U(W)=ln(W).*

Substituting equivalent of U(W) from formula (2) into equation (1) results in the expectation that an individual will contribute to a tax-deferred retirement account (TDR) versus prepaying a mortgage if:

$$E\left(\frac{W_{RET}^{\,1-RRA}}{1-RRA}\right) > E\left(\frac{W_{MORT}^{\,1-RRA}}{1-RRA}\right). \quad (3)$$

Financial Tradeoff

Tax-Deferred Retirement Account

The expected after-tax future value in a tax-deferred retirement account can be modeled as follows:

(4)
$$E(W_{RET}) = (C_{SAV} + mC_M v_T)\exp[E(r_R)T](1-\tau_T - p_T)$$

where:

- C_{SAV} = Pre-tax initial savings contribution
- m = % of employee contribution that employer matches (e.g. 50% of every $1)
- C_M = Contribution amount of employee contribution to which employer matching rate applies
- v_T = percentage that employee is vested in employer contributions at withdrawal time T
- $E(r_R)$ = Expected annual continuously compounded return within tax-deferred retirement account
- T = Time horizon (fixed) before withdrawal
- τ_T = Marginal income tax rate in year T
- p_T = 10% penalty if withdraw before age 59 ½ (and no other exceptions met)

If the continuously compounded return r_R is normally distributed with variance σ_R^2 then the annual gross or holding period return, $\exp(r_R)$, follows a lognormal distribution and the expected value of $\exp(r_R)$ is:

(5)
$$E[\exp(r_R)] = \exp\left[E(r_R) + \frac{1}{2}\sigma_R^2\right].$$

Taking the logarithm of each side in equation (5) results in the relationship between expected annual arithmetic return, μ_R, and expected annual continuously compounded return, $E(r_R)$, being defined as follows :

(6)
$$\mu_R = E(r_R) + \frac{1}{2}\sigma_R^2.$$

Rearranging formula (6) to solve for the expected continuously compounded return, $E(r_R)$:

(7)
$$E(r_R) = \mu_R - \frac{1}{2}\sigma_R^2.$$

Substituting $\mu_R - \frac{1}{2}\sigma_R^2$ for $E(r_R)$ in formula (4) and then into the constant relative risk aversion model in formula (2) results in the following expected utility from contributing to a TDR:

(8)
$$E(U(W_{RET})) = \frac{[(C_{SAV} + mC_M v_T)\exp[(\mu_R - \frac{1}{2}\sigma_R^2)T](1-\tau_T - p_T)]^{1-RRA}}{1-RRA}$$

Formula (8) expands upon the tradeoff model presented by Amromin, Huang, and Sialm (2007) by also considering the relative risk aversion of the individual and decreased utility from more volatile investments in the decision to contribute to a risky asset within a TDR or prepay a fixed-rate mortgage.

Mortgage Prepayment

The expected after-tax future value of savings from prepaying a mortgage can be modeled as follows:

(9) $$E(W_{MORT}) = C_{SAV}(1-\tau_{BT})\exp[(E(r_D)(1-\tau_{BT}i_{BT})T)$$

where

C_{SAV} = Pre-tax initial savings contribution
τ_{BT} = Marginal income tax rate in year of contribution and years prior to withdrawal
$E(r_D)$= Mortgage rate (assumed fixed)
i_{BT} = Dummy for itemize (yes=1, no=0) in year of contribution and years prior to withdrawal
T = Time horizon (fixed) before withdrawal

Substituting the expected arithmetic return μ_D for $E(r_D)$ in formula (9) and then into the constant relative risk aversion model in formula (2) results in the following expected utility from prepaying a mortgage:

(10) $$E(U(W_{MORT})) = \frac{[C_{SAV}(1-\tau_{BT})\exp[(E(r_D)(1-\tau_{BT}i_{BT})T)\,]^{1-RRA}}{1-RRA}.$$

Illustration

To illustrate the tradeoff between contributing to a tax-deferred retirement account (TDR) and prepaying a mortgage, assume a household had $10,000 of pre-tax income available to save and the following information related to formula (4):

C_{SAV} = $10,000
C_M = $6,000 (assume salary $100,000 and match up to 6% of salary)
m = 50% employer match
v_T = 100% vested
μ_R = 8% annual arithmetic return within TDR
σ_R = 15% annual standard deviation within TDR
T = 10 years before withdrawal (at retirement)
τ_T = 0.15 marginal tax rate at withdrawal (during retirement)
p_T = 0 (no 10% penalty because assume withdraw at retirement)

This would result in $E(W_{RET})$, an expected after-tax benefit at withdrawal from the TDR, of $21,976.

Now compare this to expected after-tax benefit from using the same $10,000 of pre-tax income to instead prepay a mortgage and assuming the following information related to formula (9):

C_{SAV} = $10,000
τ_{BT} = 0.25 Marginal income tax rate in current year and years prior to withdrawal
r_D = 4% Mortgage Rate (assumed fixed)
i_{BT} = 1 (assume household itemizes)
T = 10 years until savings period ends

This would result in $E(W_{MORT})$, or an expected after-tax benefit from savings generated by prepaying a mortgage, of $10,124. Table 1 compares the results of saving $10,000 of pre-tax income under different scenarios using the above assumed information and after considering relative risk aversion (RRA) as descrived in formulas (8) and (10).

Table 1

Results of Saving $10,000 of Pre-Tax Income

Where to save $10,000?	**After-Tax Future Value of Savings**	**Utility RRA=2**	**Utility RRA=5**
Tax-deferred Retirement Plan (with matching)	$21,976	-4.56×10^{-5}	-1.07×10^{-18}
Tax-deferred Retirement Plan (without matching)	$16,904	-5.92×10^{-5}	-3.06×10^{-18}
Prepay Mortgage	$10,124	-9.88×10^{-5}	-2.38×10^{-17}

The individual's after-tax expected value of $21,976 (and expected utility at different relative risk aversion levels) from contributing to a TDR (with a match) is greater than the after-tax expected value from prepaying a mortgage of $10,124. In this example the main driver of the difference was the matching, higher expected return within the tax-deferred account than mortgage interest rate, and difference in current versus future tax rate at withdrawal.

Conceptual Framework

Formulas (8) and (10), which outline the expected utility tradeoff between contributing to a TDR account or prepaying a mortgage, illustrate the complexity of making the best decision. Based on this, this study hypothesizes that, after controlling for financial tradeoff and other behavioral and demographic factors, those who use a financial planner are more likely to make tax-deferred contributions and less likely to prepay a mortgage.

Based on this, the basic theoretical framework can be summarized as follows:

Mortgage Prepayment or Tax-Deferred Contribution = *f(financial planner, financial tradeoffs, demographic)* (11)

Methods

Data

Data from the 2004, 2007, and 2010 years of the Surveys of Consumer Finances (SCF) are used. The SCF is a triennial cross-sectional survey sponsored by the Federal Reserve Board (FRB) and includes in depth information on tax-deferred retirement accounts, mortgages, and other household characteristics such as whether a household uses a financial planner.

The SCF is based on a dual-frame sample design of households within the United States. The first frame is a sample of households selected using a multi-stage area probability approach intended to provide coverage of characteristics, such as retirement assets, that are found among the majority of the population. The second frame is a sample of relatively wealthy households selected disproportionately from a stratified list sample of households obtained from tax records provided by the Statistics of Income Division of the Internal Revenue Service (SOI). Given the oversampling of wealthy respondents, descriptive data in this survey were appropriately weighted using the SCF sampling weights provided by the Federal Reserve Board to generate nationally representative statistical estimates. Further, the SCF uses multiple imputation to estimate five values for each missing data or response, which results in five data sets for each SCF year. Given the use of multiple imputed data, the repeated-imputed inference technique was used in our regression analysis as recommended by Montalto and Sung (1996).

Sample

Our sample was restricted to households that were eligible to participate in a tax-deferred retirement account (TDR), had a fixed rate mortgage, and either contributed to a TDR or prepaid their mortgage or both. This resulted in a final sample size of 2,485 households.

Empirical Model

A binary logistic regression model was used to model the likelihood of different household factors on contributing a greater percentage of savings to a tax-deferred retirement account versus prepaying a mortgage as follows:

$$\log(\mathrm{p_i}/(1-\mathrm{p_i}) = \beta_0 + \beta_1\ \mathrm{Financial\ Planner_i} + \beta_2\ \mathrm{Financial\ Tradeoffs_i} + \beta_3\ \mathrm{Other\ Demographic_i} + \varepsilon_i \quad (12)$$

In this model, p_i = the probability that household *i* has a TDR Ratio greater than 50%. The TDR ratio is equal to the total contributions to a tax-deferred retirement account divided by total contributions to a TDR account and mortgage prepayments (Amromin, Huang, and Sialm, 2007). Financial Planner$_i$, Financial Tradeoffs$_i$, and Other Demographic$_i$, represent groups of independent variables related to different household factors.

Dependent Variables

The dependent variable is a binary variable equal to 1 if the TDR Ratio is greater than 50% (else variable coded 0). Similar to the methodology employed by Amromin, Huang, and Sialm (2007) the TDR ratio is the ratio of total household contributions to a tax-deferred employer provided retirement account (e.g., 401k, 403b) divided by combined total of contributions to a TDR account and mortgage prepayments. Since this ratio is calculated only using the sample of households who either contributed to a TDR account or prepaid a mortgage or both, the TDR ratio measures the household's contributions to a TDR account relative to total savings available for either retirement or mortgage prepayment.

Independent Variables

The same independent variables were used in each of the three regression models. Similar to Finke, Huston, and Waller (2009), we determine that a household uses a financial planner if it reports a financial planner as one of its top three sources when seeking information for savings and investing decisions (dummy variable coded 1).

For the financial tradeoff variables related to tax-deferred retirement accounts, we created a binary match variable if the household reported at least one employer plan that matched employee contributions (coded 1; otherwise coded 0). To proxy for higher expected return within the tax-deferred retirement account, we created a continuous variable for each household equal to the percentage allocated to equities within their retirement account. If the household reported being 59 or younger we created an early withdraw penalty variable (coded 1; otherwise coded 0). To proxy for future tax rate we create a binary financial asset to income ratio. The assumption is that the higher the financial asset to income ratio the greater the future expected tax rate, especially relative to the current rate. After considering life cycle stages, we considered a household to have a high financial asset to income ratio (and therefore higher expected future tax rate) if these ratios were above any of the following thresholds for different age groups: Age <35: >2, Age 35-44: >4, Age 45-54: >8, Age 55-64: >16, or Age >65: >12). These threshold ratios were based on the minimum ratios needed to at replace at least 80% of pre-retirement income assuming investment in a balanced 60% equity and 40% bond portfolio returning 5% above inflation and a 10-13% annual savings rate. If the household reported a financial ratio above the specified threshold for their age group we identified them as a high financial asset to income household (coded 1; otherwise coded 0).

For the financial tradeoff variables related to mortgage prepayment, we created a mortgage rate variable equal to the mortgage rate reported on their outstanding mortgage. The marginal tax rate of the household was calculated using TAXSIM coding developed by Kevin Moore at the National Bureau of Economic Research (NBER) (TAXSIM). If the household itemized deductions on their tax return (either jointly or if at least spouse itemized when married filing separately) the household was coded as itemized

deductions=1; else coded 0. If the household reported paying that they pay private mortgage insurance (PMI)—an additional incentive to prepay a mortgage to increase equity in the home to at least 20%--the household was coded as PMI=1; else coded 0. We identified households that were not willing to take on any risk in its investments as risk averse (coded 1; otherwise coded 0).

Other variables created were created for debt aversion, liquidity constraints, wealth, education, age, and marital status. Households reporting always or almost always paying off the total balance on a credit card each month (not just amount due) were determined to be debt averse (coded 1; else coded 0). Households that were turned down for credit at least once during the past five years, not able to obtain credit later or discouraged from applying again, or with credit card balances greater than 75% of total credit card limit were considered to be liquidity constrained (coded 1; otherwise coded 0). Other variables created included log of net worth to account for the skewness of wealth, age of head of household, and separate indicator variables for whether the household was married and if anyone had a college degree. Dummy variables for each SCF year 2004, 2007, and 2010 were created to help control for any specific year effects.

Results and Discussion

Descriptive Statistics

Table 2 present descriptive statistics for households conditioned by whether the majority of their savings were used to contribute to a tax-deferred retirement account (TDA Ratio > 50%) or to prepay a mortgage (TDA Ratio $\leq$50%).

A greater percentage of households with a TDR Ratio > 50% had a financial planner, an employer match, college degree, itemized, higher financial assets to wage ratio, mortgage insurance, and were liquidity constrained and risk averse. Also, this group had higher average allocation to equities within retirement accounts, current tax rates, and mortgage rates. In contrast, this group had a smaller percentage subject to the 10% penalty, that paid full balance on credit card (debt averse), and that were married.

Table 2

Descriptive Statistics by Tax-Deferred Retirement Ratio (TDR Ratio)

Variable	TDR Ratio <0.50	TDR Ratio $\geq$0.50
Financial Planner	21.0%	25.9%
Financial Tradeoffs		
Match	23.5%	29.5%
No penalty	7.8%	7.4%
Fin Assets to Wage	3.7%	4.5%
Ratio	75.4%	78.8%
Itemize	17.8%	18.2%
Mortgage Insurance	24.7%	18.5%
Risk Averse	46.0% Mean	53.0% Mean
RetEqAlloc	(45.0% Median)	(50.1% Median)
	20.6% Mean	22.8% Mean
MTR	(25.0% Median)	(25.0% Median)
	5.79% Mean	5.84% Mean
Mortgage Rate	(5.50% Median)	(5.75% Median)

Other		
PayCCBal	48.2%	47.9%
Liquidity Constrained	20.0%	25.3%
College Degree	50.8%	56.1%
Married	85.0%	80.3%
Age	46.5 Mean (47.0 Median)	45.0 Mean (45.0 Median)
Wealth	$494,386 (247,652 Median)	$573,934 (222,321 Median)
N	358	2,127

Logistic Regression

Table 3 presents the logistic regression results reported in odds ratios in an effort to isolate the effect of each variable on the odds of contributing a greater percentage to TDR accounts than to prepay mortgage (TDR Ratio >50%). Most notably, after controlling for other factors, households with access to a financial planner were 30% (statistically significant at $p<0.10$ level) more likly to have a TDR Ratio greater than 50%. In addition, households with access to an employer match, greater allocation to equities within retirement accounts, and higher current marginal tax rate were more likely to contribute a greater portion to TDR accounts than to prepay a mortgage. In contrast, more risk averse, married, and wealthier households were statistically less likely to contribute a greater amount to TDR accounts than to prepay a mortgage. households at least 59 1/2 years old (no 10% withdrawal penalty), high financial assets to income ratio, risk averse, and liquidity constrained households were less likely to contribute to a TDR account. Households in 2004 were statistically less likely to have a TDR ratio greater than 50% in 2010 (possibly driven by low mortgage rates in 2010 than in previous survey years).

Table 3

Odds Ratios for TDR Ratio Among Households who Contribute to TDR or Prepay Mortgage

Variables	**TDR Ratio > 0.50**
Financial Planner	1.300
Financial Tradeoffs	
Match	1.365*
No penalty	1.151
Fin Assets to Wage	0.864
Ratio	1.044
Itemize	0.922
Mortgage Insurance	0.724*
Risk Averse	1.644*
RetEqAlloc	1.029**

MTR	1.089
Mortgage Rate	
Other	
PayCCBal	0.993
Liquidity Constrained	1.230
College Degree	1.134
Married	0.669*
Age	0.985
Wealth	0.911*
Years ('10 comparison)	
Y04	0.571***
Y07	0.826
Intercept	13.192***
N	2,485
Max-rescaled R^2	0.059

Note: *p < .05; **p < .01; ***p < .001

Conclusion and Implications

This study confirms that households contributing to a tax-deferred retirement (TDR) account or prepaying a mortgage are more likely to contribute a greater amount to TDR accounts than to prepay a mortgage if they have access to an employer match, greater percentage allocated to equities within a retirement account, higher current tax rate, and are more risk tolerant. In contrast, a household is more likely to prepay a mortgage if it does not have access to an employer match, has less risky retirement portfolio and lower current tax rate, and is married and wealthier. Financial planners also appear to have a positive influence on the odds of contributing a greater amount to a TDR account than to prepay a mortgage. The positive influence of a financial planner on tax-deferred contributions has interesting policy implications. Rapid financial retirement product advances combined with constantly changing tax rules, such as will continue to happen as the U.S. government deals with its expanding deficit, can be overwhelming to households and especially the less financially sophisticated (Willis, 2008). Studies have found a lack of financial sophistication among many households—both old and young--and the inability of less financially sophisticated households to respond effectively to tax reform (Maki, 1998; Lusardi and Mitchell, 2007; Lusardi, Mitchell, and Curto, 2010). As the U.S. government reconsiders major tax reforms over the upcoming years it should not underestimate the role that financial planners can play in helping consumers navigate a complex financial marketplace and make the best decisions for their unique situations. For example, perhaps offering a financial planner credit for expenses paid to a financial planner instead of, in addition to, or in combination with the Retirement Savers Credit for low-income households could help them not only make more optimal retirement savings decisions but also other important financial decisions, such as whether to contribute to a tax-deferred retirement account or to prepay debt.

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