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The Impact of the Single-Family Home on Portfolio Decisions

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Abstract

This study examines the impact of the single-family home on a family's optimal asset allocation decisions. Many researchers have studied individual investor portfolio allocations to stocks and bonds, but there has been little work examining how home ownership should affect those decisions. We believe the family home and any related financing should be considered part of the portfolio. Using a mean-variance utility function, we examine the effects of home ownership on optimal portfolio allocations to stocks and bonds. Failing to include the home and its financing can have a major impact on the optimal asset allocation strategy for a family. © 2003 Academy of Financial Services. All rights reserved.

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1. Introduction

Many researchers have studied individual investor decisions on how to allocate funds between stocks and bonds. Likewise, financial advisors provide generic recommendations regarding the proper mix of stocks and bonds at any given time based on the existing market conditions. For example, investors might be advised to hold 60% of their funds in stock and 40% in bonds. This study examines the impact of home ownership on these decisions. We

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employ the widely used concept of mean-variance analysis to determine the optimal asset allocations to stocks and bonds given general home ownership and mortgage loan scenarios. We also examine the case where the level of financing is allowed to vary and investors choose the optimal portfolio weights for stocks, bonds, and the mortgage loan.

The idea of taking a broader prospective of what an individual investor's portfolio includes is proposed by Reichenstein and Delaney (1995), Scott (1995), and Reichenstein (1998). They note that financial assets such as stocks, bonds, and cash may only be a small part of the total portfolio. Black, Ciccotello, and Skipper (2002) suggest that financial decisions should be made based on the family's entire economic portfolio, including both assets and liabilities. Furthermore, they state that financial decisions should employ modern portfolio theory to select efficient portfolios based on the risk-return profiles of the economic assets. Fraser, Jennings, and King (2000) determine the value of Social Security wealth and add this important factor to the portfolio decision making process. We add to this line of work by looking at the ramifications of including the home as an investment asset.

While there are many benefits to home ownership, we also consider the family home to be a key component of the investment portfolio. The family home is still the largest asset for many families, yet it is largely ignored when investment advice is handed out about the construction of a personal investment portfolio. Reichenstein (1998) argues that if retirement is the primary savings goal of the family, then the value of the family home should be considered part of the portfolio. We believe that any failure to consider the value of the family home in asset allocation decisions could lead to suboptimal choices.

While the home investment should not be ignored, neither should the value of any mortgage loan used to finance the home. We follow Reichenstein's (1998) suggestion to treat the entire mortgage loan balance as essentially a negative bond. The mortgage loan taken out by the family is comparable to a company issuing a callable bond. The family is obligated to make fixed payments, but can call (prepay) the loan if they choose to sell the home or refinance at a later date. As we discuss later, treating the house as an asset and the mortgage as a liability is a superior approach to simply subtracting the mortgage loan amount from the real estate value and using a net equity figure for asset allocation decisions.

The remainder of the paper is organized as follows: Section 2 reviews some of the literature related to general asset allocation with mean-variance analysis and the single-family home as part of the portfolio. Section 3 describes our data, explains any adjustments we made to it, and reveals some basic summary statistics. In Section 4 we outline our basic methodology. Section 5 is a discussion of our results, and Section 6 has our conclusions.

2. Literature review and background

2.1. Mean-variance analysis

The concepts of mean-variance analysis and the efficient frontier are mainstays in finance theory, as noted in texts such as Bodie, Kane, and Marcus (1999). The efficient frontier plots the returns and standard deviations of portfolio combinations that have the maximum return for a given level of risk. Different points on the efficient frontier can be found by using the

Sharpe (1994) ratio, which compares excess return to risk as measured by standard deviation. Many works have drawn conclusions about allocation decisions to stocks versus bonds based on mean-variance analysis. Asness (1996), for example, argues in favor of a mix of stocks and bonds and the use of leverage as a more efficient choice than 100% equities. Hodges, Taylor and Yoder (1997) use mean-variance analysis and Thorley (1995) uses a mean-variance utility function to examine the stock versus bond allocation decision with longer investment horizons. Mean-variance analysis may not, however, be appropriate for long-term investment horizons, as pointed out by Albrecht (1998). Sharpe and Tint (1990) develop an approach that uses mean-variance analysis to deal with liabilities, and Russell and Brooks (1998), among others, employ this methodology.

Institutional investments in real estate are approached using mean-variance analysis by works such as Lai, Wang, Chan, and Lee (1992), Giliberto (1992), Chandrashedaran (1999), and Chua (1999). The issue of the "fuzziness" of the efficient frontier as it pertains to real estate is discussed and tested in Gold (1995, 1996), Pagliari, Webb, and Del Casino (1995), and Cheng and Liang (2000). The fuzziness issue relates to errors in input items (means, variances, and correlations) that can lead to a range of optimal solutions on the efficient frontier rather than single points. These concerns are even more of an issue with real estate than they are with stocks and bonds because of the relative illiquidity of real estate and the use of returns based on appraisals rather than actual sales. Michaud (1998) addresses this issue in general terms when he advocates the use of a resampled efficient frontier that provides for a range of input data.

2.2. *The single-family home and mortgage as part of the portfolio*

Reichenstein and Delaney (1995) and Reichenstein (1998) discuss how to calculate a family's asset mix. In this paper, we draw upon some of the arguments in these two works. It is widely agreed that the asset allocation decision is very important, yet there is not universal agreement on what assets should be considered. When determining a family's optimal asset mix, it is common to simply ignore real estate and look only at financial assets such as stocks and bonds. We consider this to be a serious oversight. Reichenstein (1998) suggests that the home should be included in the portfolio as a substantial part of the home value may be reclaimed by the investors in the future.

Many families may have more limited housing needs later in life because of retirement, children leaving home, loss of a spouse, or other circumstances. These families may choose to move to smaller homes and recover part of their equity, often tax-free. Alternatively, they may choose to borrow against their home value by employing a vehicle such as a reverse annuity mortgage (RAM). While reverse annuity mortgages have not been widely used in the past, demographic trends such as an aging population (the over-65 age group is expected to double in the next 25 years) and greater house wealth held by the elderly suggest that there will be a growing demand for RAMs. On the supply side, both the Federal Housing Administration (FHA) and Fannie Mae have responded to the anticipated demographic changes by starting programs to make RAMs more available to the public by reducing default and liquidity risks associated with the mortgages. FHA has begun insuring RAMs so that the lender is protected against losses (including the potential loss that the homeowner may live beyond the expected time period). Fannie Mae has begun purchasing RAMs thereby improving liquidity in this market by allowing local lenders to immediately sell the loans. During 2002, Fannie Mae bought 13,780 Reverse Annuity Mortgages, a near doubling of the number issued in 2001 (Fannie Mae, 2002).

As an alternative to ignoring the home completely, some decision makers will consider just the home value minus the mortgage loan (net equity). Reichenstein and Delaney (1995) and Reichenstein (1998) both argue against this proposition. This approach would be appropriate only if the mortgage loan were a perfect hedge against the real estate, which it is not. Reichenstein (1998) points out that using just the net real estate amount is comparable to using a net stock position when considering a margin account. If an individual borrowed $1,000 to buy $1,000 in stock, no one would argue that the investor's net stock position was $0. The same argument hold for real estate financed with a mortgage loan.

Reichenstein and Delaney (1995) and Reichenstein (1998) both also suggest including the mortgage loan value in the portfolio as essentially a negative bond. An individual with a mortgage loan has to make payments that would offset interest payments received on a purchased bond. Likewise, changes in interest rates impact the market value of the loan. The mortgage loan resembles a callable bond because the homeowner can prepay the loan at any time, often to refinance. In this paper, we examine the impact of home ownership and the mortgage loan on asset allocation decisions. We use expected market returns and risk levels for both the home and mortgage loan with no netting of the positions.

2.3. *The single-family home and mean-variance analysis*

Goetzmann (1993) uses mean-variance analysis to examine the optimal portfolio weights for stocks, bonds, and net real estate in the portfolio of an individual investor. Goetzmann, who obtained his data from Case and Shiller (1990), used excess returns after adjusting for rent, taxes, and maintenance and assumes an 80% mortgage. He plotted the efficient frontier using real estate excess return data for four geographic regions. Goetzmann's (1993) work is a valuable addition to the literature that highlights the need for consideration of the impact of the home on portfolio decisions. Goetzmann (1993) uses a net real estate position with the value of the real estate less an assumed 80% loan. As noted above, a net real estate position is optimal only if the real estate and the mortgage loan are perfectly correlated. Goetzmann's methodology also allowed the size of the home investment to vary freely. The Goetzmann results present extreme alternatives in many instances suggesting that either no home ownership at all or very high real estate weights are optimal. It seems impractical to suggest that individuals would buy bigger than desired homes to optimize their portfolios. For example, someone with $200,000 and an optimal real estate net equity weight of 50% would be advised to buy a $500,000 home (considering the 80% mortgage, but ignoring the effects of rent, taxes, and maintenance costs).

Flavin and Yamashita (2002), who build on the theoretical model of Grossman and Laroque (1990), do take the home value as a given, while allowing the mortgage loan amount to vary; and they examine the impact of the home value on portfolio allocations to Treasury bills, bonds, stocks, and the mortgage loan financing. They employ after-tax real returns for the financial assets and mortgage loans, assuming marginal income tax rates of 28% federal and 5% state. Of particular note is that all interest payments on mortgage loans were assumed to be fully tax deductible, giving an after-tax real cost of 0.00% for these liabilities. As discussed below, we argue against assuming that mortgage interest payments are fully deductible since the majority of homeowners do not itemize their deductions for tax purposes. Flavin and Yamashita (2002) use the Panel Study of Income Dynamics, which has self-reported estimates of home values, for their real estate return data. Their findings suggest that for individuals with low levels of risk tolerance, home ownership does not impact the portfolio decisions. They also found that for individuals with higher levels of risk tolerance, the more prominent the home is as a proportion of the overall portfolio, the lower the optimal allocation to stock. Our work differs from Flavin and Yamashita (2002) from several perspectives. As noted below, we question their tax treatment for more than one reason. We also treat the mortgage loan as though it were a negative bond so that we capture volatility associated with changes in the value of the loan in addition to changes in market interest rates.

3. Data

This study examines how optimal asset allocation decisions of individual investors to stocks and bonds are impacted by home ownership and any related financing. The study employs quarterly data for stocks, bonds, housing prices, and mortgage loans for the period from 1983 to 1998. Quarterly total returns (capital gains and dividends) of the Standard and Poor's 500 Index are used to represent stocks. For bonds quarterly total returns are derived from the long-term corporate bond data provided by Ibbotson Associates.

3.1. Mortgage rates

The mortgage rates used in this paper are compiled by HSH Associates using an editorial survey method whereby they contact over 2,000 lenders on a regular basis. (See www.hs-h.com for the data and more information.) We consider only the 30-year, fixed-rate mortgage because it is the most common type and has the longest history available. The 30-year fixed rate data provided by HSH Associates for 1983 to 1985 includes a relatively small number of 15-year mortgages that were in their infancy at the time. The rates are the nominal rates on the mortgages and do not include the effect of discount points on the mortgage's effective rate. These mortgage rates are publicly available and widely used.

For our purposes we convert the HSH mortgage information to a quarterly cost. This cost is calculated as three months interest at the current rate plus or minus any percentage change in value of an outstanding mortgage loan because of changes in mortgage interest rates over the quarter. If interest rates increase, for example, the individual with a loan locked in at the lower rate is better off. The market value of their loan liability will have decreased over the quarter. While an individual may not actually have the option to pay off their loan at this lower market value, individuals with low interest rate loans do recognize that they have a valuable commodity. These costs are not applicable to any single investor, but rather they provide a picture of the expected costs and variability associated with mortgage loans in general. An investor who locks in interest rates at a historically low level may do better than this average, while an investor obtaining a mortgage loan when rates are high may ultimately end up exercising the call option on the loan by refinancing.

3.2. House price returns

We focus on the value of the home as a long-term or retirement asset. Consistent with Reichenstein's (1998) argument that gains in home values can be recognized at retirement, changes in home values are the returns of interest for our study. It is these changes in value that impact long-term investment decisions. Later in life investors may choose to cash out of their home investments by selling and moving to apartments or less expensive houses or by taking out reverse annuity mortgages. The investment value of the home can clearly supplement the investor's other holdings in stocks and bonds.

We use the quarterly percentage change in the value of a national house price index (HPI) as our proxy for changes in the value of a single-family home. While a national index is examined, the regional indexes are all highly correlated with the national index. We chose to use the Housing Price Index (HPI) provided by the Office of Federal Housing Enterprise Oversight (OFHEO). It is a measure designed to capture changes in the value of single-family homes in the U.S. as a whole, in various regions of the country, as well as in the individual states. The HPI dates to 1975 and is published by the Office of Federal Housing Enterprise Oversight (OFHEO) using data provided by Fannie Mae and Freddie Mac. OFHEO created the HPI at the instruction of Congress as a way to measure the exposure of Fannie Mae and Freddie Mac to real estate housing risk. The HPI is comprised of approximately 20 million repeat sales or refinancings of houses that have appeared in the combined databases, a far larger and more robust data set than any other currently available [for example, the Commerce Department's Constant Quality Housing Price Index (CQHPI) contains only 12,000 observations per year], (OFHEO, 2003). The methodology used to build the HPI is a modified version of the Case-Shiller geometric weighted repeat sales procedure, which is described in detail by Calhoun (1996).

3.3. House price variability

Home ownership is a risky venture, and no two homes are alike. Each house in each area of the country is different in the same fashion that each of the thousands of stocks available to investors is different. The problem is that while individuals can easily purchase diversified stock portfolios or stock mutual funds, they are generally limited to having only one house. The expected return on a single house chosen at random would equal the expected return of our national index, but the potential variability of returns for a solitary single-family home are far greater than that of the national index.

We use an estimate of the quarterly volatility of the returns from ownership of a single house, not of a national index. OFHEO calculates and publishes statistics, using the methodology outlined by Calhoun (1996), that allow for the estimation of "volatility and dispersion of individual house prices around the market index," which we combine with the data for the historical volatility of the national index. This total variability of the price returns of a single house is larger than that of the national index for several reasons. There are regional factors that can impact home values differently than the nation that are beyond the individual's control. An individual investor faces the extra risk that they might choose their particular house unwisely (overpay, fail to observe defects, fail to observe neighborhood changes, see a nuclear waste dump opened next door after the purchase, etc.). Homeowners in communities dominated by a single employer or a small group of employers may face even greater risks than individual homeowners at large.

3.4. Other costs and benefits of home ownership

Consistent with our focus on the long-term benefits of home ownership, the home returns we examine include only the capital appreciation of the home. While there are, of course, other benefits of home ownership only the capital appreciation is available for future consumption. One of the primary benefits of home ownership is that it provides shelter. Individuals making mortgage payments would otherwise be paying some percentage of the home's cost on the renting alternative. A case could be made for including the present value of some percentage of the avoided rental costs as an implied asset; however, such a consideration is outside the scope of this paper. Home ownership also provides intangible benefits. There are real positive, psychological returns of home ownership which increase overall utility, but are not easily quantifiable. Several authors have examined how individuals should examine the "rent versus own" decision concerning housing. While this topic is beyond the scope of this paper interested readers may want to review Chinloy (1991), Holloway (1991), Fratantoni (2001), Ioannides and Kan (1996), and Ioannides and Rosenthal (1994).

Homeowners must also bear the annual costs of property taxes and maintenance, which can be quite significant. These costs, however, are indirectly born by renters as well. The uncertainty of these factors when faced as a homeowner could, however, increase the risk of home ownership.

3.5. Before-tax versus after-tax returns

We have elected to employ nominal before-tax returns for all of our statistics and calculations. Investors are certainly concerned with after-tax returns and costs, but just how to go about calculating those after-tax returns for financial assets for a model investor is problematic. Flavin and Yamashita (2002) assume a 28% marginal tax rate for Treasury bonds and a 33% rate, 28% federal plus 5% state, for stock dividends. They also assume that all capital gains on stock are tax free, while acknowledging that this overstates the returns on stock. Capital gains tax on stock is only realized when the asset is sold, but the holding period will determine whether the sale qualifies for a preferential capital gains tax rate and also the effective annual tax rate. If some or all of the stock and bond portfolio is held in a tax deferred account such as 401k, then the tax issue is even more muddled. Simply following the traditional convention of examining before-tax returns simplifies the analysis, but tax implications may be an area for future research.

We disagree with the assumption of a full personal income tax break savings associated

Table 1
Correlation matrix of quarterly returns and other statistics for stocks, bonds, 30-year fixed rate mortgage and a single-family house for the period from 1983 to 1998

	S&P 500 Index	Long-Term Corporate Bonds	30-Year Fixed Rate Mortgage	Single-Family House
Long-term corporate bonds	0.2316			
30-year fixed rate mortgage	0.2188	0.8215		
Single-family house	0.1309	−0.0909	0.0119	
Expected return (quarterly)	0.0371	0.0292	0.0343	0.0108
Standard deviation (quarterly)	0.0736	0.0417	0.0465	0.0485
Expected return (annual)	0.1519	0.1222	0.1446	0.0441
Standard deviation (annual)	0.1283	0.0957	0.1058	0.0977

All returns are nominal figures on a before-tax basis. The returns for the S&P 500 Index are total returns reflecting both capital gains and dividends. The returns for Long-Term Corporate Bonds are total returns derived data from Ibbotson Associates. The 30-Year Fixed Rate Mortgage returns include both the interest expense and changes in the value of the outstanding debt, as though it were a bond. The returns for the single family house reflect the price change of a national housing price index, but the standard deviation captures the risk of an individual home, as well.

with the deductibility of property taxes and mortgage interest as done by Flavin and Yamashita (2002). The value of this deduction varies considerably from individual to individual. To deduct the interest, one must itemize and thus forgo the standard deduction, and often the standard deduction is larger than the interest expense. Mann (2002) notes that while 67.1% of American families owned homes in 2000, less than 30% of homeowners itemized deductions. Even when a person does take the interest deduction, the marginal effect (compared to taking the standard deduction) on the person's tax liability is often minor. For example, consider the case of an individual who has a standard deduction of $4,500, an interest deduction of $6,000, and is in the 27% marginal tax bracket. Calculating a tax savings by multiplying the marginal tax rate by the interest expense is clearly not appropriate. By itemizing the individual only gains $1,500 in deductions, which saves them just $405 in taxes even though they paid $6,000 in interest. A married couple would have even lower tax savings, if any. Peiser and Smith (1985) discuss this notion of "surplus standard deduction."

3.6. Basic statistics

Table 1 shows the quarterly and annual historical returns and standard deviations of stocks (S&P 500), long-term corporate bonds, 30-year fixed rate mortgage loans, and a single-family house. We focus on quarterly returns in our analysis. For the 1983 to 1998 period, the quarterly total return and standard deviation of the Standard and Poor's 500 Index are 3.71% and 7.36%, respectively. The quarterly return and standard deviation of Ibbotson Associates long-term corporate bonds are 2.92% and 4.17%, respectively. The 30-year, fixed-rate mortgage had an average cost of 3.43% per quarter and a standard deviation of 4.65%. Based on the national housing price index, a single-family home had a relatively low quarterly return of 1.08%. The standard deviation of the returns on a single home is estimated at 4.85% reflecting a relatively high level of risk for their low return level.

Table 1 also shows the correlation coefficients between the four categories of stocks (S&P 500), long-term corporate bonds, 30-year fixed rate mortgage loans, and a single-family house. The returns of stocks and long-term bonds have a relatively low, but positive, correlation coefficient of 0.23. Mortgage loans and housing prices are virtually uncorrelated with a correlation coefficient of 0.01. This low correlation supports the argument against using net real estate in portfolio decisions rather than including both the real estate and the mortgage loans. The mortgage loans and the long-term corporate bonds have a very high, positive correlation coefficient of 0.82, which is in line with the rationale of considering mortgages to be short bond positions.

4. Methodology

Efficient portfolios provide investors with the maximum expected return for a given level of risk or, alternatively, the minimum level of risk for a given expected return. Risk is measured by the portfolio's variance or standard deviation. Investors obviously prefer higher returns and seek to avoid risk or variability of the returns. We examine investor utility as a function of the expected portfolio returns r_p and the variance of the portfolio returns σ^2. Investors seek to maximize utility using the common utility function shown in Eq. (1). A discussion of the utility function can be seen in Bodie, Kane, and Marcus (1999).

$$r_p - \frac{1}{2}A\sigma^2 \tag{1}$$

The coefficient A indicates the individual investor's level of risk aversion. Low values of A are consistent with a higher tolerance for risk, while higher values for A equate to higher degrees of risk aversion. Using this utility function, we can see how changes in home values, relative to the overall net worth, impact optimal portfolio decisions. We report our results for levels of A of 1, 2, 3, 5, and 10.

Throughout all of our analyses, the value of the home is assumed to be fixed. With a given home value, an individual investor decides the optimal weights to be held in stocks, bonds, and in some instances, mortgage loans. An investor will not periodically rebalance his or her portfolio by selecting a home of a particular value because of the high transaction costs associated with doing so. Likewise, it is not possible to sell part of the family home or build an addition to make portfolio adjustments. There are, however, no such restrictions on financial assets that can be bought or sold with minimal transaction cost. While the transaction costs of a new first mortgage are quite high, individuals can easily pay down mortgage balances if they have available funds and can adjust their overall borrowing level by taking out a second mortgage or a home equity loan. Our methodology differs substantially from Goetzmann (1993) who uses the net equity position in real estate, assuming an 80% mortgage, and then allows everything, including the real estate weight, to vary.

In our first set of scenarios, 100% financing with a 30-year, fixed-rate mortgage loan is assumed, and investors choose how to allocate their funds between stocks and bonds. We examine the impact of different levels of home ownership relative to the individual's net worth on the portfolio allocation decisions. The home value is taken as a given and investor utility is optimized by adjusting the allocations to stocks and bonds. We also compare this to the base case where the impact of the home on portfolio decisions is ignored. Net worth for our purposes includes just the home, any mortgage loan, and the financial positions in stocks and bonds. We examine the cases where the home value is 300%, 250%, 200%, 150%, 100%, 75%, 50%, and 25% of overall net worth. For example when the home is 50% of net worth, a family may have a $100,000 home, a $100,000 mortgage, and $200,000 available for investment in securities. The portfolio weights of the home and the mortgage are thus given at 50% and −50%, respectively. We then solve for the optimal portfolio weights of stocks and bonds. We also constrain the stock and bond weights to positive values. The larger home value to net worth ratios might better reflect typical younger investor/homeowners just starting out where the home is the bulk of the portfolio. On the other hand, lower home to net worth ratios might be expected for older investors who have had the opportunity to build stock and bond portfolios over time.

In the second scenario, the weight of the family's home relative to the overall portfolio is still fixed at the 300%, 250%, 200%, 150%, 100%, 75%, 50%, and 25% levels, but the mortgage loan weight is allowed to vary. We solve for the optimal portfolio weights of stocks, bonds, and the mortgage loan. With the home value at 50% of net worth, a family might have, for example, $200,000 cash and be planning to buy a $100,000 home, but the level of financing has not yet been determined. The family could buy the home outright and have $100,000 remaining to invest. Alternatively, they could finance part of the home cost (i.e., have a negative weight in the mortgage loan) and have even more funds available for investment in stocks and bonds. Stocks and bonds are again constrained to positive weights, while the weight in the mortgage loan can vary from full financing to 0%.

5. Results

The question of interest is whether or not home ownership, and the level thereof, affects the optimal portfolio allocations to stocks and bonds. The results shown in Table 2 and graphically in Fig. 1 suggest that it does. The table shows the utility maximizing portfolio allocations to equity for given levels of home ownership relative to net worth and for different levels of risk aversion as reflected by "A" from Eq. (1). The equity weights shown are the percentage of total financial assets, defined as stocks plus bonds. 100% mortgage loan financing is assumed in these results, and only the allocation to stocks and bonds are allowed to vary. The first row of Table 2 shows the optimal allocations to equity in the case where home ownership is not considered in the portfolio decisions. Looking across this row, the optimal allocations to equity predictably decrease with higher levels of risk aversion. This result is likewise true when different levels of home ownership are considered.

Looking down the columns in Table 2 reveals the relationship between the size of the home relative to the portfolio and the optimal allocation to equity. For investors with the lowest level of risk aversion, A equals 1, there is no impact from home ownership until the home to net worth ratio reaches 250%. For all home ownership levels less than this amount,

Table 2
Utility maximizing proportions of financial assets in equity given different home ownership levels with 100% financing and different risk tolerance levels

House value % of net worth	A = 1	A = 2	A = 3	A = 5	A = 10
No house	1.0000	0.8719	0.6410	0.4562	0.3177
25%	1.0000	0.8068	0.5758	0.3911	0.2525
50%	1.0000	0.7416	0.5107	0.3260	0.1874
75%	1.0000	0.6765	0.4456	0.2608	0.1223
100%	1.0000	0.6114	0.3804	0.1957	0.0571
150%	1.0000	0.4811	0.2502	0.0654	0.0000
200%	1.0000	0.3508	0.1199	0.0000	0.0000
250%	0.9133	0.2205	0.0000	0.0000	0.0000
300%	0.7831	0.0903	0.0000	0.0000	0.0000

The Table shows the utility maximizing levels of equity in a portfolio of stocks and bonds assuming different levels of home ownership and risk tolerance levels as noted by A. The utility function maximized is given by Eq. (1),

$$r_p - \frac{1}{2}A\sigma^2,$$

where r_p is the portfolio expected return and σ^2 is the variance of the portfolio returns. The home is assumed to be financed 100% by a 30-year, fixed rate mortgage.

The first row of the Table is equivalent to the financial assets only view, which does not consider the value of the family home or mortgage loans.

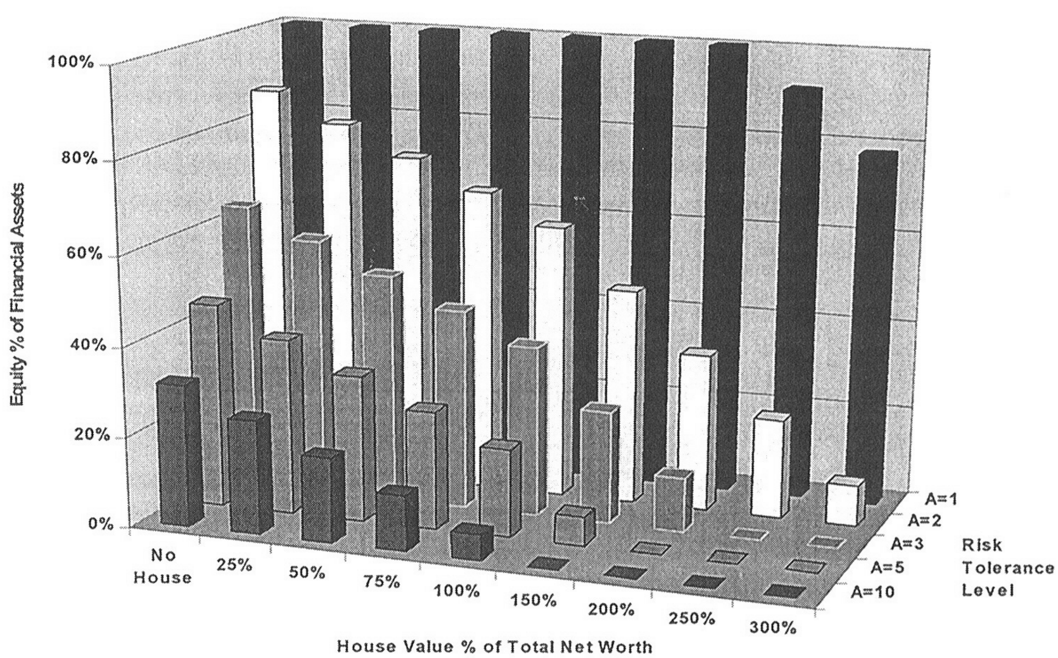

Fig. 1. Optimal portfolio allocations to equity given different levels of home ownership and risk tolerance assuming 100% financing of the home.

Table 3
Utility maximizing proportions of financial assets in equity and the level of mortgage loan financing given different home ownership and risk tolerance levels

House Value % of Net Worth	A = 1	A = 2	A = 3	A = 5	A = 10
No House	1.0000	0.8719	0.6410	0.4562	0.3177
25%	1.0000	1.0000	0.7571	0.5108	0.3260
	0.0000	*0.0000*	*0.0000*	*0.0000*	*0.0000*
50%	1.0000	1.0000	0.9893	0.6198	0.3427
	0.0945	*0.0000*	*0.0000*	*0.0000*	*0.0000*
75%	1.0000	1.0000	1.0000	0.9470	0.3927
	0.2948	*0.0000*	*0.0000*	*0.0000*	*0.0000*
100%	1.0000	1.0000	1.0000	1.0000	0.0000*
	0.3950	*0.1613*	*0.0834*	*0.0211*	*0.0000*
150%	1.0000	1.0000	0.0000*	0.0000*	0.0000*
	0.4952	*0.3394*	*0.3333*	*0.3333*	*0.3333*
200%	1.0000	0.0000*	0.0000*	0.0000*	0.0000*
	0.5453	*0.5000*	*0.5000*	*0.5000*	*0.5000*
250%	0.0000*	0.0000*	0.0000*	0.0000*	0.0000*
	0.6000	*0.6000*	*0.6000*	*0.6000*	*0.6000*
300%	0.0000*	0.0000*	0.0000*	0.0000*	0.0000*
	0.6667	*0.6667*	*0.6667*	*0.6667*	*0.6667*

Note: % Mortgage loan financing in italics

*In this instance a 0% investment in stock does not reflect a 100% investment in bonds. The optimal portfolio has no stocks or bonds. The entire portfolio consists of the home and the stated level of mortgage loan financing.

The Table shows the utility maximizing levels of equity in a portfolio of stocks and bonds assuming different levels of home ownership and risk tolerance levels as noted by A. It also shows the optimal level of mortgage loan financing as a percent of home value. The utility function maximized is given by Eq. (1),

$$r_p - \frac{1}{2}A\sigma^2,$$

where r_p is the portfolio expected return and σ^2 is the variance of the portfolio returns.

The first row of the Table is equivalent to the financial assets only view, which does not consider the value of the family home or mortgage loans.

the optimal equity investment is 100%. For more risk averse investors, with A of 2 or more, the higher the proportion the home is of total net worth, the lower the optimal allocation to stock. For example, with A equals 2 failing to consider the home would lead to an 87% weighting of equity in the portfolio, while a utility maximizing investor with a home value equal to 100% of net worth would be more satisfied with an equity weighting of only 61%; and an investor with a home value equal to 300% of net worth would maximize utility by holding just 9% of their portfolio in stock. Likewise for A equals 10, considering just stocks and bonds would lead to an equity weight of 32%, while someone with a home equal to 150% or more of net worth should hold no stock.

Table 3 and Fig. 2A and B show the utility maximizing portfolio weights for equity and the optimal levels of mortgage loan financing when the proportions of stocks, bonds, *and* the mortgage loan are allowed to vary. For most cases where the home value equals less than 100% of net worth, the optimal portfolio includes no mortgage loan financing. With the home value at more than 100% of net worth, the utility maximizing portfolios for 17 of 20 cases

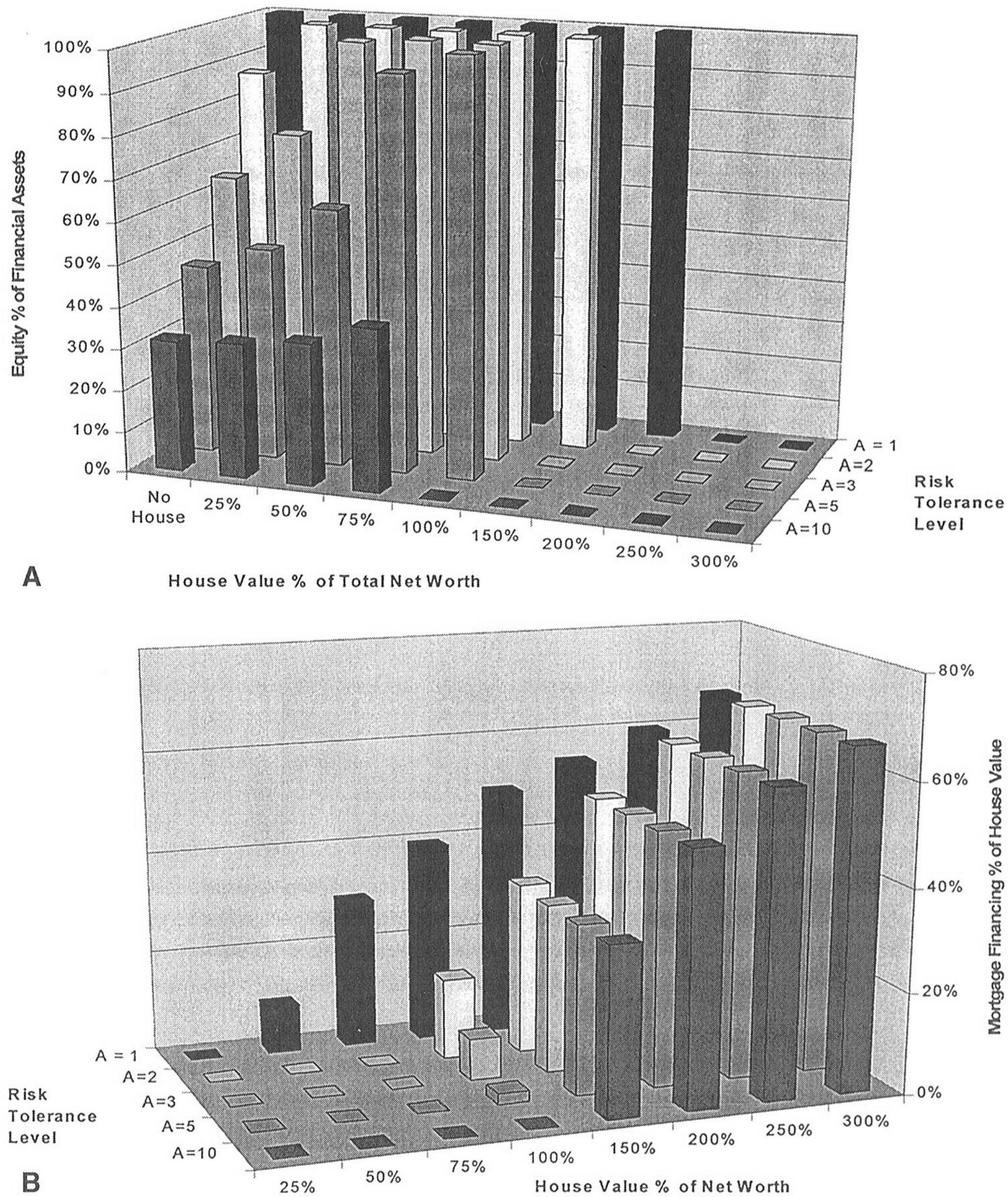

Fig. 2. (A) Optimal portfolio allocations to equity given different levels of home ownership and risk tolerance with mortgage loan financing levels allowed varying. Note that in all of the cases where optimal equity allocation is 0%, the bond allocation is also 0%. The entire portfolio in these situations consists of the family home. (B) Optimal levels of mortgage loan financing given different levels of home ownership and risk tolerance.

are comprised of the home and the offsetting mortgage loan, but no stocks or bonds whatsoever. For home to net worth ratios of less than 100%, the results shown by looking down the columns in Table 3 also contrast with the 100% financing results seen in Table 2. For A equals 5, for example, utility maximizing levels of equity increase rather than decrease as the weight of the home value relative to net worth increases. For the financial assets only scenario, the weight in equity is 46% compared to 100% for the case where the house value is 100% of net worth. For A equals 1 and 2, beginning with a house to net worth ratio of 25%, the utility maximizing portfolios are fully invested in equity and the level of mortgage loan financing increases as the level of home ownership increases. For the majority of these cases, the real estate investment is balanced with a high level of equity and little or no bonds.

The utility levels obtained in Table 3 where the mortgage loan financing is allowed to vary dominate the results shown in Table 2 where the financing level is fixed at 100%. When the financing level can vary, 100% financing is an option but it is not found to be utility maximizing.

The optimal portfolio weights for stocks and bonds when the home is considered differ substantially from the portfolio recommendations when the home is ignored. The differences are more pronounced for higher levels of risk aversion, given by A, and for higher house to net worth ratios. But while the recommendations are dramatically different, the differences in utility levels as measured by Eq. (1) are not as large. The optimal portfolio allocation typically increased overall utility levels for individual investors by 5% to 8% over the portfolio recommendations when the home was ignored.

6. Conclusions

We examine the impact of single-family homes and related mortgage loans on individual asset allocation decisions between the categories of stocks and bonds. For many investors, the home is still the dominant asset in their portfolios. We believe that increases in home values can be used by the investors at retirement and should be considered as an integral part of their investment portfolios. Advice traditionally given by investment professionals focuses just on financial assets with little or no recognition of the home in the portfolio. Failing to include the value of a home investment and mortgage loan can have a major impact on the optimal asset allocation strategy for a family. Ignoring the home completely or using a net real estate value are both unadvisable. In our example where the net real estate position was zero, failing to consider the home resulted in suboptimal portfolio decisions for both low-risk and high-risk individuals.

We find that for homeowners with heavily financed homes, leaving the home out of the portfolio analysis results in a considerable overweighting of stock. Furthermore, as the value of the home relative to investor net worth increases, the amount of stock that investors should hold in their portfolios decreases. This would have the biggest impact on younger investors where the home value as a percentage of net worth is likely to be the highest. Traditional investment advice that ignores the home value would suggest that an investor with a moderate level of risk aversion, A equals 3, hold 64% stocks and 36% bonds. If that same investor actually had a 100% financed home with a value equal to 100% of their net worth, the optimal allocation to stocks would only be 38%. If the home to net worth ratio was 200%, then the optimal allocation to stocks falls even further to 12%. These results also hold for investors who have the funds available to pay down their mortgage loans, but who choose not to do so. We believe that the higher optimal portfolio weights of bonds offset the effects of mortgage loan financing, which we consider to be negative bonds in our analysis.

Optimal portfolio holdings differ from traditional investment advice even more dramatically when investors can vary their stock, bond, and mortgage loan positions. For investors with home to net worth ratios of over 100%, some level of mortgage loan financing is a given, but they could finance more of their home value and use the extra funds to invest in stocks and bonds. We do not find this to be the case; most of these investors optimize their portfolios by holding no stocks or bonds and keeping all of their equity in real estate. With home to net worth ratios of less than 100%, investors maximize utility by having their houses completely paid for and by holding higher levels of stock than suggested by the traditional asset allocation view.

While we have looked specifically at the impact of home ownership on portfolio decisions relating to stocks and bonds, there are still many questions to be answered. Specific examinations on the effects of home ownership on investments in real estate investment trusts (REITs), Treasuries with inflation protection (TIPS), cash holdings, pension decisions, and various other assets are possible. On a broader note, Canner, Mankiw, and Weil (1997) posed "an asset allocation puzzle" asking why theoretical models differ from professional investment advice. One of the puzzles that they left unanswered was why popular advice suggests that younger investors should have portfolios more heavily weighted toward stocks than older investors when the mutual fund separation theorem argues that all investors should hold the same risky portfolio. Our findings suggest that individual investors with homes comprising a larger part of their overall portfolios, who tend to be younger, should invest less in stock, rather than more. As Canner et al. (1997) note, typical investment advice ignores factors such as home ownership, so that may be one cause of the discrepancy. But also our model does not consider the entire economic portfolio of the individual investor as discussed in Black, Ciccotello, and Skipper (2002). Including factors such as Social Security as done by Fraser, Jennings, and King (2000) and the present value of the individual's future earnings potential may change the results and lead to a more complete picture.

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