THE PENNSYLVANIA STATE UNIVERSITY
SCHREYER HONORS COLLEGE

DEPARTMENT OF FINANCE

MORTGAGE FINANCING AND THE PERSONAL PORTFOLIO

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SPRING 2014

A thesis
submitted in partial fulfillment
of the requirements
for a baccalaureate degree in Finance
with honors in Finance

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ABSTRACT

This thesis provides an in-depth study of portfolio optimization and the associated effects of a mortgage on one's portfolio allocations by incorporating the investment and financing structure of one's home. The average American has over half of their overall wealth in their home. When optimizing a personal portfolio for various levels of risk and return, it is necessary to include a mortgage into the portfolio by viewing the mortgage as a short position on the bond market. By incorporating a mortgage into an individual's allocation to stocks and bonds, one can accurately allocate their resources to account for all financial positions.

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ACKNOWLEDGEMENTS

I would like to thank Dr. Lou Gattis for guiding me through my thesis project and teaching me so much about Excel modeling and the real-world application of finance.

I would also like to thank the Schreyer Honors College and the Smeal College of Business for allowing me to study and prepare for my future career. The past four years at Penn State have been incredible and I am happy that they can culminate in the submission of this thesis project.

Finally, I would like to thank my parents, Bill and Carol Begley, for their unwavering support.

Chapter 1

Introduction

The personal portfolio, the combination of assets that make up an individual's wealth, is a finely tuned balancing act between risk and reward. An investment portfolio is historically comprised of stocks (equities) and bonds (fixed income). These assets are allocated to the portfolio based on historical trading data and forward-looking investment predictions. To predict trading patterns and future performance, analysts use historical trading data to calculate the volatility of returns, the average historical return, and each asset's observed covariance and correlation with the other assets under consideration for investment. These calculations are inputted into statistical models to calculate the appropriate allocations to each of the assets to achieve an estimated standard deviation of returns to satisfy the investor's risk tolerance. While this approach includes a variety of liquid assets, it fails to take into account the largest component of the average American's wealth, their home.

The average American can account for over half of his or her wealth in the value of their home[1]. Studies have shown that when included in the personal portfolio, a home can shift the efficient investment frontier outward[2], achieving a higher expected return with a lower expected standard deviation. This investment picture gives a more complete

[1] *Who Rules America: Wealth, Income, and Power*

[2] *The Single Family Home in the Invesment Portfolio*

measure of a person's wealth. By accounting for home value appreciation, an investor can accurately plan for financial turmoil and wealth fluctuations beyond the traditional liquid investment vehicles. Furthermore, the inclusion of mortgage financing in these calculations allows an investor to account for the leveraging effect of a mortgage on home returns and the reduction in housing returns as a function of mortgage payments. The assumption of mortgage debt also has other important implications that must be considered before investing.

A mortgage is a securitized debt agreement between a homeowner and their lender. In exchange for a large cash sum to purchase the home, a homeowner typically agrees to pay monthly debt servicing in the form of interest payments. In choosing a fixed rate mortgage, the borrower believes interest rates will rise in the future; otherwise they would borrow at an adjustable rate. Since interest rates and bond prices have an inverse relationship, the borrower has an implied short position on the bond market. Through inclusion of housing and mortgage positions as investment assets, investors will be able to accurately forecast the risks and rewards of all of their financial positions.

Chapter 2

Literature Review

The inclusion of the home as an investment has been a widely studied topic over the past thirty years to study the effect of the housing market boom on American households. The optimal portfolio is a combination of investment assets, stocks and bonds, which are plotted on a mean-variance graph; the graph shows the efficient frontier of portfolio allocations for any given risk level. There have been a number of papers published that have related to this topic.

Harry Markowitz first introduced the mean variance frontier, showing the distribution of associated risks with potential returns, in his paper, *Portfolio Selection* in 1952. Markowitz determined that a rational investor invests at levels that satisfy their risk tolerance to achieve the highest potential return. This distribution of returns, when plotted on a coordinate plane, will form a parabolic shape with the efficient investment frontier represented by the outermost points on the curve; this graph is the basis of modern portfolio theory. Markowitz states, "there is a rule which implies both that the investor should diversify and that he should maximize expected return. The rule states that the investor does (or should) diversify his funds among all those securities which give maximum expected return" (79). The Markowitz portfolio contained stocks and bonds as investment vehicles, others have begun to apply this theory to incorporate other assets, shifting the efficient frontier outward to achieve higher returns with lower marginal variance through asset diversification.

New facts in finance a research publication by John Cochrane outlines his findings pertaining to portfolio allocation metrics, most notably the irrelevance of the capital asset pricing model, CAPM, as well as the various metrics for efficient allocations. However, he establishes the new bedrocks of portfolio theory,

> "multifactor extensions of the CAPM dominate the description, performance, and explanation of average returns… [equity] returns are predictable. In particular: Variables including the dividend/price [d/p] ratio and term premium can predict substantial amounts of stock return variation… Bond returns are predictable… These predictions are not guarantees – there is still substantial risk – but the tendency is discernable…Volatility does change through time. Times of past volatility indicate future volatility" (37).

Cochrane's findings were critical findings because it revolutionized the thought process behind portfolio theory. Prior to the Fama-French model, and subsequent research, it was believed stock returns could be predicted through use of the Capital Asset Pricing Model, however now researchers believe multi-factor models are the best indicator of future returns. These new studies concluded that while "annual returns are only slightly predictable and month-to-month returns are still strikingly unpredictable, but returns at five-year horizons seem very predictable" (44). This finding is critical; based on this information, researchers are able to forecast long-term returns to calculate

expected returns from various portfolios over the lifetime of the investor. Therefore, it is believed to be possible to accurately estimate success over the long-term.

The Single Family Home in the Investment Portfolio by William Goetzmann explains the effects of a single-family home investment on a portfolio. His research found that the "annual standard deviation of an investment in a single family home decreases if the property is held for five years rather than one year… [he] found that diversification, even within a single urban market, reduces investor risk… a one-year investment in a broadly diversified portfolio is about half as risky as a one-year investment in a single family home (208-209). His research found that over the investment period dating from 1971 to 1985, the risk averse investor

> "Contained a significant proportion of wealth in a single home, although the home investment was not the predominant asset class" however "more significant is the fact that the home investment increases towards the risk-averse portion of the frontier… [and] the minimum risk portfolio, i.e., the portfolio preferred by the most risk averse type of investor, typically allocate[d] 50 percent to the home investment… This results not so much from the relatively low risk estimates for home investment, but from the low or negative correlation between residential real estate and other asset classes" (211).

This finding is critical because it shows that his research found a large allocation towards housing is a hedge against the financial markets over the 15-year period. Furthermore he states that "allocation studies based upon inputs derived from the entire

period from which we have reliable data, 1926-1989, would suggest that housing may command an even larger portion of the portfolio" (211). The findings from this paper go to show the importance of housing in the personal portfolio and the observed effect the investment has on an individual's wealth.

Portfolio Choice in the Presence of Housing by Joao Cocco from London Business School studies portfolio allocations including an investment in a single family home. The study found that "housing investment has important implications for asset accumulation and portfolio choice among stocks and treasury bills" (31). The study is relevant to my topic but, as the previous paper did, it focused on young and poor individuals to measure their allocation effects. My paper will focus on middle-income and upper middle-income individuals with the means to invest in financial assets to measure the effect of home financing.

Risks and Incentives in Underserved Mortgage Markets written by Dr. Brent Ambrose and William Goetzmann, researched poor families in Atlanta and the effect a house had on their portfolio allocations. The goal of their paper was to investigate the mortgage market in underserved markets and its effect on the community. The research found that investors in the Atlanta area "demand a substantial subsidy to increase the proportion of their housing investment... more direct subsidy programs, such as loss insurance, will be required to overcome the poor historic performance of housing investments in targeted areas" (284). These findings show that housing investment is primarily located in communities with substantial investable income due to the need for subsidy programs to stimulate housing investment in under-privileged areas. This

statement is supported by statistics from the Census Department's 1993 Survey of Asset Ownership, where it was found that

> "The lowest income quintile had a negative net worth while 25% had a net worth between $1 and $4999. Thus, approximately 50% of all low-income individuals in 1993 had a net worth below $5000… individuals with net wealth at these levels may have trouble finding affordable housing to purchase. For example, with 80% financing, the $10,000 wealth constraint and the optimal policy mix above would imply a capped housing investment of $12,500" (280).

This finding shows that additional leverage would be required for lower income housing, altering the outcome of the efficient frontier but changing the risk profile, increasing both expected risk and return.

Optimal Consumption and Portfolio Choices with Risky Housing and Borrowing Constraints is a study conducted by Rui Yao of Baruch College and Harold Zhang of the University of North Carolina at Chapel Hill. Their study "examine[d] the optimal dynamic portfolio decisions for investors who acquire housing services from either renting or owning a house" (197). Their study showed the tradeoff between owning and renting, finding that renters have "severe liquidity constraints and/or a high mortality rate. However, when the liquidity constraint is relaxed the investor chooses owning a house over renting to benefit from home ownership" (236). This paper conducted an interesting analysis regarding the optimal portfolio allocation while including the choice between renting and owning. The researchers found that home owners substitute "home equity for

risky stocks in his net worth, yet increase the equity proportion in his liquid financial portfolio to take advantage of the diversification benefit afforded by the low correlation between stock returns and housing returns" (236). This finding is very important for my thesis project because it shows an investor's portfolio allocation will change, shifting to risky stocks, to account for the diversification effect of incorporating a housing asset in an individual's portfolio.

Portfolio Choice in the Presence of Personal Illiquid Projects by Miguel Faig and Pauline Shum studied the portfolio preferences of individuals with a large portion of their wealth invested in 'illiquid' assets, such as a business or home. Their study was based on two principles, "financial assets can be used to provide diversification against bad outcomes of personal projects… [and] financial assets can be used to provide liquidity to personal projects when the timing of investment in these projects is important" (303), these principles served as the foundation of their research because "individuals are more risk averse in their portfolio choice when financial assets are used to fund projects that have a substantial penalty for discontinuing or under investing in the final stages" (304). Portfolio choice is a balance between risk and return, given the various investment opportunities in today's modern economy, it is important to weigh the potential outcomes of a number of investments before choosing a portfolio allocation. Housing, which is the focus of this paper, is an example of a large illiquid investment. The researchers state, "residential housing… generates both monetary and nonpecuniary returns… he would be unwise to put all of his funds in stocks. A downturn in the stock market may delay or frustrate his investment in a highly productive asset: the home" (306). Given these

statements, it is important to remember the illiquid nature of a home and the various implications such a large, illiquid, asset brings to an investment portfolio.

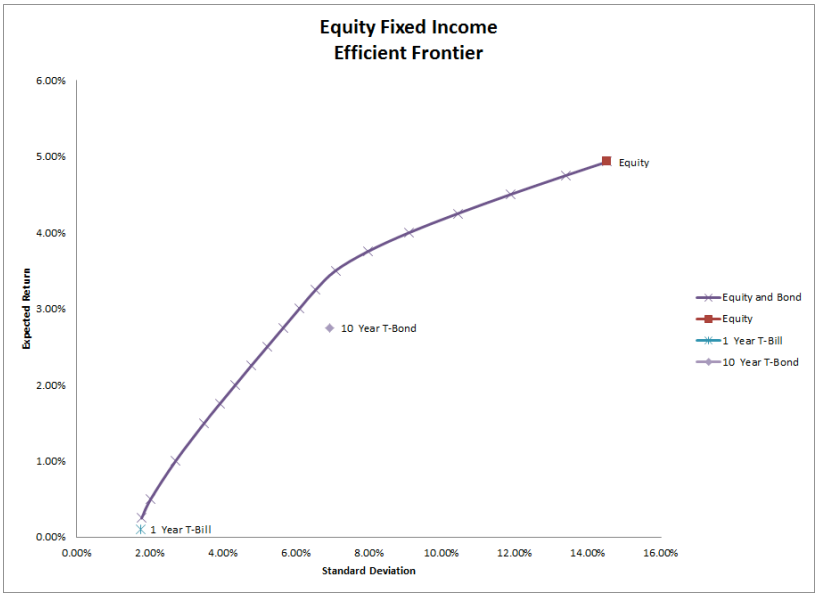
Chapter 3

Portfolio Optimization

Portfolio optimization is a process in which an investor determines the optimal investment allocations to satisfy a given criteria, typically minimizing risk and maximizing expected return, for his or her portfolio. Optimization is achieving a point on an investor's efficient investment frontier as outlined by Harry Markowitz in his 1952 paper, *Portfolio Selection*. This process begins by finding the historical volatility of returns, the standard deviation, the correlation and covariance of the assets, and estimated future returns. After finding these values, and constructing a correlation table and covariance matrix to study the assumed risks associated in pairing each asset with one another in an investment portfolio, an investor can optimize his or her investment by taking into account the volatility of their historical returns to construct a portfolio to meet an investor's goals. All assets are plotted on an x-y axis to determine the efficient frontier; the line on which all portfolio combinations that maximize the expected return or minimize the expected volatility of those returns lie. Portfolios that do not lie on this frontier, offer an equal expected return with greater estimated volatility than a portfolio on the frontier. Assuming all investors are rational and indifferent in regards to the allocation of their portfolio between all financial assets being considered, investing in a portfolio with an equal expected rate of return, but with a higher implied volatility is not a viable option. Thus, a rational investor will only allocate his or her resources to form a portfolio that lies on the efficient frontier.

Portfolio optimization requires historical capital markets data to accurately predict the various risk and return metrics used by financial analysts. By using the historical trading volatility of the S&P500 to simulate the historic risk premium and volatility of the equity market along with the historic volatility of returns and the current rates on the 1-Year US Treasury Bill and the 10-Year US Treasury Bond. Covariance and correlation matrices were built to measure the variability of returns of each asset with another. The portfolios were optimized to minimize the standard deviation with a given expected return to construct a portfolio envelope, which displays a range of expected returns and volatility estimates to satisfy the risk levels of any investor considering any combination of this basket of financial assets.

The equity risk premium is the return of the equity market minus the risk-free rate, the interest rate on the 10-year US Treasury bond. The equity risk premium is the preferred measure of equity market return because it is the difference between the 'risky' (market) return and the 'risk-free' return of the 10-year Treasury, showing the volatility of attaining the extra return of the market over that of the 'risk-less' return of the 10-year. An investor only assumes the equity risk premium because an investor can achieve the 10-year return without any risk because it is a "risk-free" asset. Therefore, the return premium on the market above the risk-free rate is the return achieved for assuming the observed market volatility. The Treasury returns and their volatilities were calculated using the historic standard deviation of returns for each maturity.



The portfolio with three investment options: 1-year T-bill, 10-year T-bond, and the S&P500, limits the investor to the traditional investment vehicles: equities and US Treasury bonds with varying maturities. With these options, an investor has limited investment exposure, hurting their diversification potential and lowering the probability of achieving their expected return on their investments. This portfolio achieves a maximum Sharpe ratio, the point at which the portfolio reaches its highest risk adjusted return, with a portfolio 100 percent invested in the equity market. Given the current low-rate environment, this is a predictable outcome, but puts an investor at risk of greater losses due to the volatility of the equity market.

Chapter 4

Data Analysis and the Home as an Investment

A home is typically the largest source of wealth for the typical American. Interestingly, the home is not only a large portion of an individual's balance sheet, but it is typically one of its highest leveraged assets; making it one of the riskiest components of an individual's financial plan. A typical down payment on a home is between, ten to thirty percent of the home's value. Therefore, assuming a home is purchased for 500,000 dollars the home would be financed with 350,000 to 450,000 dollars in debt. The leveraged position in a home magnifies the equity return on the home at the time of sale and, assuming the positive historic rates of return measured by the S&P/Case-Shiller Index, investing in a home is an attractive financial position.

The S&P/Case-Shiller housing index is a housing index that measures the appreciation of homes in the United States across a diverse list of metropolitan areas in the United States. The index uses the repeat sales method to calculate price changes. The repeat sales method "uses data on properties that have sold at least twice, in order to capture the true appreciated value of each specific sales unit."[3] The index is the benchmark for tracking the health of the domestic housing market through measuring the demand for existing homes.

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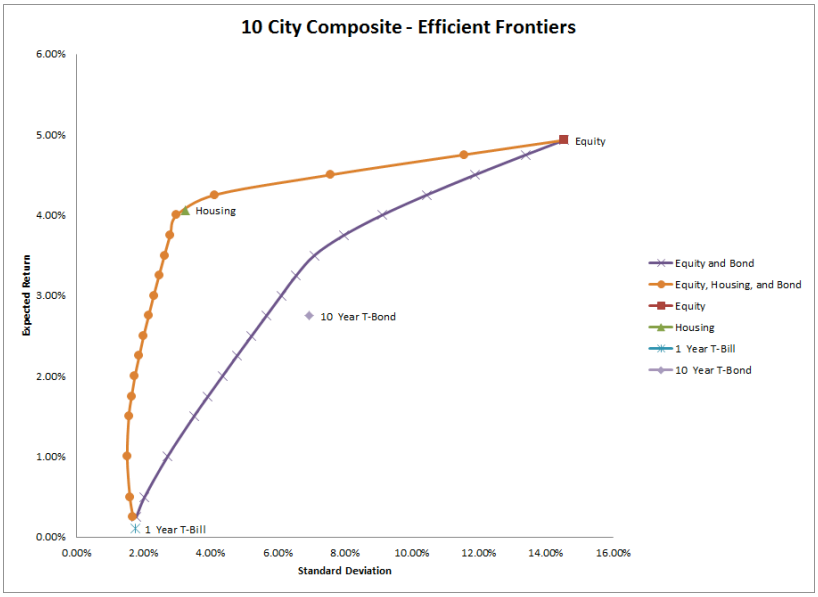
[3] *S&P/Case-Shiller Home Price Indices Methodology*

Inclusion of the home as an investment in a financial portfolio will enable an individual to account for a significant part of their financial capital and accurately forecast their financial health. By using the S&P/Case-Shiller Index as the benchmark for home price appreciation, four portfolios were constructed to show the various portfolio envelopes. The portfolios included investment in homes in San Francisco, Dallas, and Chicago while the fourth portfolio assumed the 10-City Composite index to measure a broader return of homes across ten geographic regions. The individual cities were chosen for their varied historic returns and standard deviations to give the portfolios a range of outcomes for historically high, medium, and low return areas. Each of the four portfolios, after including the home as an investment, shifted the efficient investment frontier outward, resulting in lower expected volatility with higher estimated returns.

The first of these portfolios was constructed using the 10-City Composite Index. This index includes the Boston, Chicago, Denver, Las Vegas, Los Angeles, Miami, New York City, San Diego, San Francisco, and Washington DC[4]. Therefore, this index covers a wide swath of the country, including some of the most populated areas of the United States, giving a broad view of the overall health of the housing markets. By including the 10-City Composite into an investment portfolio, as a percentage weight of an individual's overall portfolio, the portfolio sees a dramatic shift outward. This shift results in a drastically reduced standard deviation estimate for the portfolio while achieving an equal return on the portfolio as simulated in previous tests without the housing component.

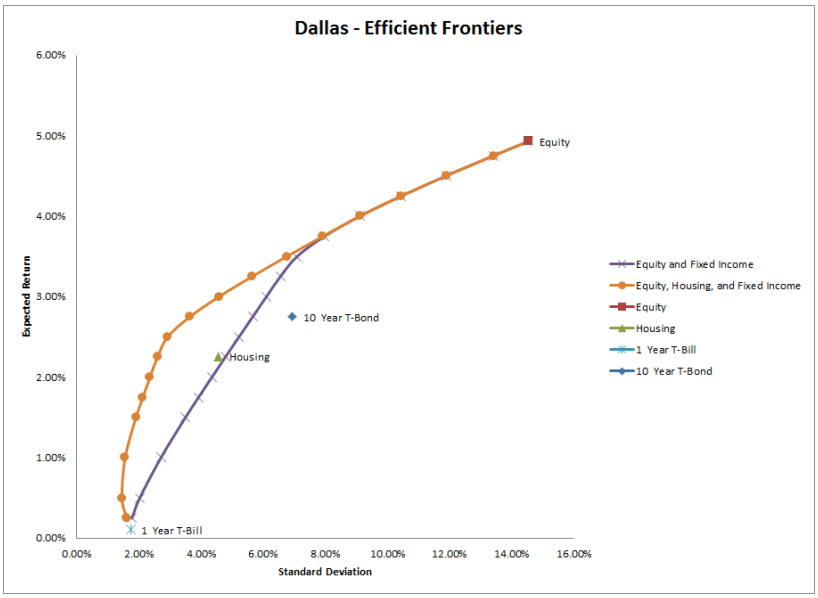
[4] *S&P/Case-Shiller Home Price Indices Methodology*

This simulation shows the diversification effect housing plays in an investor's portfolio, lowering volatility while maintaining a high rate of expected return. This positive investment effect has significant implications for investors. Most notably, an investor has the ability to invest in "risk-free" assets, i.e. 1-year and 10-year Treasuries, and still maintain a high rate of return over the long-term



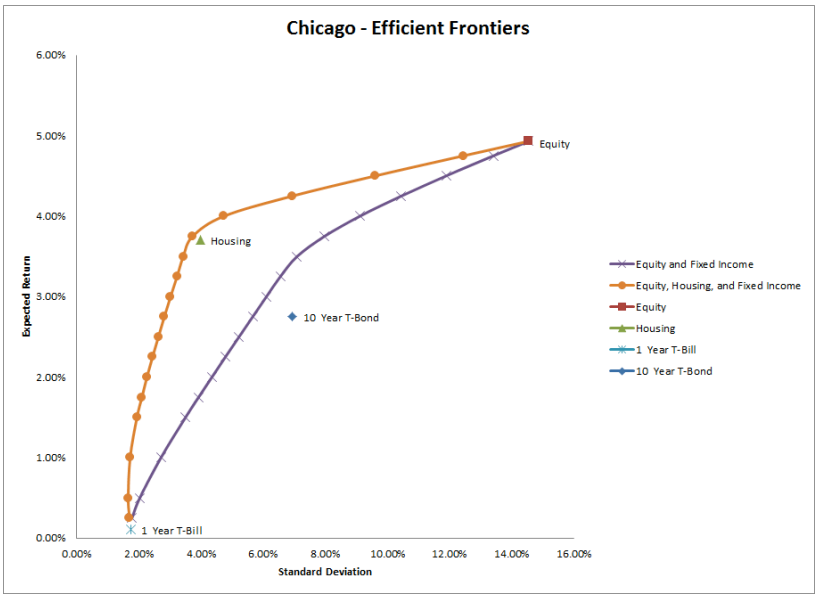
The Sharpe maximizing portfolio is found in the inflexion point of the efficient frontier. This portfolio is predominately invested in housing but with allocations in other assets. The portfolio had a higher Sharpe ratio than the Sharpe maximizing allocations of the portfolio excluding the home as an investment. The portfolio had a standard deviation of roughly 3 percent, verses an estimated 15 percent volatility in the Sharpe maximizing 100 percent equity invested portfolio. The portfolio is better positioned for steady returns given historical trading data.

The Case-Shiller housing data for the Dallas metropolitan area shows a housing market with a reduced diversification effect than the other cities monitored by the Case-Shiller Index. The Dallas market gave the study an example of a low historical return area to measure the effectiveness of housing in a portfolio, even in a historically stagnant market. As the data suggests, investment in Dallas housing resulted in reduced volatility to the point at which housing returns became too low and volatile to justify investment. An investor would see a benefit from investing in a home at the low end of the expected return range given the historical returns of the investment assets being considered. Given the historically low annual returns for Dallas housing, investment in this market is not as attractive as other housing markets around the country.



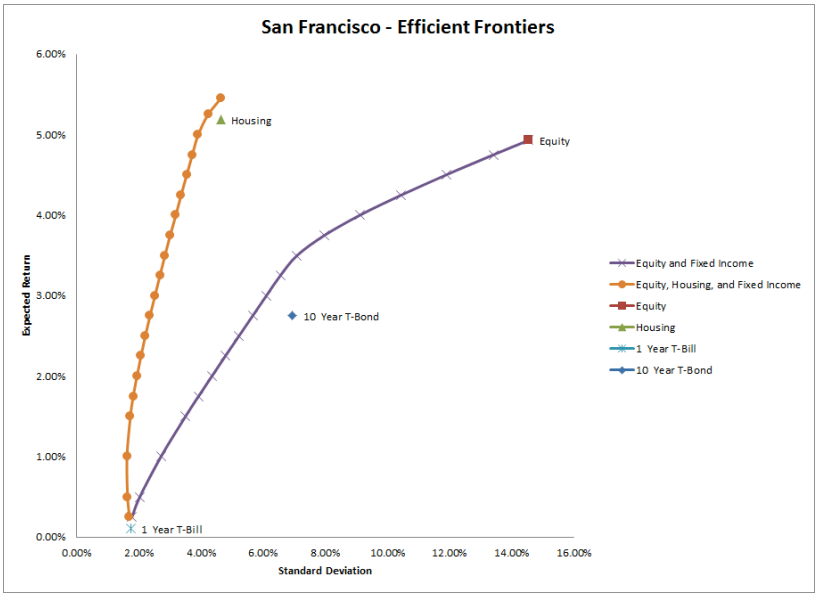
The Chicago market achieved median year-over-year returns compared to the other cities tracked in the index. This market shows a large diversification effect with the

other assets in the portfolio, resulting in a significant reduction in estimated portfolio volatility. Investment in the Chicago market returned the investor a significantly greater amount of capital than the equity and US treasury portfolio counterpart.



San Francisco is the second best performing housing market, on an annualized basis, in the Case-Shiller housing index. The San Francisco data suggests an investment in the San Francisco housing market will drastically increase returns, while lowing the portfolio's annualized volatility level. The annualized returns and standard deviations of the San Francisco housing market were so favorable to an investment portfolio that the resulting portfolios were drastically more stable and exhibit a very favorable efficient investment frontier than all of the portfolios including the other markets in the study. The

portfolio that maximized the portfolio's Sharpe Ratio the four assets consisted of a 100 percent investment in housing.



By including a home in an individual's investment portfolio, a person's investment frontier shifts outward, reducing volatility for any given expected return. Investment returns vary depending on the housing market, as any financial asset's return is dependent upon its underlying characteristics. An investment in a home should be viewed as portfolio diversification, given its low correlation to equities or treasuries, and it can offer a substantial return with low annualized risk.

Chapter 5

Home Mortgage Implications

The average American home is financed through the use of a mortgage, debt secured by real property. Assuming a fixed-rate mortgage, the monthly amortization payments are fixed amounts throughout the life of the mortgage. The amortization payments are comprised primarily of interest payments at the beginning of the amortization schedule, with principle payments becoming the primary component of the payments towards the latter end of the debt agreement. Today, many homeowners prefer a fixed-rate mortgage because the payment schedule does not change for the life of the loan, meaning one can forecast monthly payments without the risk of rising interest rates, which would affect a homeowner with an adjustable rate mortgage. Choosing a fixed rate mortgage implies the homeowner believes rates will increase over the life of the loan. Conversely, if they believed rates will fall they would have an adjustable rate mortgage to capture the impact of falling rates. This interest rate outlook has implications that should be represented throughout an individual's financial portfolio.

In a rising interest rate environment, bond prices fall, because newly issued bonds have higher rates of returns, making bonds at the old, lower, rates less valuable to the market. This outcome is reversed in a falling rate environment, where bond prices rise, hence the bond market observed since the financial crisis. Therefore, a homeowner with a fixed rate mortgage has a 'short' position on the bond market. This large position should be accounted for throughout the rest of an individual's portfolio to capture or hedge

against this position. This exercise also accounts for a short position that, in most cases, is greater than the entire value of an individual's investment portfolio.

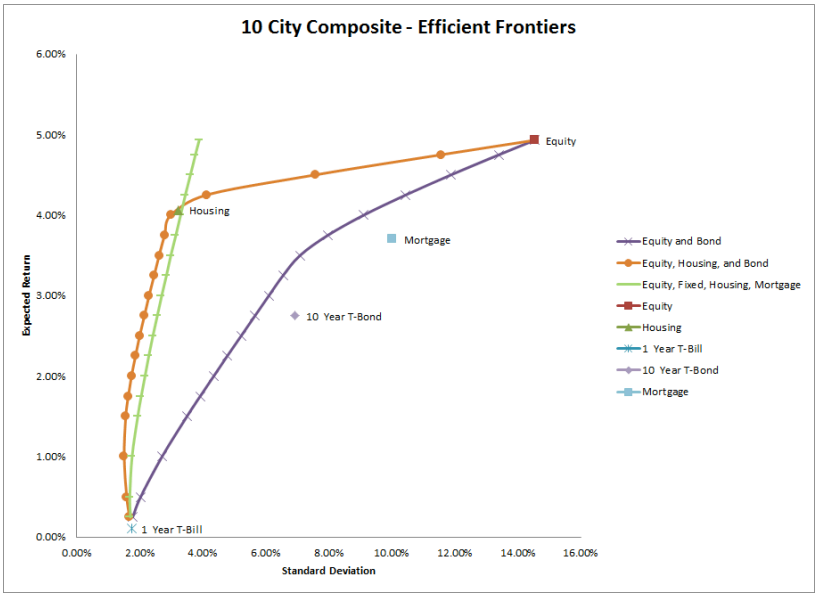
With this in mind, including the relative size of the mortgage in financial planning allocation is a critical piece of the puzzle to fully capture and hedge against supposed risks in the market. By using the 30-year US Treasury Bond as a proxy for the standard deviation in mortgage rates, assuming a 30-year mortgage is simply the thirty-year interest rate plus an investor premium, this proxy gives an accurate historic volatility of rates.

In the subsequent tests, the inclusion of mortgages in the portfolio had a two-fold effect on returns. First, the mortgage was only triggered when there was a positive weight in the home, at which time, the mortgage was assigned a negative weight of 80 percent of the investment in housing. An assumption of 80 percent financing for a housing investment had a secondary effect, leveraging returns and volatility on the housing investment. Given 80 percent leverage, housing returns and the volatility of returns for each market were subsequently levered 5x. The effect of leverage on the investment portfolio was significant, drastically increasing returns and the volatility of those returns. The mortgage reduced the returns on the portfolio as a negative weight, by the amount of 3.70 percent, the 30-year Treasury bond rate. A premium was not included in the calculation to account for the tax benefits of mortgage financing, thus assuming the premium over the 30-year treasury would amount to a net tax deduction.

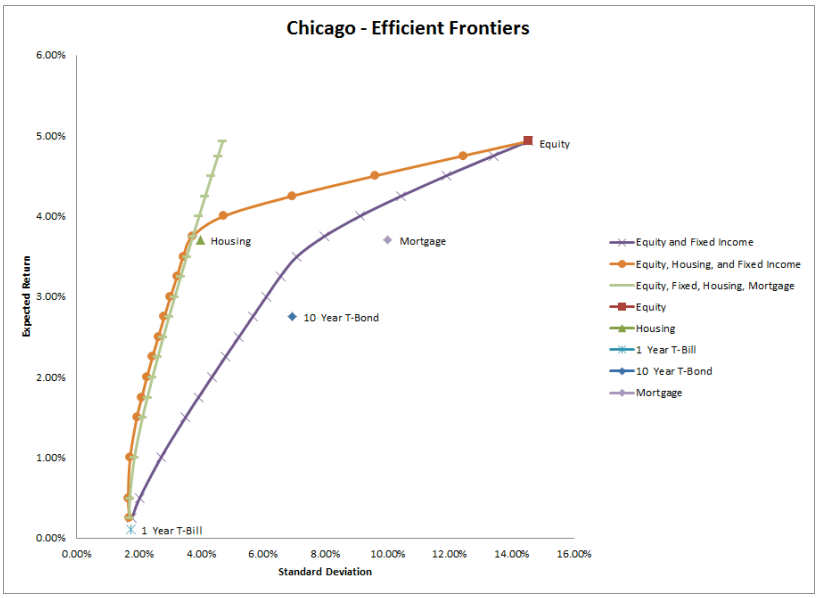
The inclusion of a mortgage in an investment portfolio had varying effects on the portfolio. First, the mortgage decreased portfolio returns for Chicago, Dallas, San Francisco, and the Composite index until the efficient frontier's inflexion point; at which

point, the mortgaged portfolio's efficient frontier surpassed and exceeded that of the unleveraged portfolio, achieving higher expected returns with lower volatility than its unleveraged peer portfolios. Second, tests showed that an investor with a leveraged mortgage position should invest heavily in US Treasuries to reduce the portfolio's standard deviation and rely on the appreciation of the home to achieve maximized returns.

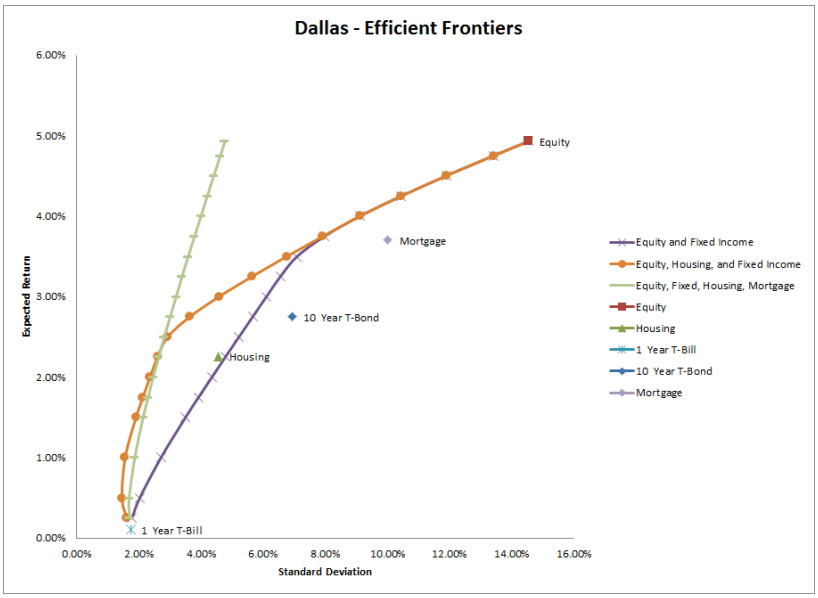
In the 10-City Composite index, the mortgage reduced returns on the portfolio until reaching the inflexion point of the efficient frontier that excluded the mortgage. Therefore, the returns expected by an investor are the result of the leveraged returns from the mortgage. Interestingly, the portfolio with the optimized Sharpe coefficient increased from 0.43 to 0.91 after introducing a mortgage to the 10-City Composite portfolio. Thus, if possible, a home in the 10-City composite market could use leverage to maximize portfolio returns given historical data.



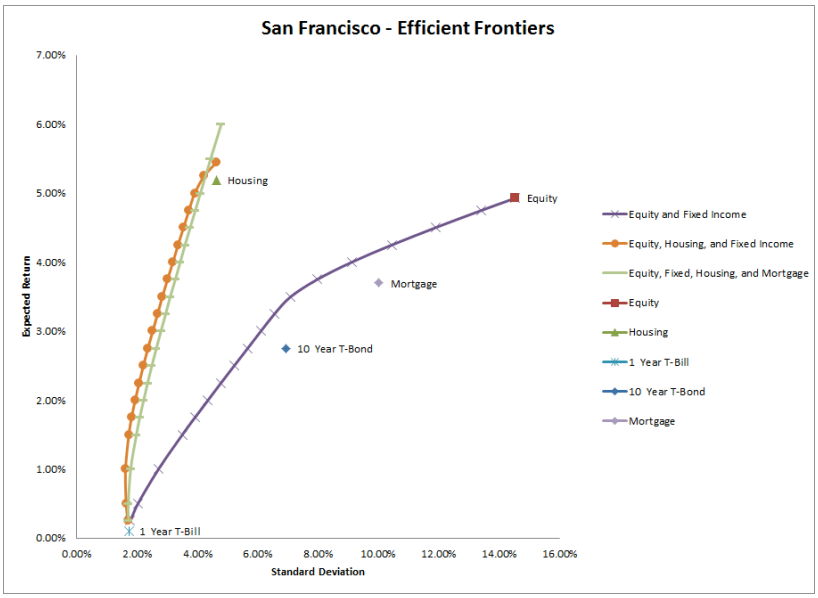
An investment in the Chicago market performed would be maximized with leverage. After adding a mortgage, the Sharpe optimizing portfolio in the Chicago market increased from 0.28 to 0.68 with the inclusion of leverage.



In the Dallas market, tests show the return on a portfolio that lies on the efficient frontier dramatically increases with a low relative increase in risk. The leveraging effect of the mortgage in a low return environment allows a homebuyer in these markets to expect a return greater than inflation, giving it a positive investment outlook. Prior to the addition of leverage to the portfolio, the Dallas market offered investors substantially lower returns with higher volatility than the other markets in its peer group. However by introducing leverage, the market could be believed to support investment with an attractive expected return relative to its peers. The Dallas market exhibited increased returns in the range past the efficient frontier's inflexion point, and the maximized Sharpe portfolio more than doubled its ratio from 0.15 to 0.35.



The San Francisco market is the second best performing housing market included in the S&P/Case-Shiller Index. Due to its relatively high historic returns, the mortgage component of the portfolio failed to expand the investment frontier under the given expected returns, showing that in markets with high annual price appreciation, outright ownership satisfies a mean-variance tradeoff that is reduced when financed with a mortgage. The Sharpe maximizing portfolio with a mortgage included had a higher Sharpe coefficient, 0.96, versus the Sharpe coefficient 0.59 with a portfolio primarily consisting of a house with no mortgage financing.



The investment returns, which exceeded the unlevered portfolios, are the result of leveraged returns derived from the mortgage. Results show the effect of mortgage financing is dependent on the historical returns on the housing in the area and, given the historical returns and interest rates on the mortgage, financing has varied benefits. In areas with high historical returns, financing introduces additional risk and liabilities while increasing returns through leverage. While these returns can be significant, losses are also subject to the same multiplier. Thus, the mortgage increases portfolio risk and equitably maximizes returns and losses. The optimized portfolios used the leveraged returns from housing, coupled with the risk-free treasuries, to maximize return while minimizing volatility.

Chapter 6

Conclusion

Buying a home is one of the most significant financial decisions an individual will make in their lifetime. The value of one's home is a substantial part of their total wealth, making the risks and rewards a major component of an individual's financial plan. Through inclusion of housing investments, an investor can control their estimated volatility levels for all of their financial positions. Historically, individuals include equity and fixed income assets in their financial plans, but this does not reflect the home and its importance as a financial nest egg. According to the S&P/Case-Shiller Housing Index, housing across the country appreciates, on an annualized basis, anywhere from 2 to 6 percent. This return is greater than that of equity risk premium and fixed income over the long term, while having a standard deviation of returns less than equities and slightly higher than US Treasuries.

The analysis used three US housing markets: San Francisco, Chicago, and Dallas along with the broader 10-City Composite Index, to simulate housing returns across geographic and historically strong, moderate, and weak housing markets in terms of annualized price appreciation. These markets were chosen because they cover a range of historical returns, giving the analysis a wider range of conclusions based on an investor's location. The analysis confirmed findings that housing increases the efficient investment frontier, shifting the investment curve outward, forecasting higher expected returns with lower estimated volatility. This outcome was seen across all of the markets and the

composite index included in the study to varying degrees depending on the annualized returns and volatilities in the respective markets. The magnitude of the shift was greatest in the San Francisco region, the region with the highest annualized return in the peer group.

By adding the mortgage component, and accounting for the associated leverage introduced by this type of debt, the results changed. The resulting portfolio combinations had increased returns with marginal changes in standard deviation, thus leverage had little affect on the portfolios due to a higher allocation invested in US Treasuries, but yielded elevated returns. Ultimately, this study shows the benefit of financing a home with a mortgage, resulting in a higher expected return with lower volatility than a portfolio without leverage, by increasing one's allocation to the low volatility of US Treasury bonds.

In conclusion, it is clear mortgage financing is a critical component in financial planning and has a substantial impact on the underlying value of one's personal portfolio. Mortgage financing leverages the equity returns on one's home and, through asset diversification in an investment portfolio, the negative servicing components of a mortgage can be combated by investing in fixed income securities with the remaining allocation being placed in the equity markets. The effects of leverage on returns are strong in historically low return areas, with relatively reduced results in areas with high historical performance. Leverage multiplies losses at the same rate as it multiplies gains. Therefore, given the environment in which you are investing in a house is critical in determining your financing strategy. The results outlined in this paper, along with the

tax benefits of mortgages including the mortgage interest tax deduction, show to mortgage debt is a logical way to finance the purchase of a home.

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Academic Vita

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Education

The Pennsylvania State University — University Park, PA
Schreyer Honors College — Class of May 2014
Smeal College of Business — Bachelor of Science in Finance

Relevant Experience

Goldman Sachs Group, Inc. (NYSE: GS) — New York City, NY
Investment Banking Summer Analyst — June 2013-August 2013

- Facilitated Liberty Property Trust's (NYSE: LRY) $1.5 billion acquisition of the Cabot Industrial Value Fund III consisting of 177 industrial real estate properties, totaling 23 million square feet
- Built three statement M&A model to support advisory efforts for a buy-side transaction
- Conducted property level due diligence on international and domestic real estate properties for proposed transactions
- Developed the road show presentation and supporting documentation for an initial public offering

PNC Financial Services Group, Inc. (NYSE: PNC) — Washington D.C.
Intern, Corporate & Institutional Banking Development Program — June 2012-August 2012

- Supported PNC bankers in servicing the financial needs of corporate clients in the Metro Washington DC, Northern Virginia, and Maryland markets with annual revenues ranging from $10MM to $50MM
- Prepared client due-diligence materials and participated in client meetings and conference calls
- Researched and authored reports covering government regulation changes to assist healthcare and government contractor clients
- Identified and targeted an additional 594 portfolio prospects while maintaining and updating a 40 company client list

Penn State Institute for Real Estate Studies — University Park, PA
Real Estate and Capital Markets Research Lab Analyst — Fall 2013

- Calculated the correlation of all publically traded REITs to market data including changes in the yield curve
- Authored a report with detailed findings to the Penn State Real Estate Alumni Advisory Board
- Utilized numerous software packages to analyze data sets including SAS and Microsoft Excel

Penn State Nittany Lion Fund, LLC. — University Park, PA
Fund Manager, Energy Sector Analyst — 2010-2011

- Member of the 30 person staff responsible for equity portfolio investment & management of a $4,300,000 mutual fund
- Research, analyze and set investment strategy for energy equity positions through qualitative and quantitative analysis using Excel, Bloomberg and FactSet
- Author of weekly, monthly, quarterly, and annual performance & activity reports for senior management and investors
- Conducted educational seminars on accounting, discounted cash flow models, equity valuation, and current economic trends

Leadership

Penn State Presidential Leadership Academy — University Park, PA
Member — 2011-present

- Selected by Penn State University to become a member of the Presidential Leadership Academy Class of 2014
- Enroll in courses taught by President Rodney Erickson, President of Penn State University and Dean Christian Brady, Dean of the Schreyer Honors College to develop leadership fundamentals and an ethical foundation through exploration of diverse viewpoints, participation in unique experiences, & discussions

Beta Theta Pi Fraternity Alpha Upsilon Chapter — University Park, PA
Executive Vice President — 2013

- Preside as the chairman of the Beta Theta Pi judicial board to hear and levy sanctions in accordance with chapter bylaws
- Maintain and monitor chapter academic standards

Recruitment Chair — 2012

- Organized and coordinated Fall & Spring fraternity rush activities
- Navigated a recruitment network of 1,156 students to create a 123 student recruitment target group