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Optimal investment strategies using multi-property commercial real estate analysis of pre/post housing bubble

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OPTIMAL INVESTMENT STRATEGIES USING MULTI-PROPERTY COMMERCIAL REAL ESTATE: ANALYSIS OF PRE/POST HOUSING BUBBLE

by

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ABSTRACT

This paper analyzes theperformance of five commercial real estate property types (office, retail, industrial, apartment, and hotel) between 2000 and 2012 to determine the U.S. housing crisis'simpact on Real Estate investing. Under the concept of Modern Portfolio Theory, the data was analyzed using investment analysis programs to determine correlation, risk/return characteristics, and trade-offs (Sharpe ratio) as well as the optimal allocation among the individual property types. In light of the results, each property type plays a different role in investment strategies in various economic cycles. Some assets are attractive solely based onpotential return, or risk for return tradeoffs; however, through diversification, other property types play valuable roles in hedging risk on investors' target returns.

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INTRODUCTION

In portfolio optimization, investors seek an allocation of assets providing the lowest risk for return. As such, there are a variety of assets to choose from including stocks, bonds, to even real estate. Then within Real Estate, investors must decide which specific property types to mix in their investment portfolio. Modern Portfolio Theory states that investors analyze assets' expected return, standard deviation, and correlation characteristics. This allows for investors to explore diversification strategies between the assets, thereby determining what mix of assets will achieve a specific target return at minimized risk. Asset mixtures vary during various economic cycles, and many times it's not necessarily a question of what to invest in, but what not to invest in. As such, investors are continuously adapting to changing economic conditions and continue to attempt to capitalize on market opportunities.

MODERN PORTFOLIO THEORY

Modern Portfolio Theory; shortly put, is the financial theory involving rational, risk adverse investors allocating assets within a portfolio to achieve the optimal asset combination. First introduced by Markowitz and Sharpe (1952) it was conceptualized that through diversification within a portfolio, an investor could achieve higher levels of return through certain asset combinations. According to Lee and Stevenson (2005), each asset's performance capability is gauged by risk and return characteristics. These are measured by its mean and standard deviation (variation), and its portfolio risk compares its correlation with alternative assets. By applying these parameters, an investor will find the optimal combination of assets offering the lowest level of risk for any target level of expected return or alternatively determining the highest return for a certain level of risk, which is the process known as mean-variance analysis (Cheng, Lin, Liu and Zhang, 2011). Postulated as an investment theory encompassing different asset types, it applies to investments running from stocks, bonds, to real estate.

Assets that are part of a MPT constructed portfolio can achieve higher returns for lower risk than if considered individually. This is explained by the levels of correlation between the different asset types. According to Cheng, Lin, Liu and Zhang, (2011) when the different individual asset types are paired in a MPT constructed portfolio, this lowers their degrees of correlation, and enlarges the likelihood of higher returns. If two asset types are completely independent of one another, meaning none of the same variables affect them both, the correlation would equal zero. As long as the assets are not perfectly correlated, an investor can benefit from diversification.

Unsystematic risk is a risk arising from a factor unrelated to the market or the system (Penny, 1982). This risk applies to a specific industry or firm; thus, it can be eradicated using portfolio diversification. If it was considered systematic risk, also known as market risk, then regardless of any combination of assets, this risk will still exist. It affects the entire market, including all the industries within it, which in turn means that the goal of diversification is to allocate enough assets so that only systematic risk remains within the portfolio. According to Black (2004), by combining 30 stocks in a portfolio, the variance of the stock is diminished and almost all unsystematic risk (diversifiable risk) is eliminated. Consequently, diversification is an effective hedge against risk, and is beneficial when applied to MPT.

However effective, MPT contains limitations in its application to Real Estate. First, MPT predicts normal distributed investment returns, which have been proven unrealistic in real estate. More so, it has been deemed more effective to describe the results based on a stable infinite variance skewed distribution, rather than a normal distribution (Sivitandies, 1998). Second, with large numbers of investors, results have been inconsistent with MPT's assumption of controlled focus groups. Even with those limitations, MPT is still an effective tool in determining optimal allocation strategies in real estate, and is continually utilized by investors.

STOCKS VS REAL ESTATE

In real estate there are two types of investments, REITs, which are publicly traded real estate securities, and private real estate, which are actual tangible properties. Between the two, however, private real estate has been deemed more beneficial in terms of portfolio diversification. This is explained by the correlation between the assets. The more directly an asset is affected by a change in another, either positive or negative, the higher the correlation between the two. According to Black (2004), when comparing the NAREIT Index and the Russell 2000 Index (a small capitalization index) there was a high positive correlation of (.722). However, when computing correlation between the NCREIF (a private real estate index based on appraisal values and transactions) and the S&P 500, there was conversely a low correlation of (.0523) (Black, 2004). The lower correlation between private real estate and the stock index indicates that private real estate and stocks are mixed in an investment portfolio, investors benefit from diversification.

When considering the optimal real estate allocation, the time frame plays a key factor. In the long-term, research has shown that private real estate is considered a more worthwhile investment. Fugazza, Guidolin and Nicodanna (2007), concluded that for a one-year time frame the optimal real estate allocation was 9%; however, a ten-year time frame had an optimal real estate allocation of 44%. Thus, over time real estate becomes increasingly attractive. This is explained by the positive relationship real estate has with the investment horizon. Real estate is deemed an illiquid asset in comparison to stocks and bonds. Hence, it is arguable that the longer you plan on holding onto direct real estate, the larger its profit potential.

There are a variety of factors separating private real estate from securities, with one main difference being efficiency. The stock market is considered efficient, investors have access to individual stock prices through indexes such as the S&P 500. Within the stock market, prices and market value are generally in equilibrium. Information on the market is widely available, so either through buying or selling securities, investors bring the security price to equilibrium almost immediately. Stocks are easily applied to MPT as the investment allocation system assumes market efficiency, which the stock market experiences. Real estate property returns however are more difficult to gauge. Unlike the stock market, real estate investors must consider factors such as financial and operating leverage, location, leasing terms, and tenant mixtures to measure unsystematic (diversifiable) risk in the real estate market. (Viezer 2000)

The private real estate market, by its very nature, is inefficient. Lin and Vandell (2007) note that private real estate is considered a heterogeneous asset, and is plagued by market uncertainty. Perhaps the most efficient gauge of private real estate values is the NCRIEF database (private real estate index based on appraisal data and transaction costs), which researchers have relied heavily on for information in the real estate markets. NCREIF only releases quarterly returns, as opposed to the S&P 500 reporting daily returns. Only every quarter can the real estate market essentially "fix itself" and put prices in equilibrium; therefore, it's lagged in comparison to the stock market. Penny (1982) suggests that the general uniqueness of properties, lower transactions, and real estate market differences also contributes to the difficulty of pricing in the private real estate market.

PROPEPRTY TYPE COMPARISONS

Once a portfolio manager decides the optimal allocation of real estate to a mixed asset portfolio, they then must decide how to diversify between the different property types and geographical locations. Between the two, however, Petersen and Singh (2003), concluded that property type diversification gives higher risk-adjusted returns as compared to geographical diversification. Risk-adjusted returns are based on a reduction of nonsystematic risk. Overall, there are five types of commercial property types generally recognized in the academic literature: hotel, apartment, retail, industrial and office. Using MPT, investors construct the efficient frontier to determine how much to distribute to each. Stephen and Simon (2005), Mueller and Laposa (1995) suggest that returns for each, however, vary depending on different time periods experiencing different economic cycles.

Mueller and Laposa, (1995) state that NCREIF returns data can be segmented into different periods based on three indicators: GDP growth, total returns, and capital appreciation. By separating the sub-periods, investors are able to construct time-period specific efficient frontiers. Thus, investors determine the optimal allocation for each period, and portfolio weights to different property types may vary. Those weights are determined by standard deviation, expected return, and correlation. Once all three are determined, investors can plot the efficient frontier (Petersen & Singh, 2003).

Petersen and Singh (2003) calculated risk, return, and adjusted-risk returns for each of the five property types over a 20-year period, 1982-2001. During that period, apartments were the most attractive investment with annualized returns of 10.15 percent. Apartments were followed

by industrial, retail, hotel, and office, implying office properties held the lowest returns, and were thus least profitable. When considering volatility, hotels and office properties recorded the highest standard deviations, suggesting they were the riskiest in terms of total risk. Conversely, industrial, retail and apartment had lower standard deviations, concluding apartments were associated with the least risk of the group. Lastly, apartments ranked the highest in terms of the Sharpe ratio. The Sharpe ratio is essentially a measure of the unit of return you receive for every unit of risk. Office properties, contrarily calculated a negative ratio. Hotels, retail, and industrial each had relatively low, yet positive Sharpe ratios.

By developing a cross correlation matrix, Petersen and Singh (2003) also show the level of correlation between the property types between 1982 and 2001. Hotel and retail had the lowest correlation, meaning in terms of strict diversification, they were the most attractive combination. Office and industrial properties, however, had the highest correlation, suggesting there were no (or very little) diversification benefits between the two. Excluding hotels, the correlations between the retail, office, industrial, and apartment sectors were all relatively high. These correlations ranged from the lowest, between retail and apartment (0.61%) to the highest correlation, between industrial and office 96 percent. Thus, from a diversification perspective, hotels offer the most potential benefit between any one of the other property types, considering none of hotel's correlations with any of the other property types rose over 50 percent. This information allows an investor to construct the efficient frontier.

Petersen and Singh (2003) also show that between the years of 1982 and 2001, the maximum risk-return portfolio had 100% weight on apartments, with a return of 4.95% and a

risk of 2.50%. At the minimum variance, the optimal portfolio consisted of 41% apartments, 44% retail, and 15% in hotels. That minimum risk point on the efficient frontier boasted a 4.47% return accompanied by 2.25% of risk. Risk-adverse investors would suggestively benefit by diversifying the portfolio beyond apartments, with hotels and retail. Less risk-adverse investors would benefit from their portfolios consisting of mostly apartments and only a small percentage in hotels and retail. Also, at no point on the efficient frontier did industrial and office properties appear in the optimal allocation.

Contrary to Petersen and Singh (2003), Stephen and Simon (2005), analyzed returns between four property types: retail, R&D, office, and warehouses between 1978 and 1988, they determined that office properties were among the most profitable. These profitable office returns contrast starkly with office returns between 1982 and 2001, as office properties were not weighted in the efficient frontier. This exemplifies that no time invariant optimal portfolio allocation strategy exists. Investors must adjust their allocation strategies during different economic cycles. The U.S. housing bubble of 2006 is a prime example of this as detailed below.

Housing Bubble

During the early 2000's the U.S. housing market experienced rapid increases in home pricing up until late 2005/early 2006, when home prices peaked and then essentially freefell downward, thus creating a housing crisis. This process is known as the bursting of a housing bubble. A housing bubble is theoretically described as a deviation of private real estate growth from its normal rudiments (Lai & Van Order, 2010). Bubbles are caused by a variety of factors, ranging from low interest rates, deregulation, easily accessible credit (subprime loans), and

speculative home purchases by investors (Muller, Almy&Engelschalk, 2010). These factors and overall market optimism drove U.S. home prices to unsustainable heights in 2005. At that point the market essentially corrected itself, and the bubble burst, lowering home prices to appropriate levels. The market was lagged in its realization however, as it wasn't until the increases in defaults and foreclosure rates during 2005 and 2006 that eventually led to the sub-prime market collapse in 2007. It wasn't until after the sub-prime market crash that property values plummeted downward, and it has unfortunately been considered as one of the key attributes leading to the fall of 2008 crash and the recession.

HYPOTHESIS

MPT plays a pivotal role in real estate investing, from determining how much of an investment portfolio to dedicate to real estate; and specifically, choosing which real estate property types to invest in. In this paper, I focus on the diversification within real estate by specifically looking at the optimal asset allocation strategy to the various real estate property types.

Prior research suggest that both apartments (Petersen and Singh, 2003) and office properties (Stephen and Simon, 2005) have played important roles in real estate allocation decisions. However, these studies relied on data prior to the house market crisis. Thus, I plan to explore differences in optimization strategies in the pre-crisis period and the post-crisis period. I expect to find that post-crisis, there will be a greater weight invested in apartments, due to the rapid increase in foreclosures post-housing bubble. I also believe that hotels will become a less attractive investment, since tourism has been negatively affected by the recession. Furthermore,that the sub-prime market crash and the market crash of 2008 will have large impacts on portfolio optimization strategies.

DATA

This study concentrates on quarterly-annual commercial property returns provided by the NCREIF index from 2000 to 2012. The NCREIF index (national center of real estate investment fiduciaries) releases quarter-annual returns for commercial property acquired in the private sector for the sole purpose of investing. These properties in question were acquired from tax-exempt institutional investors and then held in a fiduciary environment. In purpose of this study, quarter-annual returns produced by NCRIEF, between 2000 and 2012 were analyzed.

Result

The analysis begins by illustrating the volatility of property returns between 2000 and 2012, followed by analysis on the comparative risk and return characteristics of each individual commercial property type before and after the housing crisis. Correlation matrixes are produced to show the possibility of diversification benefits between the property types. Time-period-specific efficient frontiers are then constructed using risk and return rates, and in addition, covariance data. Also plotted are alternative weight allocations in comparison to the efficient frontiers. Then given the volatility of Period 2's returns, sub-set efficient frontiers are also created to demonstrate the differences in investment decisions within the separate time periods.

Individual Property Type Comparisons: 2000 to 2012

Between 2000 and 2012, there are many economic factors driving property return/risk characteristics. From 2000 to 2005 Q2 property values rose to historical heights, while peaking in Quarter 2, 2005; however, after peaking the market began showing signs of volatility with increasing foreclosures and defaults. The sub-prime market collapsed in 2007 leading home

prices to catapult downward until crashing in the fall of 2008. Property returns remained negative until 2010, when property values began slowly rising again resulting in positive returns. Figure 1 illustrates the volatility of quarter-annual Real Estate returns between 2000 and 2012 and the S&P 500 quarter-annual returns.

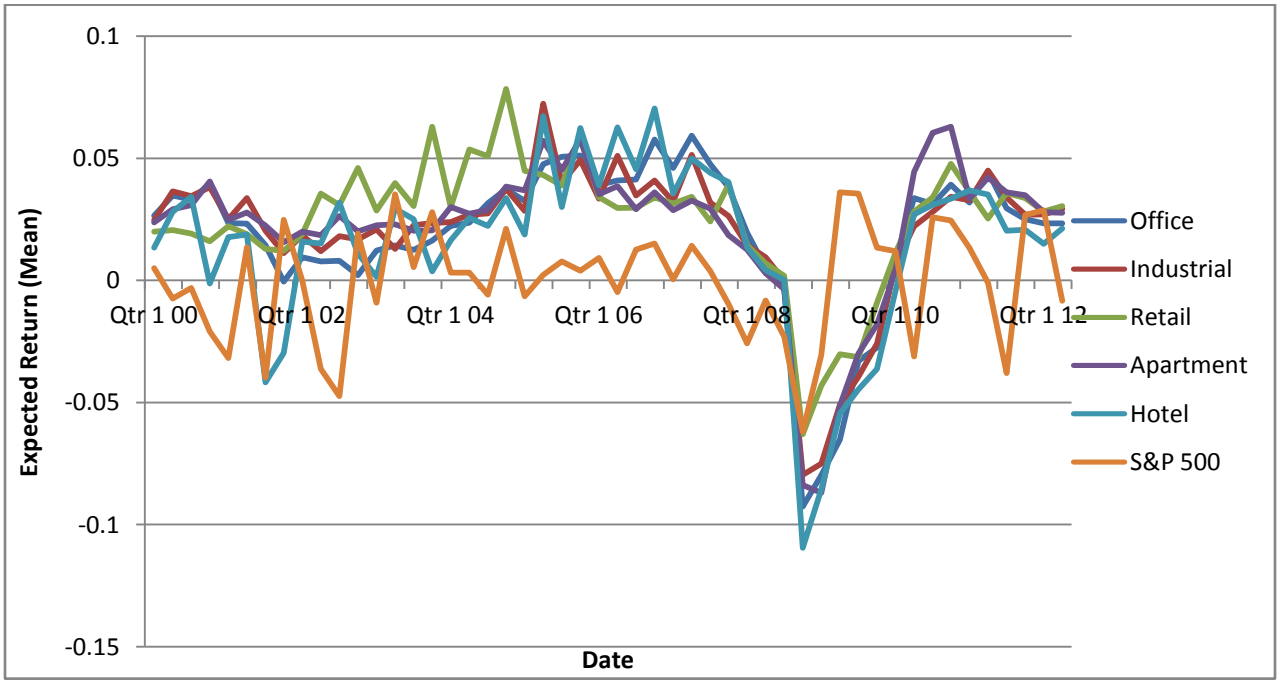

Figure 1: Quarter-annual property returns and S&P 500 returns: (2000-2012)

Most noticeably in Figure 1 is the starkness of the S&P 500's inflection points. Overall, the S&P 500 appears to lack consistency and produced mostly inferior returns as opposed to real estate; however, during the 2008 Q3 crash, excluding retail, the S&P 500 was less affected and actually outperformed the alternative property types. Of the property types, hotels most noticeably, appear to experience the highest volatility from 2000 to 2012 with stark increases and decreases as shown in Figure 3. In Quarter 3 of 2001, for instance, hotel returns dropped

substantially, most presumably because of the terrorist acts on 9/11. Also, during the crash in 2008, hotels exhibited low returns, thus again showing its susceptibility to changes economic conditions. Retail on the other hand, looked to have provided the highest returns between 2002 and early 2005 (right before the bubble burst). All five property type returns plunged in 2007, and actually went negative during the 2008 crash. Retail alsoreported the highest returns relative to other property types in the midst of that crash. Those returns, while still negative, comparatively show retail property as the least susceptible property-type option.

In comparison of the individual property types, Table 1 summarizes risk and return during Period 1 and Period 2. Between the two periods, all property types average returns dropped and standard deviations rose. Hotel properties remained the riskiest and produced the lowest returns during both periods. Hotels returns dropped from 1.62% to 1.44%while its standard deviation doubled from 2.20% to 4.37%. Office properties went from having the second-lowest risk and return to second-highest risk and return from Period 1 to Period 2. Its return dropped from 2.15% to 1.74% and its standard deviation tripled from 1.29% to 4.09%. Industrial's standard deviation nearly tripled as well, increasing from 1.3% to 3.63%. Its returns dropped from 2.66% to 1.53%. Apartments went from least risky to most third most risky, with risk quadrupling from 0.93% to 3.88%. Apartment returns dropped from 2.75% to 1.67%

Table 1: Summary of individual property type risk, return and Sharpe ratio (Period 1) & (Period 2)

		Office	Industrial	Retail	Apartment	Hotel
Period 1						
	Average quarter-annual return (%)	2.15	2.66	3.34	2.75	1.62
	Risk (standard deviation) (%)	1.29	1.30	1.74	0.93	2.20
	Sharpe Ratio	0.10	0.43	0.48	0.51	-0.15
Period 2						
	Average quarter-annual return (%)	1.74	1.53	1.83	1.67	1.44
	Risk (standard deviation) (%)	4.09	3.63	2.89	3.88	4.37
	Sharpe Ratio	0.10	0.05	0.17	0.08	0.02

Most notably, in both periods, retail held the highest returns, with 3.34% during Period 1 and 1.83% during Period 2. During Period 1, that high return held corresponding risk, making it the second most risky property at 1.74%; however, after the bubble burst, retail not only held the highest return, but became least risky as well with a standard deviation of 2.89%. During Period 1, hotels were the only property to produce a negative Sharpe ratio. Apartments had the highest Sharpe ratio of 0.51, retail and industrial properties had slightly lower ratios, while office properties exhibited a ratio of 0.10. During Period 2, all properties actually produced positive Sharpe ratios. Retail held the highest at 0.17; the others however all had ratios under 0.10. Thus, during Period 2, retail is in terms of risk and return, the optimal property-type investment.

Correlation

The elimination of unsystematic risk in an investment portfolio is a key strategy in pursuit of portfolio optimization. By mixing a portfolio with different property types, investors partake in diversification, therefore hedging the portfolio against potential changes in the economic environment.By producing a correlation matrix, investors can determine how linked each property type is to the others, and mix their portfolio assets effectively.

Table 2 summarizes the correlations between each of the individual property typesand the S&P 500. During Period 1, among the property types, industrial and retail were least the correlated with acoefficient of 0.17. Interestingly, retail held the lowest correlation coefficient between all of the alternate property types; thus, retail appears to be the most attractive portfolio mixer. Conversely, office properties haveextremely high correlations with industrial properties and apartments; therefore, making it aless attractive mixing prospect.

In relation to all property types, the S&P 500 held the lowest correlations with all property types, except retail. Retail actually held a 0.38 correlation with the S&P 500, making it the least attractive asset partner in terms of diversification benefits in a multi-asset portfolio. Overall, however, the correlation matrix suggests that private real estate as a whole would be a worthwhile diversifier in an overall investment portfolio.

Table 2: Correlation Matrix (Period 1) & (Period 2)

Period 1						
	Office	Industrial	Retail	Apartment	Hotel	S&P 500
Office	1					
Industrial	0.86	1				
Retail	0.20	0.17	1			
Apartment	0.87	0.92	0.25	1		
Hotel	0.52	0.59	0.41	0.58	1	
S&P 500	-0.02	0.03	0.38	-0.04	0.13	1
Period 2						
	Office	Industrial	Retail	Apartment	Hotel	
Office	1					
Industrial	0.98	1				
Retail	0.95	0.96	1			
Apartment	0.95	0.96	0.96	1		
Hotel	0.98	0.97	0.94	0.93	1	
S&P 500	0.27	0.26	0.29	0.33	0.30	1

The correlation between property types in Period 2 contrasts dramatically from before the housing bubble burst. As shown in Table 2 the correlation coefficients skyrocketed, with many rising 50%. The correlation ratios became so high, in fact, that the lowest ratio(between hotels and apartments) was a shocking 93%. Office properties, as in Period 1, were once again least attractive in terms of diversification benefits, and were 98% correlated with industrial properties and hotels. Overall, judging by the high property correlations rates, it is assumptive that diversification would be less ineffective in Period 2; thus, the criteria in determining the optimal portfolio mix would be primarily based off of risk and return characteristics.

The S&P 500, like Period 1, held a lower correlation in relation to all property types, ranging from 0.27 to 0.33. These results contrast greatly with the correlations among the property types themselves with no individual property type correlation lower than 0.90. Therefore, a portfolio made up of entirely private real estate would not have benefited from diversification during Period 2. However, as in Period 1, private real estate would allow investors the opportunity to benefit from mixing private real estate in a multi-asset portfolio.

Efficient Frontier

In modern portfolio theory, investors seek to optimize investment portfolios with variations in their allocation of assets. As previously stated, however, in pursuit of that optimization, one must determine the returns, standard deviation, and correlation between the assets to construct an efficient frontier. In summary, the efficient frontier is a graphical representation of an optimal portfolio of assets that maximizes return for a specific level of risk, or minimizes risk for a target level of return (Petersen & Singh, 2003) The efficient frontier plots

the line from minimum risk-low return (bottom left of the graph) to maximum risk-high return (top right of the graph), in an upward sloping curve to the right. At any point on the efficient frontier line, that point directly reflects the optimal weight (or asset allocation) of each asset to attain a target risk and return (Petersen and Singh, 2003).

Figure 2 is the graphical summarization of the comparative time-period's efficient frontiers. At a glance, it is apparent that the risk and return possibilities between the time periods contrast dramatically. Not only does Period 1 hold the potential for higher returns than Period 2, but those returns are less risky as well. Most notably, Period 2's efficient frontier isn't even a line, but a single point; thus, the graph indicates that there is only one optimal strategy after the housing bubble burst. In summarization, Table 3 and Table 4, list the risk and return of the individual plot points on both efficient frontiers.

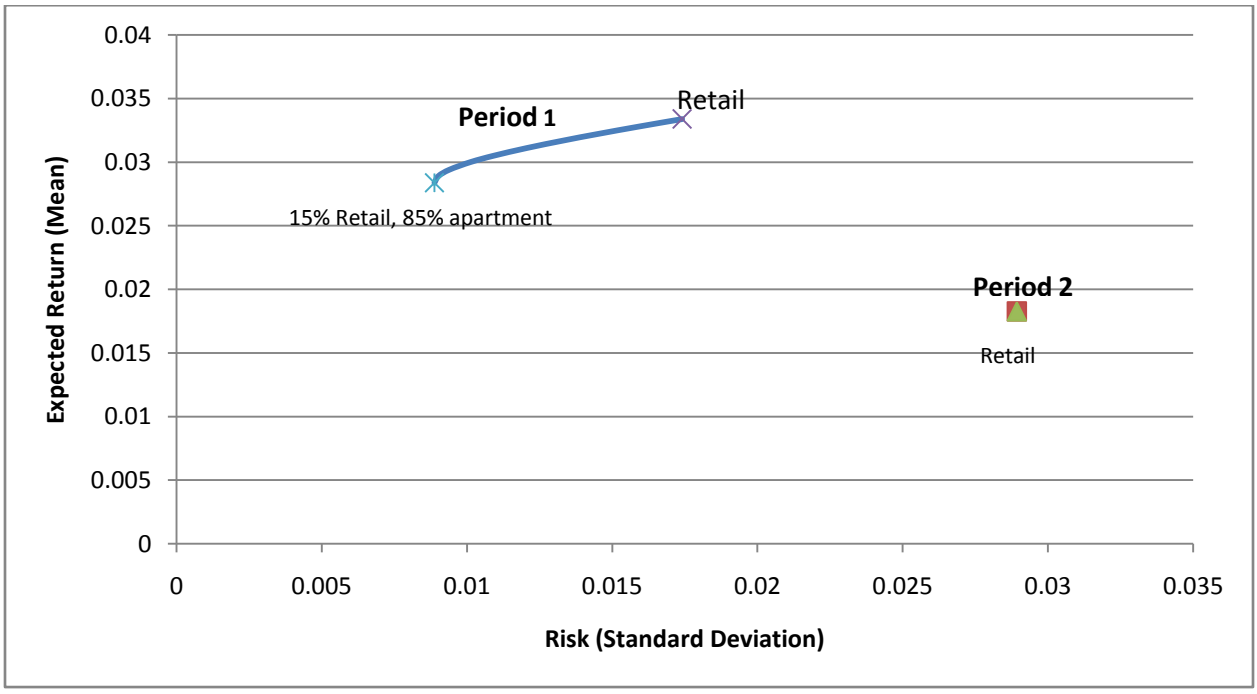

Figure 2: Comparative efficient frontiers (Period 1 & Period 2)

Risk and Return

As illustrated in Figure 2 and Table 3, during Period 1 the highest risk and return mixture would be to invest 100% in retail, with a risk of 1.74% and return of 3.33%. However, diversification can be a powerful tool in minimizing risk at a target return rate. For example, by investing 90% in retail and 10% in apartments, an investor would trade off 1.8% of return for 8.6% less risk.

Along the efficient frontier, and specifically shown in Table 3, risk-conscious investors can further benefit by investing more in apartments and less in retail as it approaches the minimum variance. The minimum variance is the minimum risk for return an investor can take on in the optimal efficient frontier. In Period 1's case, the minimum variance invests 85% in apartments and only 15% in retail. This mixture provides a risk rate of 0.88% and 2.84%rate of return.

Table 3: Allocation weights and risk/return range (Period 1)

Office %	Industrial %	Retail %	Apartment %	Hotel %	Risk	Return
		100			**1.74**	**3.34**
		90	**10**		**1.59**	**3.28**
		80	**20**		**1.44**	**3.22**
		72	**28**		**1.33**	**3.17**
		61	**39**		**1.20**	**3.11**
		51	**49**		**1.09**	**3.05**
		43	**57**		**1.01**	**3.00**
		33	**67**		**0.93**	**2.94**
		24	**76**		**0.90**	**2.89**
		15	**85**		**0.88**	**2.83**

In regards to Period 2, Table 4 indicates that there is only one optimal strategy, 100% allocation in retail for a return of 1.83% and 2.89% risk. However peculiar, this can be explained by Table 1, which shows that retail had the lowest risk and highest return relative to the other

property types within the time-period. Also, the high correlations,as shown in Table 2, indicate that during Period 2 there was essentially no benefit in diversifying between the varying property types. Therefore, no combination of mixed property types other than retail could create a more efficient portfolio.

Table 4: Allocation weights and risk/return range (Period 2)

Office %	Industrial %	Retail %	Apartment %	Hotel %	Risk %	Return %
		100			2.89	1.83

Alternative Allocation Methods

Further evidence of the efficient frontier's optimization, plotted in Figure 3 and 4 are representation points of 100% allocation to each of the varying property types during both periods. As expected, all alternative points provide inferior returns relative to the efficient frontier. Table 5is a representation of the scenario if 100% was allocated to any specific property type, or equally distributed them across a portfolio during Period 1 and Period 2

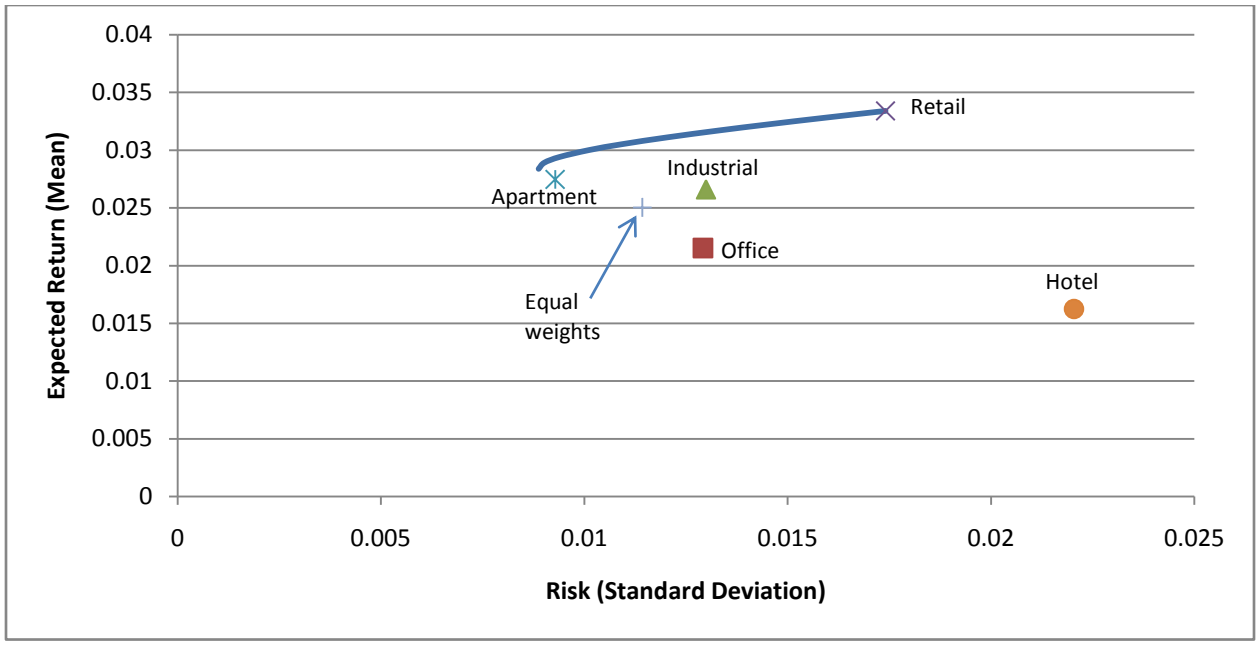

Figure 3: Efficient frontier & 100% allocation of individual property types & equal weights (Period 1)

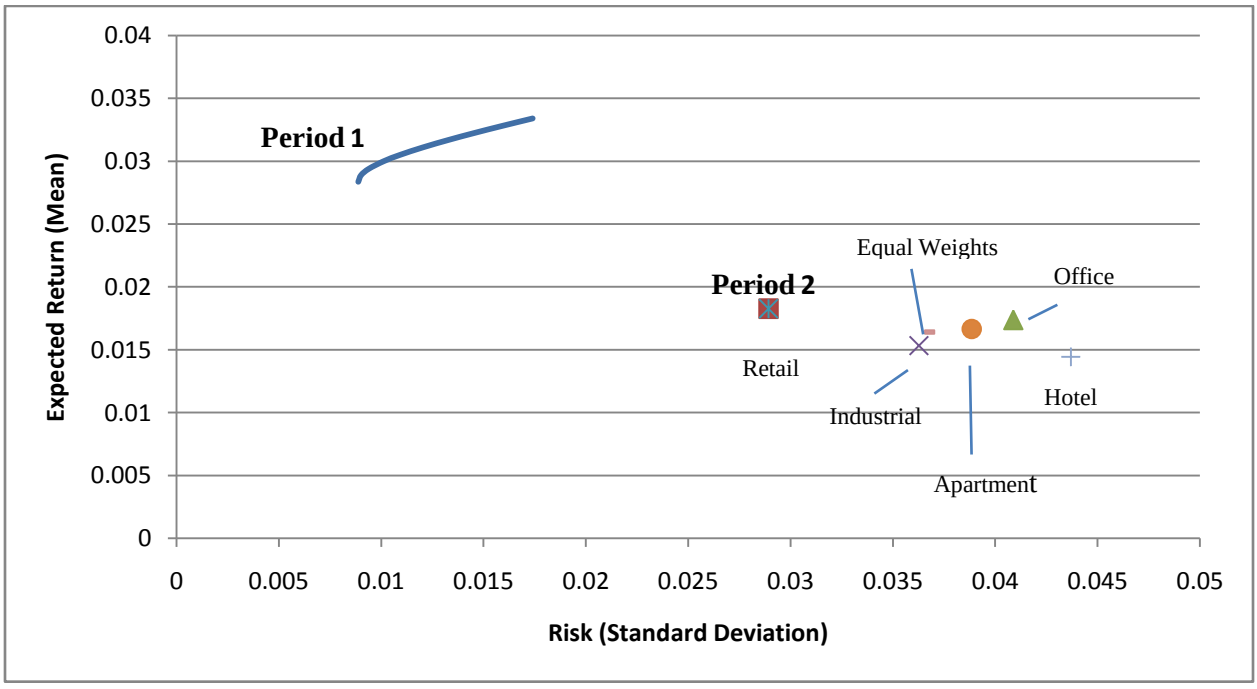

Figure 4: Efficient frontier & 100% allocation of individual property types & equal weights (Period 2) vs. (Period 1)

During Period 1, excluding retail (which is on the efficient frontier) apartments would be the most attractive alternative. If investing 100% in apartments investors would have received a return of 2.75% at a risk of 0.93%. That point would produce lower returns at a greater risk than the minimum variance point on the efficient frontier. In comparison, during Period 2, with the exception of Period 1's 100% allocation in hotels, at no point in Period 2 does any mixture of property-type portfolio achieve the return of Period 1's efficient frontier or alternative allocation points. Also, every possible return/risk point in Period 2 has a far greater risk than Period 1.

Table 5: Alternative Portfolios (Period 1) & (Period 2)

Period 1			**Period 2**	
	Risk	Return	Risk	Return
100% Office	1.29	2.15	4.09	1.74
100% Industrial	1.30	2.66	3.63	1.53
100% Retail	1.74	3.34	2.89	1.83
100% Apartment	0.93	2.75	3.88	1.67
100% Hotel	2.20	1.62	4.37	1.44
Equal Weights	1.14	2.50	3.66	1.64

As illustrated above, at no point on Period 2's efficient frontier could investors achieve the risk/return provided on Period 1's efficient frontier. Period 1's maximum return has a risk over one percent lower than Period 2's optimal portfolio and Period 1's minimum variance return equals Period 2's maximum return, but at lower risk. Also, note that Period 1's lowest return risk is also two percent lower than Period 2's maximum return/risk. To examine this further, Period 2 was split into sub-periods to analyze more in-depth the cause of Period 2's inferior risk/returns to Period 1

Period 2: Sub-Periods

By splittingPeriod 2 into sub-periods based on key events during the time-frame, it allows investors a more insightful look at the cause of Period 2's high risk/low returns. As such, Period 2-1 illustrates risk and returns from 2005 Q2 to 2007 Q1; thus, from when the housing bubble burst to the sub-prime mortgage market collapse. Period 2-2 ranges from the sub-prime market crash to the 2008 Q3 crash while Period 2-3 is split between the 2008 crash and 2009 Q4. Lastly, Period 2-4 ranges from 2010 Q1 to 2012 Q2. Also, Figure 3 is a graphical representation comparing Period 1, Period 2 and its encompassing sub-periods.

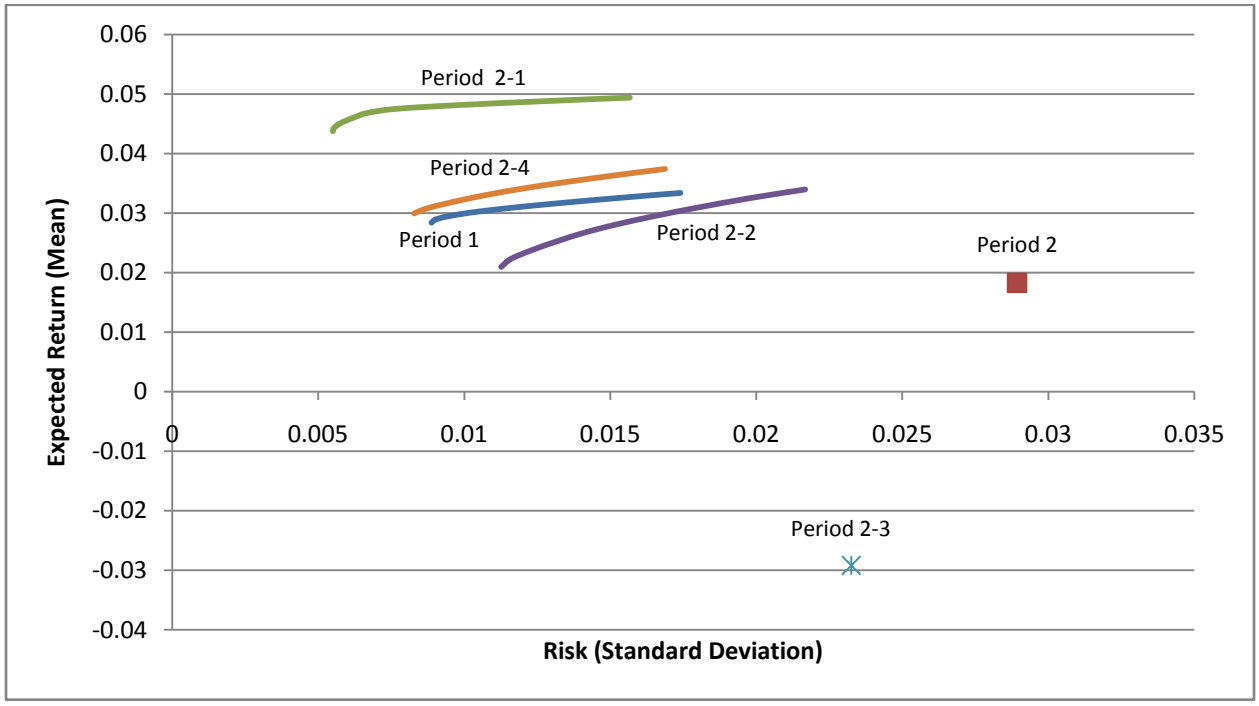

Figure 5: Efficient frontiers (Period 1, Period 2 & Period 2 sub-set periods)

In regards to Figure 3, Period 2-1 saw the greatest potential returns. During Period 2-2 the sub-prime mortgage market collapsed and the market saw a dramatic drop in returns.

Thedrop continued into Period 2-3,and properties began producing negative returns as the stock market crashed in 2008. However, in Period 2-4 the returns went positive once again, and are even higher than Period 1, indicatingthat the market is recovering.

Table 6: Summary of individual property type risk, return and Sharpe ratio (Period 2-1;2-2;2-3;2-4)

		Office	Industrial	Retail	Apartment	Hotel
Period 2-1						
	Average quarter-annual return (%)	4.67	4.02	3.68	3.86	4.94
	Risk (standard deviation) (%)	0.68	0.75	1.07	1.01	1.57
	Sharpe Ratio	**1.39**	0.62	0.20	0.33	1.03
Period 2-2						
	Average quarter-annual return (%)	3.40	2.67	2.37	1.92	3.04
	Risk (standard deviation) (%)	2.17	1.65	1.34	1.22	2.03
	Sharpe Ratio	**0.82**	0.28	-0.11	-1.93	0.56
Period 2-3						
	Average quarter-annual return (%)	-5.02	-4.52	-2.92	-4.57	-5.51
	Risk (standard deviation) (%)	3.44	3.01	2.32	3.46	3.85
	Sharpe Ratio	-1.65	-1.74	-1.51	**-1.49**	-1.61
Period 2-4						
	Average quarter-annual return (%)	2.91	2.86	3.11	3.74	2.37
	Risk (standard deviation) (%)	0.99	0.99	0.93	1.69	1.22
	Sharpe Ratio	2.88	2.78	**3.27**	2.19	1.89

In analyzing the sub-periods more closely, Table 6 provides a more insightful demonstration of the individual property type returns and risks. It becomes obvious that from Period 2-1 to Period 2-2 returns between all properties began dropping; however, in Period 2-3 all five properties produced deeply negative returns. After 2009, into Period 2-4, returns all become positive once again.

Period 2-1

Table 7 shows that during Period 2-1, the minimum risk for return was to invest 56% of a portfolio in office property, 1% in retail, and 43% in industrial property for a 4.39% return and0.52% of risk. Interestingly, during Period 2-1, hotels offered the highest potential return on

the efficiency frontier, which contrasted starkly with hotels' overall average returns in Period 1 and 2, where hotels actually produced the weakest returns as shown in Table 1. That being said, investors could invest 100% in hotels for 4.93% return and 1.45% risk.However, by investing in office property, investors could achieve a Sharpe ratio of 1.39, compared with hotel's ratio of 1.03. Conversely, retail properties only offered a Sharpe ratio of 0.20, the lowest among the varying property types.

Table 7: Allocation weights and risk/return range (Period 2-1)

Office %	Industrial %	Retail %	Apartment %	Hotel %	Risk	Return
				100	**1.57**	**4.94**
26				**74**	**1.23**	**4.87**
48				**52**	**0.97**	**4.81**
71				**29**	**0.77**	**4.75**
89	**2**			**9**	**0.67**	**4.68**
84	**10**			**6**	**0.63**	**4.62**
79	**18**			**3**	**0.60**	**4.56**
74	**26**				**0.57**	**4.50**
63	**37**				**0.55**	**4.43**
56	**43**	**1**			**0.55**	**4.38**

Period 2-2

In comparison, Period 2-2 had a far lower efficient frontier, and at no point could an investor potentially achieve the same returns as Period 2-1. For risk-adverse investors, Table 8indicates that with 39% allocated to retail and 61% in apartment properties, the minimum variance portfolio offers 2.09% return at 1.12% risk. Office properties during Period 2-2 alone were the leader in terms of potential returns; however, not entirely optimal. Office properties high return came with high risk. That maximum return of3.40% was accompanied by2.16%of risk; however, that combination produced the highest Sharpe ratio among the property types with 0.82. Like Period 2-1, hotels again offered the second highest Sharpe ratio at 0.56, and industrial

properties also offered a positive, yet lower Sharpe ratio. Retail and apartments, however, both conversely produced negative Sharpe ratios.In all, Period 2-2's maximum return is over 1 ½ percent lower than Period 2-1's minimum variance point, further evidence of lowering returns.

Table 8: Allocation weights and risk/return range (Period 2-2)

Office %	Industrial %	Retail %	Apartment %	Hotel %	Risk	Return
100					**2.17**	**3.40**
74	**1**	**8**		**17**	**1.98**	**3.25**
61	**7**	**19**		**12**	**1.81**	**3.10**
48	**14**	**30**		**8**	**1.66**	**2.96**
35	**20**	**42**		**3**	**1.52**	**2.81**
21	**26**	**53**			**1.41**	**2.67**
10	**26**	**55**	**8**		**1.31**	**2.52**
3	**23**	**54**	**20**		**1.23**	**2.38**
	11	**50**	**39**		**1.16**	**2.23**
		39	**61**		**1.12**	**2.09**

That being said, even though the housing bubble essentially burst in the summer of 2005, it doesn't appear that the market recognized its inefficiencies until the sub-prime mortgage market crashed in 2007. After that, as proved by Period 2-2's returns/risk, it appears that the collapse of the sub-prime mortgage market was the key event/indicator leading to the significant reduction in Period 2's returns.

Table 9: Allocation weights and risk/return range (Period 2-3)

Office %	**Industrial %**	**Retail %**	**Apartment %**	**Hotel %**	**Risk %**	**Return %**
		100			2.32	-2.92

Period 2-3

During Period 2-3, as seen in Table 6, all five individual property returns produced negative returns. Table 9specifically indicates that Period 2-3's efficient frontier is only made up

of one point, 100 percent invested in retail. However, even as the optimal property investment choice, retail produced a staggeringly low return of -2.92%and 2.32%of risk.Table 6 offers an explanation, since retail had the least negative returns and the lowest risk among the comparable property types in Period 2-3. These results coincide with Table 1, which suggested that during the overall Period 2 time-frame, retail also held the highest return and lowest risk as well.

All property types, including retail, had substantially negative Sharpe ratios during Period 2-3; however, contrary to Period 2-2, retail actually produced the most attractive Sharpe ratio among the varying property types at-1.51. Furthermore, as opposed to preceding periods there was little deviation between the individual property types, with industrial properties offering the lowest Sharpe ratio of -1.74. Overall, during Period 2-3, investors would optimally have avoided investing in commercial Real Estate all together.

The overall negative returns in Period 2-3, as indicated in Figure 6 and Table 9, were produced in the midst of the stock market crash.For that reason, Period 2-3's negative returns presumably were the cause of Period 2's one-point efficiency frontier.

Table 10: Allocation weights and risk/return range (Period 2-4)

Office %	Industrial %	Retail %	Apartment %	Hotel %	Risk	Return
			100		**1.69**	**3.74**
		14	**86**		**1.55**	**3.65**
		27	**73**		**1.42**	**3.57**
		41	**59**		**1.29**	**3.48**
		53	**47**		**1.19**	**3.40**
	2	**64**	**35**		**1.09**	**3.32**
	10	**65**	**25**		**1.01**	**2.24**
9	**11**	**66**	**14**		**0.93**	**3.15**
19	**10**	**67**	**4**		**0.87**	**3.07**
25	**25**	**50**			**0.82**	**2.99**

Period 2-4

As shown in Table 10, all five property types in Period 2-4, contrary to Period 2-3 produced positive returns. Risk-adverse investors could achieve low risk by investing 25% in office and industrial properties each, and 50% in retail. That combination would allow investors a 2.99% return for 0.82% of risk. Risk-taking investors, however, could invest solely in apartments for a 3.74% return for 1.69% of risk. Most striking, as noted above, is that Period 2-4 actually produces superior returns relative to Period 1, as shown in Figure 3.

Also, contrary to the other Period 2 sub-periods, all five property types in Period 2-4 produced positive Sharpe coefficients. Retail offered the highestSharpe ratio of 3.27, while hotels offered the lowest at 1.90. Those ratios aresignificantly higher than the proceeding Period 2 sub-periods, Period 2, and even Period 1. Property values fell so low during the 2008 crash that as property values rise once again, returns do as well. Therefore, in terms of risk/return trade-offs, Real Estate has since 2010 has become a more attractive investment than any time in the past decade.

Summary

Between the four Period 2 sub-set periods, there is overwhelming evidence of economic cycle volatility. In Period 2-1, from when the housing bubble burst to the sub-prime mortgage market crash, hotel properties held the highest potential returns; yet, judging by risk/return trade-off, office properties were most attractive; yet, after the sub-prime market collapse in 2007, office properties held the highest Sharpe ratio and produced the highest returns. Conversely, hotel properties at their peak contribution only made up 17% of the Period 2-2 optimal portfolio. In Period 2-3 when the stock market collapsed, all property types produced negative returns, but

retail was the comparable best.Period 2-4 conversely offers diversification benefits, and shows positive movements in regards to returns.

CONCLUSION

The results in this study show the impact that the bursting of the U.S. housing bubble had on commercial real estate investing. Real estate from 2000 q1 to 2005 q2 (when the housing bubble burst) produced superior return for risk relative to after the housing bubble 2005 q3 to 2012 q2, which only produced a one-point efficient frontier. In early 2007, the sub-prime mortgage market collapsed and was the key event that led to rapidly declining property values/returns and the market crash in the fall of 2008. Retail was the most attractive investment in terms of return potentialbefore and after the housing bubble burst; however, retail also held the lowest risk for highest return post housing bubble, making it an appealing sole optimization choice. Examining sub-periods within the post bubble period shows that returns varied from positive to substantially negative (during the 2008 crash time-frame). Thus, during different cycles investors must adapt and strategize appropriately to capitalize on opportunities.As investors further seek to eliminate unsystematic risk, diversification strategies and risk/return analysis allow them to continue pursuing portfolio optimization.

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