“Role of REITs in Mixed – Asset Portfolios”

Master Thesis

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Abstract

In my thesis I analyze the role played by Real Estate Investment Trusts (REITs) worldwide. I investigate the optimal percentages to be invested in mixed - asset diversified portfolios, basing my analysis on the Sharpe Model (Capital Asset Pricing Model or CAPM). Through the analysis of return - risk distributions, correlations and optimal portfolios, I quantify the optimal amounts that should be invested in REITs both in nationally and internationally diversified portfolios. I conclude the thesis with the study of real estate-only portfolios. I find that geographic diversification of REITs-only portfolios brings benefits in terms of average higher returns and lower risks.

I would like to thank the professor Erasmo Giambona for supervising my final thesis.

Alessandro Amoruso

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Table of contents

1. Introduction

In my thesis, I study and analyze the role played by Real Estate Investment Trusts in mixed asset diversified portfolios and in a real estate-only portfolio context. Many other studies have turned the attention on this specific subject. My analysis results to be in line with the outcomes of the previous studies both in terms of optimal percentage range that should be invested in optimal national/ international portfolios and in terms of diversification possibilities of real estate-only portfolios.

I study mixed asset diversified portfolios, within the most developed countries worldwide. The analyses of the world asset integrations show evident diversification benefits among different countries. I examine mean returns, standard deviations, Sharpe ratios and correlation coefficients. The Capital Asset Pricing Model (CAPM) analysis shows that, on average, portfolios of different kinds of investment yield higher returns and pose lower standard deviations than those obtained by individual investments within the portfolio. This thesis could turn out to be useful for private and institutional investors who want to have knowledge about exposure percentages that could be optimal to be invested in real estate securities both in nationally and internationally diversified portfolios. It could also offer interesting insights about the real estate-only diversification topic.

The majority of early researches use data series that are less than 15 years, which could bring to a lack of statistical accuracy. My thesis adds further research material, since I analyze a very recent period with a broader time horizons. For nine (out of 10) countries, I take into consideration a 15 years time period; anyways the general analysis never falls below the threshold of 8 years. Furthermore my study results innovative because of the lack of a specific research on optimal allocations of indirect-only investment in real estate. This study gave me the possibility to verify if the integration process for real estate securities is become a reality, as already experienced by stock and bond assets.

The thesis is organized as follows; chapter 2 offers an overview of the recent literature review. It will cover studies on the diversification benefits of holding real estate investments, under the form of Real Estate Investment Trusts (REITs) both in mixed - asset and real estate-only portfolios. The chapter includes a review of those researches which analyze the optimal allocations to real estate securities. Chapter 3 presents an overview of data and some preliminary results. Chapter 4 offers an

overview of the methodology used, and includes explanations of data and formulas used. Chapter 5 presents and analyzes the empirical results. Finally, chapter 6, summarizes and concludes the thesis.

2. Literature Review

During the last 15 years, with the increasing availability of real estate stock data, researches and paper works have increased considerably in this area. This chapter is divided in 4 paragraphs, which offer different reviews on different but still related topics: diversification benefits of holding real estate investments in mixed asset portfolios; diversification benefits of holding real estate investments in real estate-only portfolios; optimal allocations to real estate securities; and, finally, a brief review of the Modern Portfolio Theory.

2.1 Diversification Benefits in Mixed - Asset Portfolios. A Real Estate Perspective

Asabere *et al.* (1991) are among the first researchers to analyze the diversification benefits of international real estate investments by using a monthly index based on the price movements of securities issued by property companies located throughout the world. Their correlation analysis evidenced diversification gains from adding real estate securities to a mixed asset portfolio. Eichholtz (1996) compares international property, stocks and bonds performance of nine different countries. He compares internationally diversified property portfolio frontiers and he finds that they outperformed both domestic property portfolios and international stock/bond portfolios. Moreover the correlation coefficients between countries results to be much lower for property than stock and bond investments. Eichholtz and Koedjik (1996) are some of the first researchers to study real estate investment benefits from a disaggregate regional level. They find that, given the low correlation coefficients between regions, international real estate stocks should provide good portfolio implications. Mull and Soenen (1997) add property securities to bond and stock portfolios. They use mean returns, standard deviations, coefficient of variations, Sharpe ratios and correlation coefficients for all three investment, and they adjust the real estate investment for monthly currency fluctuations They find that, depending on the period, real estate securities play different roles providing or not providing diversification benefits. Gordon *et al.* (1998) efficient frontiers analysis shows that when international real estate stocks are included in mixed asset portfolios it is possible

to obtain higher return levels, with lower standard deviations. Liu and Mei (1998) outcome is slightly different. In their study, the diversification benefit of including real estate securities is still present. On the other hand, they state that the results could be period specific, given the currency fluctuations over the period examined. Gordon and Canter (1999) and Maurer and Reiner (2002) efficient frontier analysis also finds that integrating real estate stocks leads to superior performance. Contrasting results are shown by Stevenson (2000). He casts doubts on the enhanced benefits of holding international real estate stocks in a mixed asset portfolio by examining potential benefits on both hedged and unhedged basis. Conover *et al.* (2002), in their mean variance portfolio analysis, suggest that given the strong segmentation in Real Estate markets foreign investments could bring advantages in terms of portfolio's efficiency.

2.2 Diversification Benefits in Real Estate-only Portfolios

As seen in the previous section, the majority of the studies find that international real estate provides diversification benefits. Addae-Dapaah and Kion (1996) note that, from the perspective of a Singaporean investor, diversification benefits of real estate-only portfolios do exist due to the very low correlations among the seven countries analyzed. They also find that the benefits increase when the return are adjusted for currency fluctuations. Wilson and Okunev (1996) study co-integration tests among three countries: UK, USA and Australia. The results show no long run equilibrium relationship, so bringing to the conclusion that diversification benefits should be gained. Eichholtz (1997) states that regional diversification is more beneficial than property type. Finally both Pierzak (2001) and Bigman (2002) find that an internationally diversified real estate portfolio outperforms a domestic portfolio.

2.3 Optimal Allocations to Real Estate Securities

There is not a very extensive literature about the optimal allocation of real estate investment securities in mixed-asset portfolios. Many studies are mainly focused on the optimal allocation range of direct real estate. On the other hand, a few studies have looked specifically at the addition of public investments in real estate. Geltner, *et al.* (1995), Sanders (1999) and Rosen (2001) consider investments in both private and public real estate within a mean-variance framework. They

suggest an allocation to real estate of about 30 to 35% depending on the rate of return assumed. Craft (2001) finds that in over the 1979 to 1998 period, a mean variance portfolio model would predict a 17% optimal allocation in public real estate. In an asset/liability framework this allocation turns out to be between 4% and 10%. Finally, Feldman (2003), who runs the study from 1987 to 2001, with a 15 years time period, found a maximum real estate allocation of 45% with 15% allocated to REITs and 30% allocated to direct unleveraged real estate. Also Feldman's research combines both direct and indirect real estate in the same mean-variance portfolio analysis.

2.4 Diversification and Modern Portfolio Theory

I calculate the diversification potential by using the traditional CAPM and Modern Portfolio Theory (MPT). Modern Portfolio Theory states that in mixed asset diversified portfolios frontiers, the portfolio with the best return risk combination for all the investors is called Market Portfolio. This portfolio shows the highest Sharpe ratio, which represents the risk premium or the additional return above the risk free asset a portfolio provides in relation to the risk an investor bears. Markowitz (1953) first assumed the existence of an efficient frontier which minimizes the risk for certain expected returns. In other words, the efficient frontier is the set of portfolios with minimum standard deviation and maximum return. The portfolio return is calculated through the following formula:

$$E(R_p) = \sum w_i \, E(R_i)$$

The following formula, instead, is used for the portfolio variance.

$$\sigma^2_p = \sum_i w_i^2 \sigma_i^2 + \sum_i \sum_j w_i w_j \sigma_i \sigma_j \rho_{ij}$$

Where $E(R_p)$ represents the expected return of the portfolio, $E(R_i)$ the expected return of the individual asset and w_i the weight of the individual asset in the portfolio. σ^2_p is the portfolio variance, and $\sigma_i \sigma_j \rho_{ij}$ the covariance between the individual assets. Lui's and Mei's (1998) research found that international real estate investments should be added to diversified portfolios of stocks and bonds.

Modern Portfolio Theory remarks

Literature return has showed that whilst security returns are normally distributed Real Estate returns distributions are not. Sirmans and Worzala (2003) and Lizieri and Finley (1995) found questionable the use of mean-variance framework, given that ex post data are not necessarily stable over time and, therefore, not always a good predictor of the future. Nevertheless, the MPT framework is still used in many studies because of the lack of better alternatives.

Portfolio performance measurement

In the Capital Asset Pricing Model analysis an important role is played by the Sharpe ratio. If a portfolio shows higher Sharpe ratio than a benchmark portfolio, then the portfolio has outperformed its benchmark.

$$S = E(R - R_f)/\sigma = E(R - R_f)/[var(R - R_f)]$$

Where R is the asset return, R_f is the return on a benchmark asset, such as the risk free rate of return, $E(R - R_f)$ is the expected value of the excess return over the benchmark return, and σ is the standard deviation of the excess asset return.

3. Data Overview

In chapter 3, I will make a first comparison of the results obtained in the different markets. The performances are measured through arithmetic means of the monthly returns, standard deviations, Sharpe ratios and correlation coefficients.

3.1 Data Characteristics

My dataset consist of 10 countries spread over 4 different continents. In order to give the reader a clear structure of my research, I here below summarize the passages of the analysis:

i. Analysis 1: conducted over periods comprised between 10 and 15 years, it includes real estate securities, government bonds, stocks and, where available, corporate indices. Due to data availability, in this analysis, the Singaporean market will be the only one covered by an eight years time horizon, rather than 15.

ii. Analysis 2: same characteristics of analysis 1, with the inclusion of money market assets in the optimal portfolio allocation. Depending on data availability, these assets will be either 3 month cash indices or 3 month Treasury Bills.

iii. Analysis 3: given the remarkable correlations shown in the previous two researches between government and corporate bond assets, this analysis is conducted excluding the corporate bond asset class from the optimal portfolio allocation. The time frame is 15 years for all the countries, except for Singapore, for which it is eight years.

iv. Analysis 4: run using a unique 8 years sub-period for all the countries, this analysis includes all the ten sample countries and analyzes mixed asset portfolios of real estate securities, government bonds, stocks and, where available, corporate bonds.

v. Analysis 5: same characteristics of analysis 4, with the inclusion of the money market assets in the optimal portfolio allocation. Depending on data availability, these assets will be either 3 month cash indices or 3 month Treasury Bills.

vi. Analysis 6: for the same reason mentioned in point iii, this analysis is conducted excluding the corporate bond asset from the optimal portfolio allocation. The time frame is 8 years for all the countries and all the portfolios will be composed by 4 asset classes.

vii. Correlation analysis: provides correlation coefficients between national EPRA/NAREIT indices. This study represents the first step towards the subsequent diversification analysis.

viii. Diversification analysis: considers real estate-only portfolios. Three different portfolios have been built: an European, an American/Asiatic and a worldwide portfolio. The analysis examines the portfolios both at regional and interregional level.

The asset classes considered in this eight analyses are the following: cash, bond, stock and indirect real estate. Even though analyses 2 and 4 show a broader portfolio investment scenario, analyses 3 and 6 result to be more homogeneous, in terms of asset portfolio composition. These two last studies, in fact, are carried out using 4 typical assets: 3 month cash or T-Bill indices, EPRA/NAREIT indices, national large capitalization stock market indices, and finally national all maturities government bond indices. All the data are expressed in local currencies, so that exchange

rate fluctuations are implicit in the derived returns. In my analysis I take into consideration neither currency risks nor transaction costs. Moreover, I include only national indices expressed in total returns, which are comprehensive of both dividends and capital gains.

Exhibit 1 summarizes the average return risk profile of all the indices analyzed over the 15 years time frame, on an annual basis.

Exhibit.1 (Average Countries' Return Risk Relationship. Time period: 1993 – 2008)

Country	Time period	Cash Asset	Real Estate Asset	Stock Asset	Govt. Bond Asset	Corporate Bond Asset
Belgium	*1993 - 2008*	*T-Bill 3 Month*	*FTSE EPRA/NAREIT*	*BEL 20*	*ML BELGIAN*	-
	Return	*3,66%*	*8,19%*	*12,10%*	*6,08%*	-
	Risk	*0,39%*	*10,79%*	*17,36%*	*3,99%*	-
France	*1993 - 2008*	*JPM CASH 3 Month*	*FTSE EPRA/NAREIT*	*CAC 40*	*ML FRENCH*	-
	Return	*4,09%*	*16,79%*	*11,01%*	*6,14%*	-
	Risk	*0,50%*	*17,86%*	*19,74%*	*4,03%*	-
Germany	*1993 - 2008*	*MNY MKT 3 Month*	*FTSE EPRA/NAREIT*	*DAX 30*	*ML GERMAN*	-
	Return	*3,67%*	*4,17%*	*12,14%*	*5,64%*	-
	Risk	*0,32%*	*23,25%*	*21,59%*	*3,84%*	-
UK	*1998 - 2008*	*JPM CASH 3 Month*	*FTSE EPRA/NAREIT*	*FTSE 100*	*JPM UK*	*IBOXX 1-15Y*
	Return	*5,45%*	*6,77%*	*5,42%*	*5,54%*	*5,48%*
	Risk	*0,36%*	*17,48%*	*17,81%*	*4,84%*	*3,65%*
	1993 - 2008	*JPM CASH 3 Month*	*FTSE EPRA/NAREIT*	*FTSE 100*	*JPM UK*	-
	Return	*5,76%*	*9,29%*	*9,51%*	*7,01%*	-
	Risk	*0,35%*	*16,75%*	*16,25%*	*5,29%*	-
Switz.	*1993 - 2008*	*JPM CASH 3 Month*	*FTSE EPRA/NAREIT*	*UBS 100*	*DS INDEX*	-
	Return	*2,22%*	*11,72%*	*11,83%*	*4,18%*	-
	Risk	*0,40%*	*13,22%*	*18,51%*	*3,78%*	-
US	*1993 - 2008*	*JPM US CASH 3 Month*	*FTSE EPRA/NAREIT*	*S&P 500*	*JPM US*	*ML US AA-AAA*
	Return	*4,58%*	*14,71%*	*10,78%*	*6,19%*	*6,52%*
	Risk	*0,53%*	*14,55%*	*15,26%*	*4,51%*	*4,68%*
Canada	*1993 - 2008*	*JPM CASH 3 Month*	*FTSE EPRA/NAREIT*	*S&P/TSX*	*JPM CANADA*	*DEX AA UNIVERSE*
	Return	*4,53%*	*12,45%*	*12,78%*	*7,39%*	*7,30%*
	Risk	*0,47%*	*15,69%*	*16,40%*	*4,80%*	*4,26%*
Australia	*1997 - 2008*	*JPM CASH 3M*	*FTSE EPRA/NAREIT*	*S&P/ASX 200*	*JPM AUSTRALIA*	*MACQUARIE BK.AU.*
	Return	*5,69%*	*10,62%*	*11,78%*	*5,56%*	*5,46%*
	Risk	*0,28%*	*12,44%*	*13,61%*	*3,87%*	*2,67%*
	1993 - 2008	*JPM CASH 3M*	*FTSE EPRA/NAREIT*	*S&P/ASX 200*	*JPM AUSTRALIA*	-
	Return	*5,98%*	*12,71%*	*12,96%*	*6,81%*	-
	Risk	*0,35%*	*12,07%*	*13,15%*	*4,71%*	-
Japan	*1997 - 2008*	*JPM CASH 3 Month*	*FTSE EPRA/NAREIT*	*S&P TOPIX*	*JPM JAPAN*	*ML JAPAN AAA*
	Return	*0,36%*	*12,33%*	*4,65%*	*2,13%*	*1,92%*
	Risk	*0,11%*	*30,11%*	*19,40%*	*2,93%*	*2,51%*
	1993 - 2008	*JPM CASH 3 Month*	*FTSE EPRA/NAREIT*	*S&P TOPIX*	*JPM JAPAN*	-
	Return	*0,69%*	*9,91%*	*4,05%*	*3,51%*	-
	Risk	*0,25%*	*28,34%*	*18,31%*	*3,62%*	-

Exhibit 2, instead, shows the results of the 2000 – 2008 sub-period, on an annual basis. As expected, the two periods examined show that the cash asset presents the lowest rates of return and standard deviations: between 1993 and 2008 its average rate of return is 3.9%, while the average standard deviation is 0.4%. The sub-period (2000-2008) performances are in line with the main period, showing, on average, a 3.2% rate of return and a 0.3% standard deviation. Another common trend of these two periods is that real estate securities have obtained significantly high

performances, posing quite high levels of risk. Comparing the average returns of national NAREIT indices with those obtained by national stock indices, it comes out that, over the time period 1993 - 2008, REITs yield 11.1% versus 10.8% of the stock indices. Nevertheless, the average standard deviation results to be lower for real estate securities: 17% versus 17.4% for the stock indices. Always in the main period, the government and, where available, the corporate bonds manage, on average, a 5.9% and 6.9% annual total return, with an average risk of 4.3% and 4.5%, respectively. In the sub-period the performances of real estate securities are even more impressive considering that they maintain a lower level of volatility than stocks even if performing higher average total returns. REITs yield on average 7.2% more than stocks (12.6 versus 5.4%), posing an average risk of 18.5% compared to 19% for stocks. Government and corporate bond indices show lower return - risk profiles than real estate and stocks. The average return is 4.9% for the government and 5.1% for the corporate bonds. As regards the annual risk profile, it turns out to be, on average, 3.7% for the government and 3% for the corporate bonds. It is important to note that these two kinds of bond assets will not be comparable in my analysis, given that the sample used for the corporate bond assets is by far smaller and therefore less significant statistically, than that used for the government bonds.

Exhibit .2 (Average Countries' Return Risk Relationship. Time period: 2000 – 2008)

Country	Time period	Cash Asset	Real Estate Asset	Stock Asset	Govt. Bond Asset	Corporate Bond Asset
Belgium	*2000 - 2008*	*T-Bill 3 Month*	*FTSE EPRA/NAREIT*	*BEL 20*	*ML BELGIAN*	-
	Return	*3,18%*	*10,33%*	*7,71%*	*5,01%*	-
	Risk	*0,27%*	*10,67%*	*18,78%*	*3,34%*	-
France	*2000 - 2008*	*JPM CASH 3 Month*	*FTSE EPRA/NAREIT*	*CAC 40*	*ML FRENCH*	-
	Return	*3,45%*	*19,58%*	*2,39%*	*4,87%*	-
	Risk	*0,35%*	*19,56%*	*20,77%*	*3,36%*	-
Germany	*2000 - 2008*	*MNY MKT 3 Month*	*FTSE EPRA/NAREIT*	*DAX 30*	*ML GERMAN*	-
	Return	*3,36%*	*0,40%*	*2,29%*	*4,84%*	-
	Risk	*0,29%*	*24,94%*	*24,01%*	*3,28%*	-
UK	*2000 - 2008*	*JPM CASH 3 Month*	*FTSE EPRA/NAREIT*	*FTSE 100*	*JPM UK*	*IBOXX 1-15Y*
	Return	*5,13%*	*11,58%*	*3,44%*	*5,13%*	*5,54%*
	Risk	*0,30%*	*18,05%*	*17,78%*	*4,61%*	*3,59%*
Switz.	*2000 - 2008*	*JPM CASH 3 Month*	*FTSE EPRA/NAREIT*	*UBS 100*	*DS INDEX*	-
	Return	*1,80%*	*7,95%*	*4,27%*	*3,56%*	-
	Risk	*0,35%*	*8,88%*	*19,77%*	*3,68%*	-
US	*2000 - 2008*	*JPM US CASH 3 Month*	*FTSE EPRA/NAREIT*	*S&P 500*	*JPM US*	*ML US AA-AAA*
	Return	*3,84%*	*17,07%*	*2,19%*	*6,68%*	*6,64%*
	Risk	*0,59%*	*16,03%*	*17,54%*	*4,98%*	*4,26%*
Canada	*2000 - 2008*	*JPM CASH 3 Month*	*FTSE EPRA/NAREIT*	*S&P/TSX*	*JPM CANADA*	*DEX AA UNIVERSE*
	Return	*3,86%*	*17,12%*	*10,09%*	*7,04%*	*6,00%*
	Risk	*0,37%*	*14,11%*	*17,28%*	*3,99%*	*2,87%*
Australia	*2000 - 2008*	*JPM CASH 3 Month*	*FTSE EPRA/NAREIT*	*S&P/ASX 200*	*JPM AUSTRALIA*	*MACQUARIE BK.AU.*
	Return	*5,84%*	*10,16%*	*11,95%*	*6,12%*	*6,01%*
	Risk	*0,29%*	*12,40%*	*13,43%*	*3,80%*	*2,59%*
Singapore	*2000 - 2008*	*T-Bill 3 Month*	*FTSE EPRA/NAREIT*	*STI*	*CGBI SG*	-
	Return	*1,67%*	*14,86%*	*8,77%*	*3,98%*	-
	Risk	*0,24%*	*32,15%*	*21,29%*	*3,33%*	-
Japan	*2000 - 2008*	*JPM CASH 3 Month*	*FTSE EPRA/NAREIT*	*S&P TOPIX*	*JPM JAPAN*	*ML JAPAN AAA*
	Return	*0,30%*	*17,00%*	*1,03%*	*1,53%*	*1,14%*
	Risk	*0,11%*	*28,43%*	*19,37%*	*2,35%*	*1,82%*

This first set of results brings to the conclusion that investing in real estate securities may provide gains in term of average return risk relationship, at least if compared to the stock assets under examination. The diversification topic will be further on treated in the following paragraph, through the study of the correlation coefficients.

3.2 Cross Regional Asset Correlations

In this section I explain the cross regional correlations between the ten countries. As the previous section, the analysis is divided in two periods: one from 1993 to 2008,and another sub-period from 2000 to 2008. For this study a complete historical data series for the Singaporean EPRA/NAREIT index was not available. The correlation matrices are derived from comparisons of monthly total returns for the asset categories.

Exhibit 3 and 4 provide the correlation coefficients of national EPRA/NAREIT indices, considering all the 10 countries, over the main and sub-period respectively. The correlation matrix in exhibit 4 shows that for the shorter period the correlation coefficients are stronger. As expected, the highest correlations are detected between those countries which come from the same continent. In particular, the Canadian and US market correlation results to be 0.6 in the sub-period and 0.75 in the main period. In both periods the lowest correlation coefficients appear between the US and Japanese market: 0.14 and 0.13 in the main and sub-period respectively. In general the correlation coefficients maintain quite low values. From exhibit 3, I have verified that the average value from 1993 to 2008 is 0.31 while from 2000 to 2008 is 0.43. In countries like Switzerland and Japan, the correlations with other foreign property companies result to be the lowest. Furthermore, when the comparison is focused on different continents the correlations' decrease is apparent.

Exhibit 3 Correlation Matrix 1993 – 2008 (Indirect Real Estate Market)

	EPRA/NAREIT BELGIUM	*EPRA/NAREIT FRANCE*	*EPRA/NAREIT GERMANY*	*EPRA/NAREIT UK*	*EPRA/NAREIT SWITZERLAND*	*EPRA/NAREIT US*	*EPRA/NAREIT CANADA*	*EPRA/NAREIT AUSTRALIA*	*EPRA/NAREIT JAPAN*	*EPRA/NAREIT SINGAPORE*
EPRA/NAREIT BELGIUM	*1,00*									
EPRA/NAREIT FRANCE	*0,49*	*1,00*								
EPRA/NAREIT GERMANY	*0,36*	*0,49*	*1,00*							
EPRA/NAREIT UK	*0,34*	*0,54*	*0,44*	*1,00*						
EPRA/NAREIT SWITZERLAND	*0,42*	*0,48*	*0,29*	*0,24*	*1,00*					
EPRA/NAREIT UNITED STATES	*0,31*	*0,43*	*0,30*	*0,43*	*0,19*	*1,00*				
EPRA/NAREIT CANADA	*0,31*	*0,43*	*0,33*	*0,38*	*0,14*	*0,60*	*1,00*			
EPRA/NAREIT AUSTRALIA	*0,33*	*0,39*	*0,25*	*0,29*	*0,19*	*0,28*	*0,29*	*1,00*		
EPRA/NAREIT JAPAN	*0,17*	*0,24*	*0,18*	*0,26*	*0,17*	*0,14*	*0,31*	*0,31*	*1,00*	
EPRA/NAREIT SINGAPORE	*0,25*	*0,30*	*0,22*	*0,28*	*0,19*	*0,24*	*0,31*	*0,24*	*0,26*	*1,00*

The correlation coefficients in this table have been calculated by means of the statistical analysis in excel. These correlation coefficient reflect the average correlation over the period described.

The higher values obtained in the sub-period can be considered an evidence of the fact that, over shorter time horizons, countries can be more significantly affected by external events respect to longer periods[i].

[i] The proof of this assumption is beyond the thesis purpose. It could be an issue to further research.

Exhibit 4 Correlation Matrix 2000 – 2008 (Indirect Real Estate Market)

	EPRA/NAREIT BELGIUM	EPRA/NAREIT FRANCE	EPRA/NAREIT GERMANY	EPRA/NAREIT UK	EPRA/NAREIT SWITZERLAND	EPRA/NAREIT US	EPRA/NAREIT CANADA	EPRA/NAREIT AUSTRALIA	EPRA/NAREIT JAPAN	EPRA/NAREIT SINGAPORE
EPRA/NAREIT BELGIUM	1,00									
EPRA/NAREIT FRANCE	0,60	1,00								
EPRA/NAREIT GERMANY	0,47	0,65	1,00							
EPRA/NAREIT UK	0,37	0,64	0,63	1,00						
EPRA/NAREIT SWITZERLAND	0,56	0,62	0,54	0,44	1,00					
EPRA/NAREIT UNITED STATES	0,43	0,58	0,45	0,49	0,44	1,00				
EPRA/NAREIT CANADA	0,49	0,63	0,48	0,56	0,45	0,75	1,00			
EPRA/NAREIT AUSTRALIA	0,37	0,47	0,37	0,34	0,23	0,37	0,48	1,00		
EPRA/NAREIT JAPAN	0,18	0,25	0,26	0,31	0,14	0,13	0,29	0,40	1,00	
EPRA/NAREIT SINGAPORE	0,35	0,47	0,32	0,46	0,33	0,34	0,41	0,35	0,26	1,00

The correlation coefficients in this table have been calculated by means of the statistical analysis in excel. These correlation coefficient reflect the average correlation over the period described.

Exhibit 5 and 6 show the correlation coefficients between the national stock markets. Contrarily from the real estate analysis, the correlations between countries result much higher. From 1993 to 2008, the lowest correlation value has been found between the Belgian and the Japanese market. Anyway the value remains pretty significant: 0.4. The highest value appears between the French and German market. Over the main period, the average correlation between the stock assets turns out to be 0.67.

Exhibit 5 Correlation Matrix 1993 – 2008 (Stock Market)

	BEL 20	CAC 40	DAX 30	FTSE 100	UBS 100	S&P 500	S&P/TSX	S&P/ASX 200	S&P TOPIX
BEL 20	1,00								
CAC 40	0,74	1,00							
DAX 30	0,70	0,88	1,00						
FTSE 100	0,72	0,85	0,77	1,00					
UBS 100	0,75	0,82	0,81	0,82	1,00				
S&P 500	0,63	0,78	0,74	0,81	0,77	1,00			
S&P/TSX	0,53	0,73	0,68	0,70	0,62	0,73	1,00		
S&P/ASX 200	0,58	0,65	0,60	0,67	0,64	0,64	0,68	1,00	
S&P TOPIX	0,40	0,56	0,55	0,50	0,54	0,47	0,55	0,60	1,00

The correlation coefficients in this table have been calculated by means of the statistical analysis in excel. These correlation coefficient reflect the average correlation over the period described.

As already seen for the real estate securities, the shorter sub-period shows stronger correlations as the main period. The average correlation between the different stock markets reaches the value of 0.72. Exhibit 5 shows that the maximum value comes out between the UBS 100 and the CAC 40 Index: 0.93. Even the minimum value, between the Belgian and Japanese market maintains a high

correlation standard: 0.46. The correlation matrices of the stock indices underline the existence of significantly high coefficients, over both the 1993 – 2008 and the 2000-2008 time period. This in turn implies that diversification benefits can hardly be found through stock-only investments.

Exhibit 6 Correlation Matrix 2000 – 2008 (Stock Market)

	BEL 20	CAC 40	DAX 30	FTSE 100	UBS 100	S&P 500	S&P/TSX	S&P/ASX 200	S&P TOPIX	STI
BEL 20	1,00									
CAC 40	0,78	1,00								
DAX 30	0,74	0,92	1,00							
FTSE 100	0,80	0,91	0,81	1,00						
UBS 100	0,82	0,93	0,86	0,87	1,00					
S&P 500	0,70	0,88	0,80	0,87	0,85	1,00				
S&P/TSX	0,61	0,77	0,73	0,73	0,66	0,73	1,00			
S&P/ASX 200	0,65	0,74	0,71	0,74	0,72	0,67	0,70	1,00		
S&P TOPIX	0,46	0,64	0,62	0,57	0,59	0,51	0,65	0,65	1,00	
STI	0,70	0,69	0,68	0,71	0,68	0,61	0,60	0,71	0,60	1,00

The correlation coefficients in this table have been calculated by means of the statistical analysis in excel. These correlation coefficient reflect the average correlation over the period described.

The government bonds have been the third asset considered. In this paragraph, a correlation study for corporate bonds has not been conducted, due to the lack of data available for all the countries. The results are shown in exhibits 7 and 8: the lowest correlation has been measured between the Belgian and Japanese market. The German and French markets result to be the most correlated. Even though the average value of the correlation coefficients is still high (0.59), the analysis of the coefficients shows that stronger diversification benefits could be obtained diversifying the investments among government bonds rather than stocks. This is particularly true when the diversification takes place between countries from different continents.

Exhibit 7 Correlation Matrix 1993 – 2008 (Government Bond Market)

	ML BELGIAN	ML FRENCH	ML GERMAN	JPM UK	SW DS	JPM US	JPM CANADA	JPM AUSTRALIA	JPM JAPAN
ML BELGIAN	1,00								
ML FRENCH	0,84	1,00							
ML GERMAN	0,76	0,86	1,00						
JPM UK	0,62	0,71	0,66	1,00					
SW DS	0,65	0,71	0,68	0,68	1,00				
JPM US	0,63	0,65	0,67	0,66	0,58	1,00			
JPM CANADA	0,56	0,61	0,58	0,68	0,58	0,78	1,00		
JPM AUSTRALIA	0,54	0,58	0,53	0,66	0,56	0,74	0,82	1,00	
JPM JAPAN	0,28	0,28	0,39	0,34	0,39	0,32	0,34	0,40	1,00

The correlation coefficients in this table have been calculated by means of the statistical analysis in excel. These correlation coefficient reflect the average correlation over the period described.

Exhibit 8 shows the results obtained in the sub-period. In the shorter period the correlations increase considerably. The maximum-minimum range goes from 0.89 to 0.44. The former appears to be a common trend among the European countries; the latter instead has been calculated between the Singaporean and Canadian market. Once again diversification between different continents seems more valuable than that obtainable within the same region.

Exhibit 8 Correlation Matrix 2000 – 2008 (Government Bond Market)

	ML BELGIAN	ML FRENCH	ML GERMAN	JPM UK	SW DS	JPM US	JPM CANADA	JPM AUSTRALIA	JPM JAPAN	CGBI WGBI SG
ML BELGIAN	1,00									
ML FRENCH	0,89	1,00								
ML GERMAN	0,88	0,87	1,00							
JPM UK	0,83	0,85	0,85	1,00						
SW DS	0,80	0,80	0,80	0,67	1,00					
JPM US	0,82	0,83	0,83	0,78	0,66	1,00				
JPM CANADA	0,80	0,81	0,81	0,76	0,63	0,88	1,00			
JPM AUSTRALIA	0,76	0,77	0,77	0,77	0,65	0,81	0,82	1,00		
JPM JAPAN	0,49	0,50	0,49	0,49	0,48	0,50	0,46	0,49	1,00	
CGBI WGBI SG	0,55	0,53	0,53	0,45	0,45	0,56	0,44	0,46	0,44	1,00

The correlation coefficients in this table have been calculated by means of the statistical analysis in excel. These correlation coefficient reflect the average correlation over the period described.

Finally, the study is concluded with the analysis of the money market. The correlation matrix in exhibit 9 shows quite variable outcomes between countries: the correlation coefficients range from a minimum of -0.02 to a maximum of 0.87. The former has been shown both between the Singaporean and French market and between the Singaporean and Japanese market and the latter between the Swiss and the German market. Once again diversification gains between different continents seem more apparent: the Oceanic and Asiatic continent show low values both between them and between the other continents. On the other hand, Europe and America turn out to be quite correlated markets both within and outside the continents.

Exhibit 9 Correlation Matrix 1993 – 2008 (Money Market)

	BELGIUM T-BILL	FRANCE CASH	MNY MKT GERMANY	UK CASH	SWITZ. CASH	US CASH	CANADA CASH	AUSTRALIA CASH	JAPAN CASH	SING. T-BILL
BELGIUM T-BILL	1,00									
FRANCE CASH	0,69	1,00								
MNY MKT GERMANY	0,86	0,71	1,00							
UK CASH	0,38	0,46	0,42	1,00						
SWITZ. CASH	0,83	0,72	0,87	0,43	1,00					
US CASH	0,34	0,41	0,41	0,73	0,46	1,00				
CANADA CASH	0,48	0,59	0,51	0,58	0,58	0,69	1,00			
AUSTRALIA CASH	0,14	0,40	0,22	0,44	0,33	0,49	0,52	1,00		
JAPAN CASH	0,81	0,63	0,75	0,35	0,71	0,25	0,44	0,28	1,00	
SING. T-BILL	0,04	-0,02	0,09	0,26	0,09	0,47	0,07	0,04	-0,02	1,00

The correlation coefficients in this table have been calculated by means of the statistical analysis in excel. These correlation coefficient reflect the average correlation over the period described.

The analysis of the sub-period 2000 – 2008 basically confirms the outcomes obtained for the other assets. The maximum/minimum correlation is now stronger. The range shrinks between 0.16 and 0.92. The highest value is measured between the German and Swiss market. Also the average value of the correlation coefficients results to be higher than the main period, passing from 0.44 to 0.61.

Exhibit 10 Correlation Matrix 2000 – 2008 (Money Market)

	BELGIUM T-BILL	FRANCE CASH	MNY MKT GERMANY	UK CASH	SWITZ. CASH	US CASH	CANADA CASH	AUSTRALIA CASH	JAPAN CASH	SING. T-BILL
BELGIUM T-BILL	1,00									
FRANCE CASH	0,82	1,00								
MNY MKT GERMANY	0,88	0,83	1,00							
UK CASH	0,67	0,66	0,70	1,00						
SWITZ. CASH	0,91	0,88	0,92	0,72	1,00					
US CASH	0,73	0,63	0,72	0,74	0,71	1,00				
CANADA CASH	0,77	0,73	0,76	0,74	0,75	0,87	1,00			
AUSTRALIA CASH	0,40	0,51	0,49	0,71	0,45	0,56	0,55	1,00		
JAPAN CASH	0,53	0,59	0,63	0,57	0,54	0,47	0,48	0,72	1,00	
SING. T-BILL	0,34	0,18	0,33	0,41	0,31	0,74	0,47	0,32	0,16	1,00

The correlation coefficients in this table have been calculated by means of the statistical analysis in excel. These correlation coefficient reflect the average correlation over the period described.

This last study found that diversification benefits may rise by investing in money markets of different continents. For the first time in this cross regional asset analysis, negative values appear between countries and the correlations reach unprecedented low values. Nevertheless, the average correlations remain quite high. Once again, the inter-continental diversification is rewarded.

3.3 Monthly Return Analysis

In this section I show the results obtained in the monthly return analysis. The study takes into consideration 4 major asset classes: cash, bonds, stocks and real estate securities. It considers monthly indices' trends of each country singularly. Due to data availability, the corporate bond trend has not been analyzed.

Figure 3.1 shows the total returns of the US market indices. Over the course of the years, both the American EPRA/NAREIT index and the S&P 500 have obtained positive performances in terms of average total returns. On the other hand, the real estate index shows minor fluctuations than the stock index, especially over the sub-period 2000 - 2008. This explains the constant high exposure of the US market portfolio in indirect real estate securities. In both periods, the optimal allocation in the US NAREIT index always ranges between 26% and 31%[ii]. Despite the lower volatility of the indirect property investment, the US average total return[iii] performs significantly better than the stock market throughout the sub-period. Figure 3.1 below gives a picture of the US indices' performances.

[ii] See the "Mixed – Asset Portfolios Analysis" in paragraph 5.2.

[iii] In this analysis all the average total returns are considered on annual basis.

Figure 3.1 (US Market Monthly Returns. Time period: 1993 – 2008)

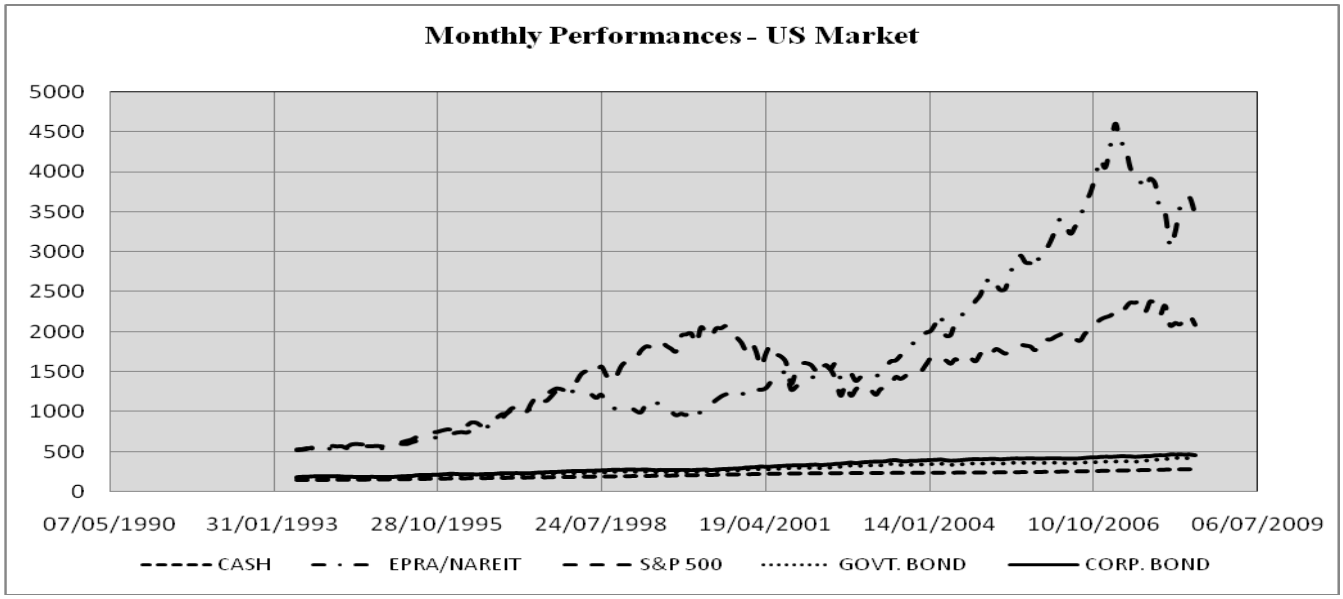
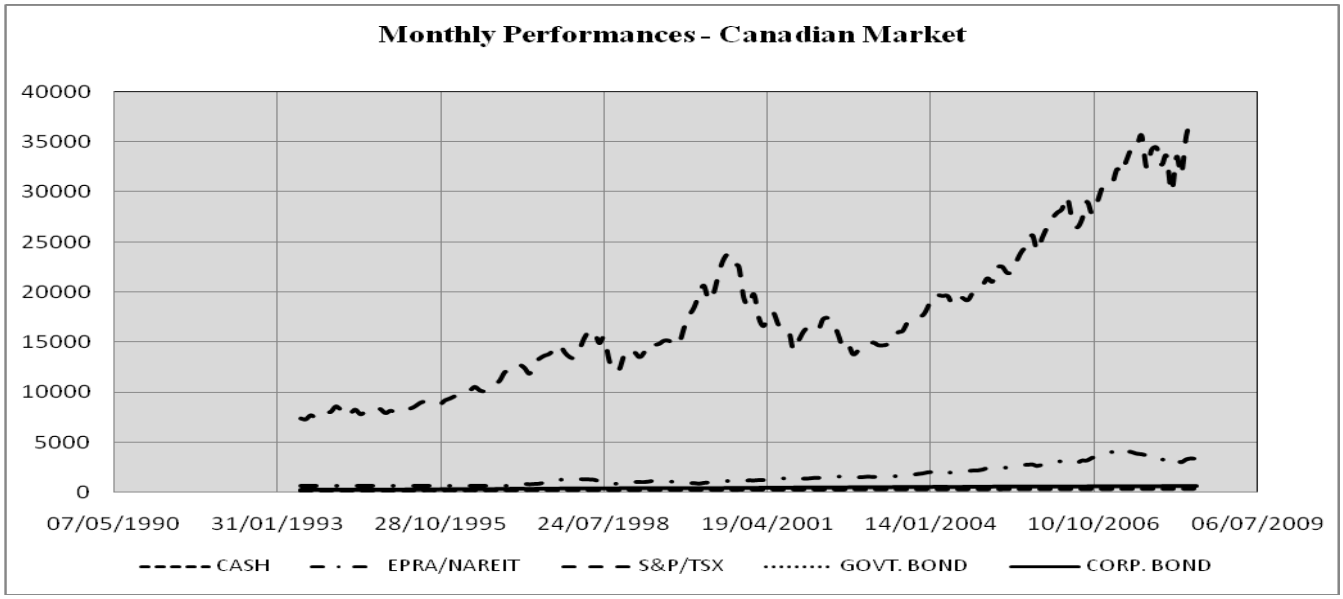


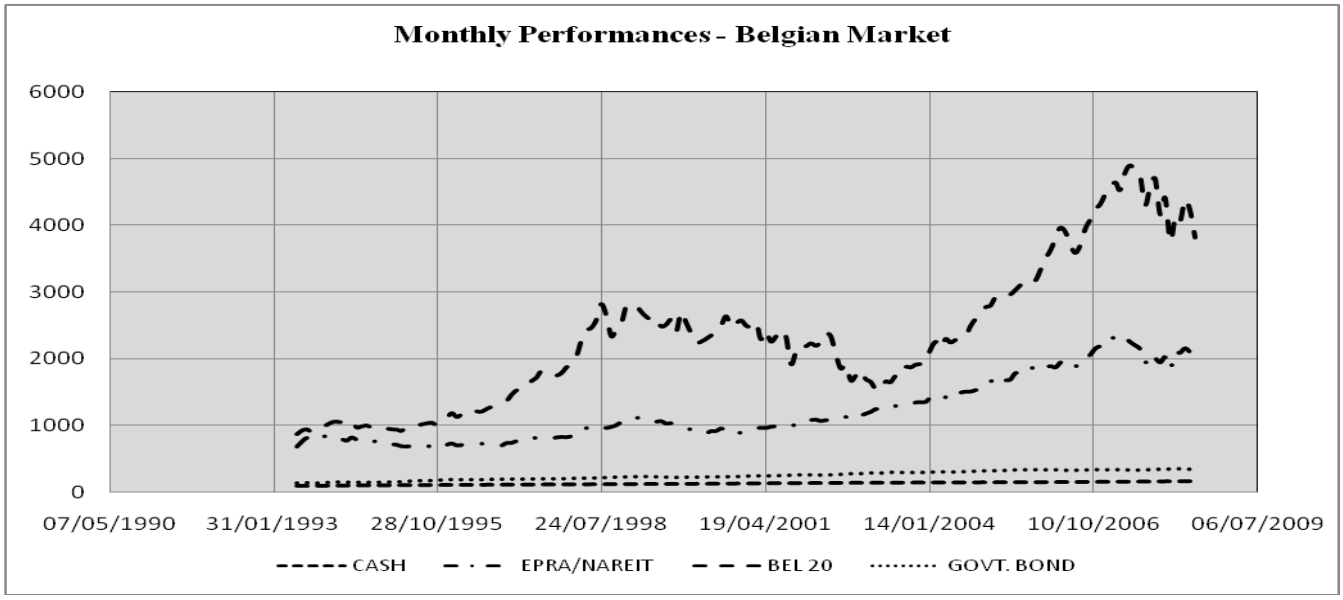
Figure 3.2 shows the performances of the Canadian market over the period 1993 – 2008. Considering the sub-period 2000-2008, it is possible to notice that the EPRA/NAREIT Index has performed better than the other indices. The volatility, expressed by the index fluctuations, is large but still lower than the stock market. The study of the entire period (from 1993 to 2008), however, underlines a slightly higher performance of the stock market, in terms of average total return, respect to the NAREIT index. On the other hand, the volatilities of the real estate and stock index approach to similar values.

Figure 3.2 (Canadian Market Monthly Returns. Time period: 1993 – 2008)



The analysis of the Belgian market shows two different trends. Basing the study on the entire period, it is apparent that the BEL 20 has obtained better performances than the NAREIT index, in terms of average total return. Figure 3.3 below plots the trend of the four assets.

Figure 3.3 (Belgian Market Monthly Returns. Time period: 1993 – 2008)

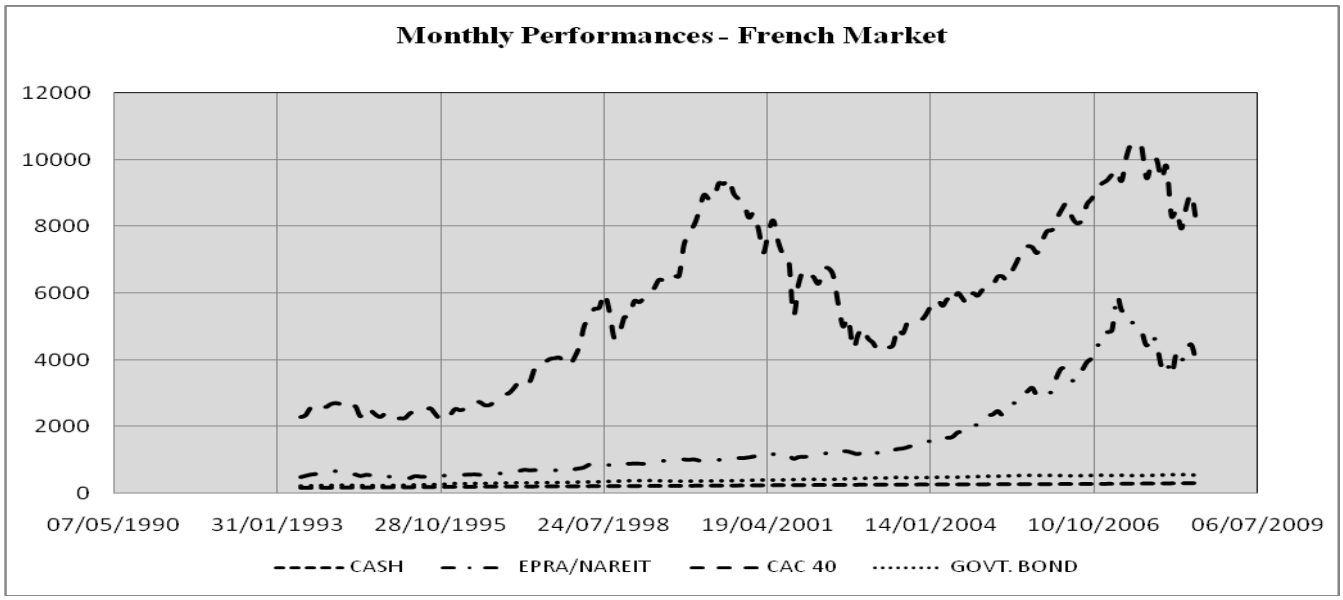


On the other hand, the better trend of the stock asset has been accompanied by a higher volatility. During the sub-period 2000 - 2008, the real estate returns have been remarkable, performing better

than the Belgian stocks. The volatility of the EPRA/NAREIT index, however, has been maintained to lower values over both the periods considered.

The situation of the French market is represented in figure 3.4. It shows that, from 1993 to 2008, the volatility of the CAC 40 resulted to be higher than the French NAREIT index.

Figure 3.4 (French Market Monthly Returns. Time period: 1993 – 2008)



Despite of this, the average total returns of the real estate securities have been higher in both periods and, in particular way, from 2000 to 2008.

A quite opposite situation has been experienced by the German market. From 1993 to 2008, the trend of the German NAREIT index shows a significant level of risk. From figure 3.5 it can be observed that the NAREIT performances have been particularly weak. In June 2008, the real estate index barely ends up with a higher value than that measured in June 1993 (starting point of my analysis): from 639 the closing value turned out to be 787, which is, over a 15 years time period, a pretty dramatic outcome for an equity index. This basically explains why in the following optimization analysis[iv] the German EPRA/NAREIT index will never enter the optimal market portfolio.

[iv] See paragraph 5.2.

Figure 3.5 (German Market Monthly Returns. Time period: 1993 – 2008)

Figure 3.6 depicts the performances of the UK market. Over the entire period, the EPRA/NAREIT index has obtained positive returns, posing a quite large volatility. The analysis of the sub-period shows an even more positive trend, in terms of average total returns. From the comparison of the NAREIT with the FTSE 100 index it is possible to notice that the real estate index has performed significantly better than stock index, maintaining very similar levels of risk. Over the long run, however, the FTSE 100 "beat" the NAREIT index in terms of both higher average total return and lower average volatility.

Figure 3.6 (UK Market Monthly Returns. Time period: 1993 – 2008)

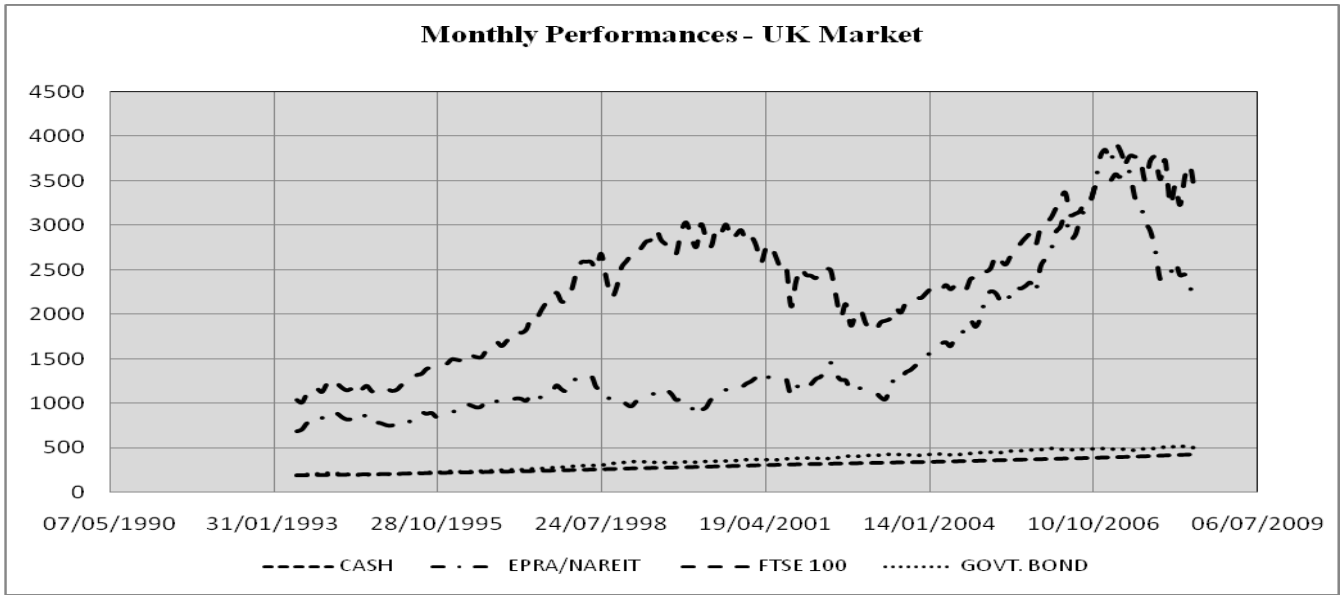
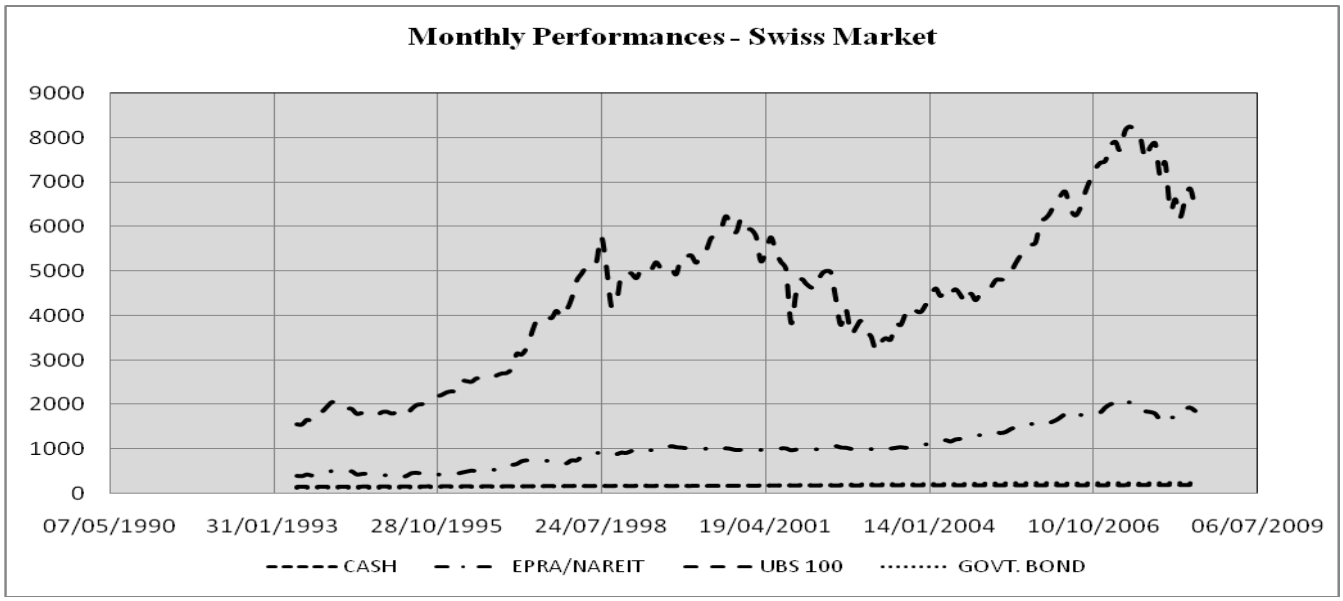


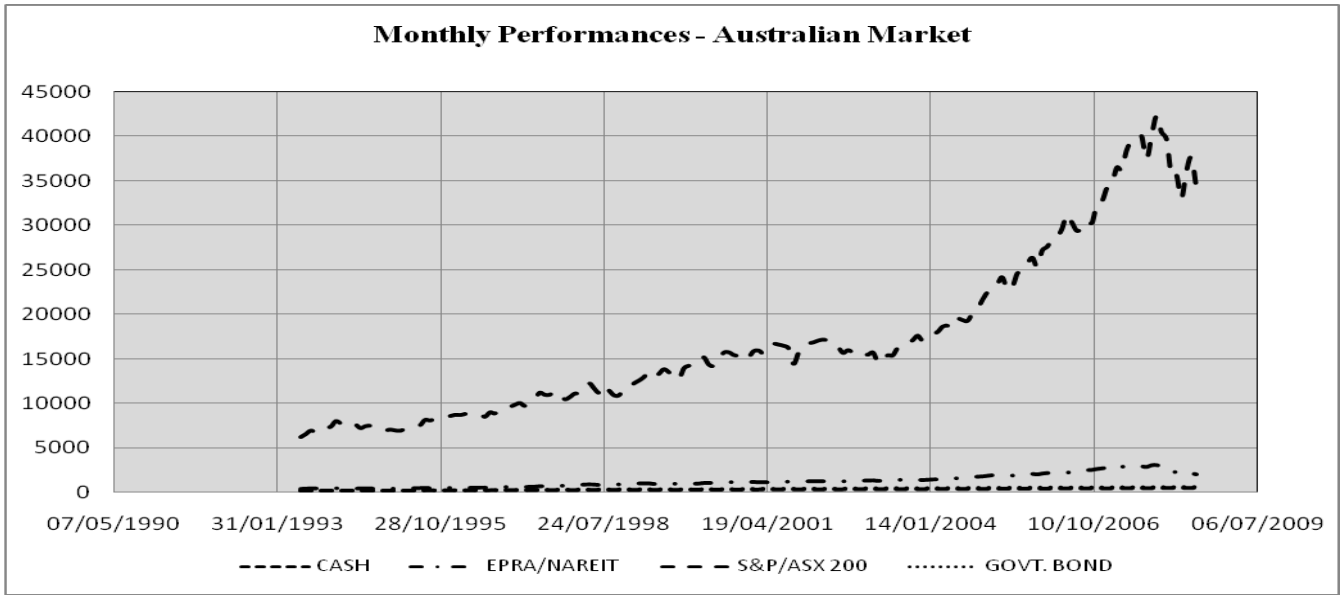
Figure 3.7 represents the results of the Swiss market. In the long run the Swiss NAREIT index has obtained positive average total return performances, in line with the UBS 100 index. The graph below shows a low volatility of the local real estate securities, especially if compared with the stock index. Furthermore, over the sub-period, the NAREIT index has performed two times better than the UBS 100 in terms of average total return.

Figure 3.7 (Swiss Market Monthly Returns. Time period: 1993 – 2008)



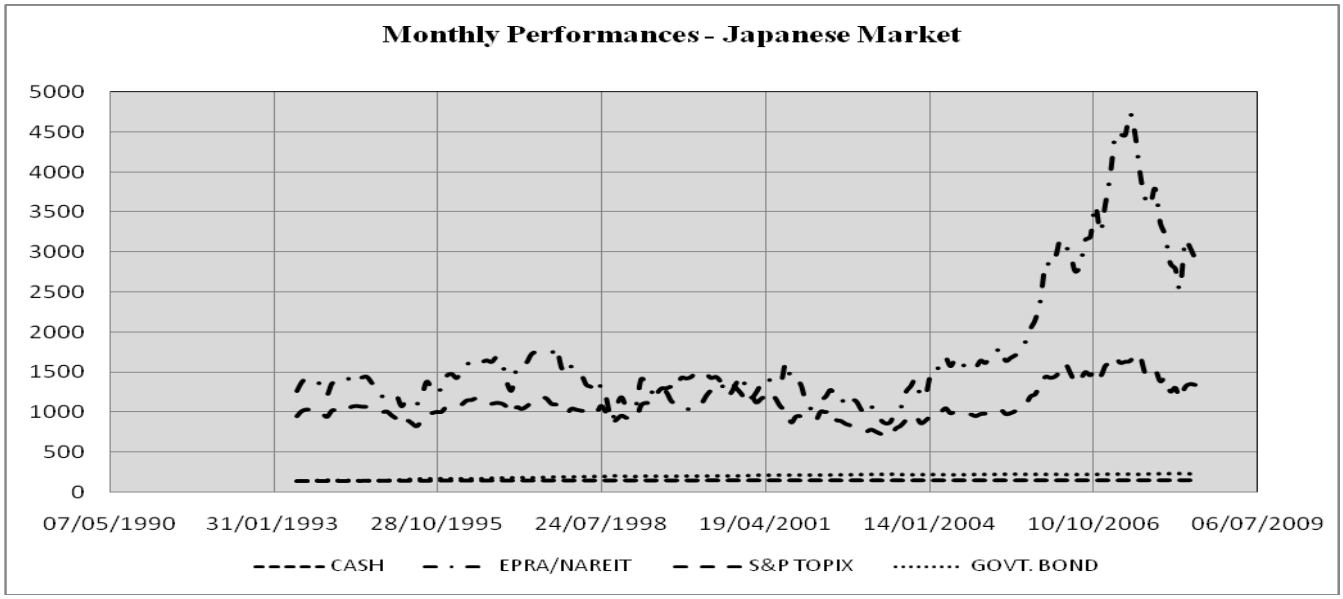
In the Australian market, the NAREIT and S&P/ASX 200 indices have performed similarly: from 1993 to 2008 the rates of return have shown close values. Figure 3.8 plots the volatility of the Australian real estate index, putting into evidence its lower fluctuations than those experienced by the stock index, both in the sub and in the main period. On the other hand, as it can be seen in the graph below, over the period 2000 – 2008,the S&P/ASX 200 has outperformed the Australian NAREIT, in terms of average total return. The analysis conducted over the 1993 -2008 time period explains why, in the optimization analysis, the Australian NAREIT index will present percentages above the typical optimal range.

Figure 3.8 (Australian Market Monthly Returns. Time period: 1993 – 2008)



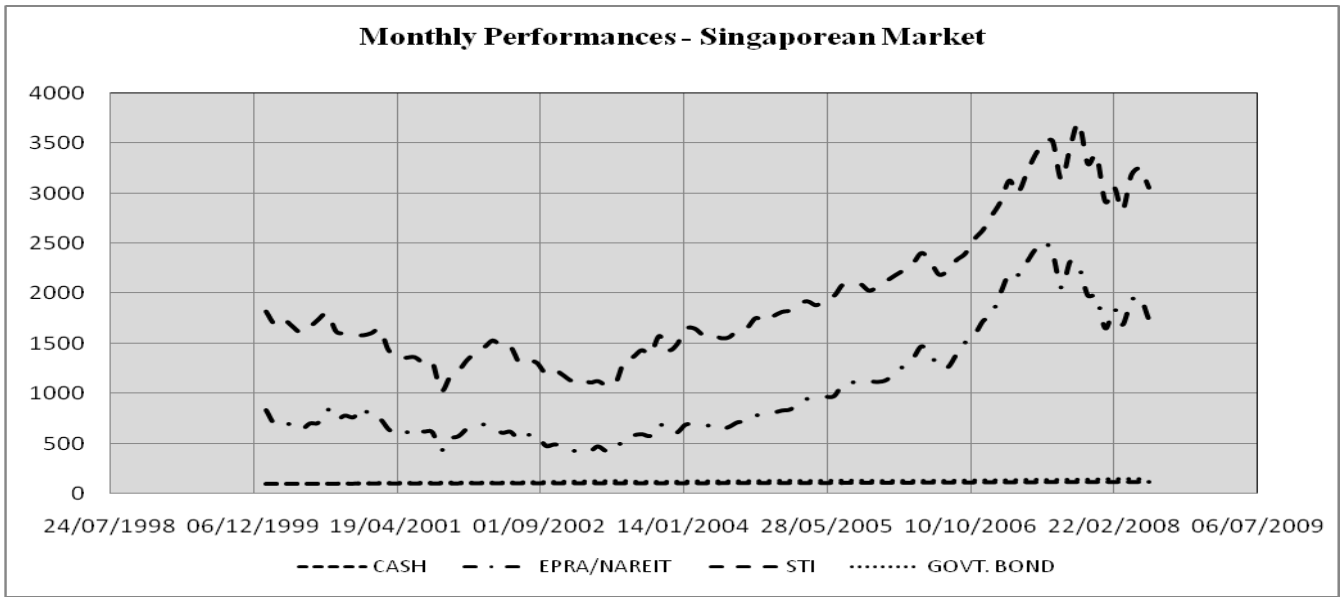
The Japanese real estate index, in my analysis, has been the top performer of the local market, in terms of average total return, both in the main and in the sub-period. Nevertheless, as figure 3.9 reveals, these top performances have been accompanied by extremely high fluctuations of the local NAREIT index. Comparing it with the local S&P TOPIX, it appears that the real estate index has been riskier than the stock index. On the other hand, over the past 15 years, the average NAREIT total return has been by far higher than the local stock benchmark (in my case the S&P TOPIX).

Figure 3.9 (Japanese Market Monthly Returns. Time period: 1993 – 2008)



Finally, for the Singaporean market, the monthly performance analysis has been conducted only for the period 2000 - 2008. Figure 3.10 shows that the Singaporean NAREIT index has been very volatile over the past 8 years, performing positive total returns. The comparison with the STI stock index gives evidence of the better performances of the real estate index, even though accompanied by significantly high levels of volatility.

Figure 3.10 (Singaporean Market Monthly Returns. Time period: 2000 – 2008)



4. Methodology

This chapter will be structured as follows. The first paragraph will offer a detailed description of the data, including the sources used. In the second paragraph I explain formulas and the empirical model used. In the third and last paragraph I will elicit my conclusions.

4.1 Data, Time Periods and Analysis Framework

For the analysis conducted in my thesis, I obtained the data from DataStream dataset, available at the University of Amsterdam. I analyze ten different countries, which in turn represent four different continents: America, Asia, Europe and Oceania. The countries studied are Australia, Belgium, Canada, France, Germany, Japan, Singapore, Switzerland, the United Kingdom and the United States of America. The time horizon ranges between a minimum of 8 years and a maximum of 15 years, starting June 21st 1993 to June 21st 2008. The time frame for this type of researches is typically 10 years or even less. From this perspective, my thesis takes into exam a more statistically significant dataset than previous researches. Nevertheless, a dataset of 15 years was not readily available for the Singaporean market, for which was only available the period that goes from 2000 to 2008, at least for the stock and government index. A complete dataset from 1993 to 2008 was, in fact, available for the Singaporean NAREIT index. However, for comparison reasons, a second study has been run using only "one for all" time horizon of 8 years, which corresponds to time period used for Singapore. The indices found are all expressed in total returns. The total return index (RI) is constructed using an annualized dividend yield, as follows:

$$RI_t = RI_{t-1} * (PI_t / PI_{t-1}) * (1 + DY_t/100 * 1/N)$$

Where:

RI_t = return index on day t

RI_{t-1} = return index on previous day

PI_t = price index on day t

PI_{t-1} = price index on previous day

DY_t = dividend yield % on day t

N = number of working days in the year (as common practice 260)

The use of a total return index, which also accounts for dividend payment data, enables a more realistic method, since the discrete quantity of dividend paid is added to the price on the ex-date of the payment. Then:

$$RI_t = RI_{t-1} * (PI_t / PI_{t-1})$$

except when t = ex-date of the dividend payment D_t then:

$$RI_t = RI_{t-1} * [(P_t + D_t) / PI_{t-1}]$$

Where:

P_t = price on ex-date

P_{t-1} = price on previous day

D_t = dividend payment associated with ex-date t

Gross dividends are used, where available, and the calculation ignores tax and re-investment charges. Adjusted closing prices are used throughout to determine price index and hence return index. At this point the RI is calculated back to the base date.

In the optimization analysis the optimal portfolios are built taking into consideration the traditional four major categories: cash, stocks, bonds and real estate. The indices generally come from same sources and use same computation's methods. All the property indices are EPRA/NAREITs (National Association of Real Estate Investment Trusts) from FTSE. I use the NAREIT index for one main reason: this index is not appraisal based, which means that does not suffer from the smoothing and seasonal biases. The money market has been generally represented by the 3 month cash index from JP Morgan. Only for three countries, in particular Belgium, Germany and Singapore, I used 3 month Treasury Bills. Given that the short term T-Bills were expressed in

interest rate values (not percentages) on an annual basis, I have computed the monthly returns by indexing the interest rates as follows:

$$R_M = (I_A/12)/100$$

Where R_M is the monthly return and I_A the interest value expressed on annual basis.

For the stock assets I use national indices, typically considered local benchmarks. For the European continent, I selected the BEL 20, the CAC 40, the DAX 30, the UBS 100 and the FTSE 100 indices for the Belgian, French, German, Swiss and UK market respectively. As regards the American continent, I used the S&P 500 and S&P/TSX COMPOSITE indices, for the US and Canadian market; the Australian S&P/ASX 200, for the Oceanic continent and, finally, the Japanese S&P TOPIX 150 and the Singaporean STI indices, for the Asiatic continent. The common characteristic of these equity indices is that they are liquid, tradable, easily replicable and they basically include all the leading companies quoted in the local stock exchanges. The dimension of these indices varies depending on the country size. As regards the bond assets, I take into consideration both government and, where available, corporate bond indices. The former are constituted by "all maturities" bonds, the latter by A-grade bonds. Given the high correlation coefficients shown between these two bond asset classes, and due to data availability, I also run an analysis without including the corporate bonds. This also gave me the possibility to verify if the better performances of the corporate bond, in terms of return risk relationship, could have somehow affected the optimal amounts that should be invested in real estate securities. The bond indices are taken from DataStream and the sources vary from JP Morgan and Merrill Lynch to CitiGroup. All the bond indices are constituted by using a bunch of all maturities government and corporate bonds.

4.2 Portfolio Optimization – Sharpe Model (CAPM)

The basic objective of the CAPM model is to describe the relationship between the risk and the expected return in condition of high developed countries. This model has been invented by W. Sharpe and J. Lintner in 1960. The rationale of the CAPM is that an investor can eliminate the residual risk, which is the intrinsic or specific risk of a particular company, whilst holding a diversified portfolio of assets. On the other hand the portfolio assumes that some systematic risks,

such as that of a recession, cannot be eliminated through diversification. Each investor, therefore, must be rewarded for this systematic risk by earning returns that must be higher than safer assets like T-Bills. The CAPM equilibrium return can be expressed by the following equation:

$E(r_p) = r_f + [E(r_m - r_f)/ s^2_m]COV_{im}$

In the equation above $E(R_p)$ represents the expected return on the capital asset, R_f the risk free interest rate, COV_{im} is the covariance between asset I and the market portfolio, s^2_m is the variance of the market portfolio, $E(r_m)$ is the expected return of the market and $[E(r_m - r_f)/ s^2_m]$ is the market required risk premium per unit of risk. $\beta_i = COV_{im} / s^2_m$ is the market beta, which is the asset *i* risk normalized by the risk of the overall portfolio.

The model uses the statistical variance as the measure of risk and the expected return as the measure of the portfolio long term prospects. The decision variables are the amounts to be invested in each asset and the final objective is to maximize the overall portfolio's return which is calculated according to Sharpe method.

The portfolio return risk relationship is determined by using the following formulas:

$$r_P = \sum_{n=1}^{N} w_n r_n \qquad (1)$$

$$VAR_P = \sum_{i=1}^{N}\sum_{j=1}^{N} w_i w_j COV_{ij} = \sum_{i=1}^{N}\sum_{j=1}^{N} w_i w_j S_i S_j C_{ij} \qquad (2)$$

Formula (1) represents the portfolio return, which is a linear function of the assets weights; formula (2) is the portfolio volatility that instead is a non linear function of the asset weights. From formula (2), it is possible to notice that COV_{ij} can be also calculated by multiplying the standard deviation of the assets *i* and *j* for the correlation coefficient between *i* and *j*.

In order to change the monthly returns and standard deviations to annual values, I used the following formulas:

$$[(1+r_m)^{12} - 1] \qquad (3)$$

$$(s_m)^{1/12} \qquad (4)$$

Where r_m represents the average of the time period monthly returns and s_m is average standard deviation of the monthly returns.

The covariance matrix has been calculated by means of the statistical analysis in excel, while the optimal portfolios through the Excel Solver. In this model, I have used the following constrains: $\sum w_n \geq 0$ and $\sum w_n = 1$. The first constrain means that the minimum investment amount in all the assets must be zero. In a so constrained portfolio, the shorting is not allowed. The meaning of the second constrain is that the investor must be fully invested. The final objective is to maximize the slope of the straight line from the risk free return through the market portfolio. The slope of the so called security market line (SML), is given by the following ratio:

$$SHARPE\ RATIO = (r_p - r_f)/s_p$$

The Sharpe ratio is widely considered a good measure of risk adjusted return, since it gives the risk premium per unit of risk measured by the standard deviation. The risk free monthly returns have been annualized by using the formula (3).

5. Performance Analysis

In this chapter, I will perform an in depth analysis of the optimal portfolio risks and returns. In paragraph 5.1 I will first assess the asset integrations, as described in chapter 4, and then I will describe the worldwide asset integrations. In paragraph 5.2 I will provide a description of the results of the efficient portfolios, and the consequent diversification benefits. Paragraph 5.3 will be focused on a real estate-only portfolio analysis. Finally, I will elicit my conclusion in paragraph 5.4.

5.1. World Asset Integrations

In chapter 4, I have analyzed the correlation coefficients, comparing same asset classes among different countries. One outstanding result has been that the government bond and stock assets present significant correlation coefficients both between continents and between countries. The study has also shown that the NAREIT and the money market assets present lower correlations than

bond and stock, especially in the study of different continents. As regards the REITs, this can be explained by their dual asset market nature, in which two markets exist for trading real estate assets: one which trades properties directly and another which trades REIT shares that provide ownership of underlying properties indirectly. The turning point, for REIT markets, is that private and public markets are not always consistent: REITs are often traded in very unique conditions, since unique are the local factors, and this could make the difference between the real estate and the equity-bond market.

In this section, I study the correlations between REITs and between REITs and government bond, stock and cash asset. In the analysis of the correlations between real estate securities I do not take into account the coefficients within the same country, given that it would be one. For comparison reasons, in order to conduct the study using same statistical observations for all the countries, even when different assets are examined, like French REITs and CAC 40, the correlation coefficients found within same countries are not considered. The comparison will be always done using the same number of observations. During the period 1993 – 2008, the analysis has shown that low average correlations exist between countries. The lowest average coefficient has been found between real estate securities and cash assets, -0.06, followed by the average correlation between NAREIT and government bond indices, 0.02. The average correlation between real estate securities turned out to be 0.31, while the one between stock and NAREIT indices 0.32. In this initial study, given the low correlations shown between the different assets, the diversification gains result to be evident both between real estate assets and between real estate, government and stock assets. The sub-period 2000 – 2008 shows that the average correlations between real estate securities and cash decrease further on: now the value is -0.17; same decreasing trend is experienced by REITs and government bonds, for which the correlation outcome is -0.07. On the other hand, the analysis of the correlation matrix between real estate securities and between stocks and REITs underlines increasing coefficients, respect to the main period. The correlation between REITs is now 0.43, while the correlation between REITs and stocks is 0.38. Even though these coefficients result slightly higher than the period 1993–2008, it seems that, from a mixed asset diversification perspective, these increased values could be “hedge” by the lower coefficients found between real estate securities and cash/bond assets. Also this section gives evidence of diversification opportunities through the investment in indirect real estate.

5.2 Mixed – Asset Portfolio Analysis

Exhibit 11 provides a preliminary description of the results obtained in analysis 1[v]. The portfolios are built from the perspective of a national investor who invests in his own local market. The purpose of this preliminary study is to examine what percentage of REITs should be optimal in national and international portfolios. When the cash asset does not enter the portfolio the typical indirect real estate allocation ranges between 0 and 43%. The general allocation trend, however, results to be between 5 and 25%. The three more impressive results are represented by the Australian, German and US market, which tend to show an above or below average exposure: 43% and 0% and 30% respectively. Due to the very weak performances of the German NAREIT index, throughout the six analyses the indirect real estate investment never enters the optimal portfolio allocation of the German market. Due to data availability reasons, in analysis 1 the time horizon of the Japanese and Singaporean portfolio is shorter than the main period (1993-2008). In analysis 3, only the Singaporean market keeps the different time horizon.

Exhibit 11 (Optimal Portfolio Weights – No Cash)

Country	Continent	Time Horizon	Optimal Portfolio Return	Optimal Portfolio St.deviation	Sharpe ratio	EPRA/NAREIT Weight	Stock Index Weight	Govt. Bond Index Weight	Corp.Bond Index Weight
US	America	1993 - 2008	9%	6%	0,79	30%	8%	29%	33%
Canada	America	1993 - 2008	8%	4%	0,92	9%	10%	37%	43%
Japan	Asia	1997 - 2008	3%	3%	0,86	5%	3%	45%	47%
Singapore	Asia	2000 - 2008	5%	3%	0,87	5%	2%	93%	-
Belgium	Europe	1993 - 2008	7%	4%	0,81	9%	12%	78%	-
France	Europe	1993 - 2008	9%	5%	0,86	23%	2%	75%	-
Germany	Europe	1993 - 2008	6%	4%	0,72	0%	13%	87%	-
UK	Europe	1993 - 2008	8%	6%	0,33	9%	19%	72%	-
Switzerland	Europe	1993 - 2008	6%	5%	0,94	21%	10%	69%	
Australia	Oceania	1993 - 2008	12%	9%	0,61	43%	35%	21%	-
Average						15%			

Exhibit 12 below summarizes the optimal REIT asset allocation, when a shorter time horizon, (same for all the countries) is studied. The typical allocation range remains quite consistent with the main period, ranging between 4 and 26%. The US and Australian markets are now within the optimal range that, according to my analysis, should be invested in indirect real estate. This gives value to the hypothesis that possible national events could have affected the optimal allocation

[v] See paragraph 3.1 for a review of the general structure.

percentages obtained in analysis 1[vi]. On the other hand, the UK and Swiss markets show above range percentages: 53 and 34% respectively. Such a big change, compared with the previous analysis, is mainly due to the fact that, over the sub-period, the UK and Swiss stock market returns have been significantly lower than those yielded over the entire 15 years period. This has led the two countries to move the optimal investment amount from the national stock to the national NAREIT index.

Exhibit 12 (Optimal Portfolio Weights – No cash. Time period: 2000 – 2008)

Country	Continent	Time Horizon	Optimal Portfolio Return	Optimal Portfolio St.deviation	Sharpe ratio	EPRA/NAREIT Weight	Stock Index Weight	Govt. Bond Index Weight	Corp.Bond Index Weight
US	America	2000 - 2008	9%	5%	1,01	26%	0%	8%	65%
Canada	America	2000 - 2008	9%	4%	1,26	22%	4%	75%	0%
Japan	Asia	2000 - 2008	3%	3%	0,94	8%	0%	92%	0%
Singapore	Asia	2000 - 2008	5%	3%	0,87	5%	2%	93%	-
Belgium	Europe	2000 - 2008	6%	4%	0,89	23%	4%	73%	-
France	Europe	2000 - 2008	8%	5%	0,95	24%	0%	76%	-
Germany	Europe	2000 - 2008	5%	3%	0,47	0%	4%	96%	-
UK	Europe	2000 - 2008	9%	10%	0,36	53%	0%	0%	47%
Switzerland	Europe	2000 - 2008	5%	4%	0,91	34%	1%	65%	-
Australia	Oceania	2000 - 2008	9%	5%	0,50	4%	38%	58%	0%
Average						20%			

The average of the optimal national weights turns out to be 15% in analysis 1 and 20% in analysis 2. In these two analyses the corporate bond assets have entered the portfolio allocation, when available.

In analysis 3 and 4, I also add the cash asset to the previous portfolios. Consistently with analysis 1 the optimal allocation range in indirect real estate securities is between 5 and 25%. Only the US market keeps showing an above range percentage (30%). The explanation comes from the very competitive return risk relationship of the US NAREIT index which, in the last 15 years, has constantly "beaten" the local S&P 500[vii].

[vi] Even though the find of the causes which have brought these "abnormal" values are outside the thesis purpose, an explanation of these results can be found in paragraph 3.3 which analyzes the monthly returns of every country singularly.

[vii] See analysis in paragraph 3.3 about the US market.

Exhibit 13 (Optimal Portfolio Weights – Cash Included)

Country	Continent	Time Horizon	Optimal Portfolio Return	Optimal Portfolio St.deviation	Sharpe ratio	Cash	EPRA/NAREIT Weight	Stock Index Weight	Govt. Bond Index Weight	Corp.Bond Index Weight
US	America	1993 - 2008	9%	6%	0,79	0%	30%	8%	29%	33%
Canada	America	1993 - 2008	8%	4%	0,92	0%	9%	10%	37%	43%
Japan	Asia	1997 - 2008	3%	3%	0,86	0%	5%	3%	45%	47%
Singapore	Asia	2000 - 2008	5%	3%	0,87	0%	5%	2%	93%	-
Belgium	Europe	1993 - 2008	7%	4%	0,81	0%	9%	12%	78%	-
France	Europe	1993 - 2008	9%	5%	0,86	0%	23%	2%	75%	-
Germany	Europe	1993 - 2008	6%	4%	0,72	0%	0%	13%	87%	-
UK	Europe	1993 - 2008	8%	6%	0,33	0%	9%	19%	72%	-
Switzerland	Europe	1993 - 2008	6%	5%	0,94	0%	21%	10%	69%	-
Australia	Oceania	1993 - 2008	12%	9%	0,61	0%	43%	35%	21%	-
Average							15%			

Exhibit 14 shows the results obtained in the sub-period 2000-2008. Except the German market, all the countries' percentages result to be in a range between 3 and 26%.

Exhibit 14 (Optimal Portfolio Weights – Cash Included. Time Period: 2000 – 2008)

Country	Continent	Time Horizon	Optimal Portfolio Return	Optimal Portfolio St.deviation	Sharpe ratio	Cash	EPRA/NAREIT Weight	Stock Index Weight	Govt. Bond Index Weight	Corp.Bond Index Weight
US	America	2000 - 2008	9%	5%	1,01	0%	26%	0%	8%	65%
Canada	America	2000 - 2008	9%	4%	1,26	0%	22%	4%	75%	0%
Japan	Asia	2000 - 2008	3%	3%	0,94	0%	8%	0%	92%	0%
Singapore	Asia	2000 - 2008	5%	3%	0,87	0%	5%	2%	93%	-
Belgium	Europe	2000 - 2008	4%	1%	0,90	65%	8%	2%	26%	-
France	Europe	2000 - 2008	5%	1%	0,97	75%	6%	0%	19%	-
Germany	Europe	2000 - 2008	4%	2%	0,48	44%	0%	2%	53%	-
UK	Europe	2000 - 2008	6%	2%	0,37	81%	11%	0%	0%	9%
Switzerland	Europe	2000 - 2008	3%	1%	0,93	69%	11%	1%	20%	-
Australia	Oceania	2000 - 2008	8%	4%	0,50	17%	3%	32%	48%	0%
Average							10%			

The average of the optimal percentages is 15% in analysis 3 and 10% in analysis 4. These two last studies show more coherent results. It seems that the inclusion of the cash asset has balanced the investment amounts, and also the investment percentages in indirect real estate do not present significant above or below range results.

Finally, Exhibit 15 and 16 provide an overview of the results obtained when the corporate bond assets exit the analysis of the optimal portfolio allocation. The objective of these two analyses is to determine the optimal average percentage that should be invested in indirect real estate, through the study of homogenous portfolios, in terms of asset allocation. Analysis 5 and 6 are, therefore, conducted considering allocations among cash, government bonds, stocks and real estate security assets.

Exhibit 15 (Optimal Portfolio Weights – Corporate Bond Asset Excluded)

Country	Continent	Time Horizon	Optimal Portfolio Return	Optimal Portfolio St.deviation	Sharpe ratio	Cash	EPRA/NAREIT Weight	Stock Index Weight	Govt. Bond Index Weight
US	America	1993 - 2008	9%	6%	0,78	0%	31%	9%	60%
Canada	America	1993 - 2008	9%	5%	0,85	0%	14%	12%	73%
Japan	Asia	1993 - 2008	4%	3%	0,95	0%	5%	4%	91%
Singapore	Asia	2000 - 2008	5%	3%	0,87	0%	5%	2%	93%
Belgium	Europe	1993 - 2008	7%	4%	0,81	0%	9%	12%	78%
France	Europe	1993 - 2008	9%	5%	0,86	0%	23%	2%	75%
Germany	Europe	1993 - 2008	6%	4%	0,72	0%	0%	13%	87%
UK	Europe	1993 - 2008	8%	6%	0,33	0%	9%	19%	72%
Switzerland	Europe	1993 - 2008	6%	5%	0,94	0%	21%	10%	69%
Australia	Oceania	1993 - 2008	12%	9%	0,61	0%	43%	35%	21%
Average							16%		

As expected, given the high correlation between the corporate and the government assets and the similar performances of these two assets over time, the effect of this new portfolio allocation has been to move the optimal investment exposures from the corporate to the government bonds. The NAREIT index has been affected only marginally and, however, it keeps staying within the typical range of 5 - 25%.

Exhibit 16 (Optimal Portfolio Weights – Corporate Bond Asset Excluded. Time period: 2000 - 2008)

Country	Continent	Time Horizon	Optimal Portfolio Return	Optimal Portfolio St.deviation	Sharpe ratio	Cash	EPRA/NAREIT Weight	Stock Index Weight	Govt. Bond Index Weight
US	America	2000 - 2008	10%	6%	1,00	0%	31%	0%	69%
Canada	America	2000 - 2008	9%	4%	1,26	0%	22%	4%	75%
Japan	Asia	2000 - 2008	3%	3%	0,94	0%	8%	0%	92%
Singapore	Asia	2000 - 2008	5%	3%	0,87	0%	5%	2%	93%
Belgium	Europe	2000 - 2008	4%	1%	0,90	65%	8%	2%	26%
France	Europe	2000 - 2008	5%	1%	0,97	75%	6%	0%	19%
Germany	Europe	2000 - 2008	4%	2%	0,48	44%	0%	2%	53%
UK	Europe	2000 - 2008	6%	2%	0,36	89%	11%	0%	0%
Switzerland	Europe	2000 - 2008	3%	1%	0,93	69%	11%	1%	20%
Australia	Oceania	2000 - 2008	8%	4%	0,50	17%	3%	32%	48%
Average							11%		

For the US market the results obtained remain consistent with the previous: the US optimal percentage re-presents an above range result (31%) both in the main and in the sub-period. Also the optimal percentage of the Canadian market increases until reaching the value of 14%, but still remaining within the range. These two new investment percentages have led the optimal average

exposure in indirect real estate to a 100 basis point increase respect to analysis 3, in particular from 15 to 16%.

In the 2000-2008 time frame, the optimal allocation ranges between 3% and 22% (with the exclusion of the US market). Exhibit 16 shows that the average percentage that should be invested in real estate securities is 11%, 100 bps more than analysis 4. Once again this is due to the increased allocation in REITs of the US market.

In conclusion, the optimal percentage that should be invested in indirect real estate ranges from 5 to 25% over the main period 1993 - 2008 and between 3 and 26% over the sub-period 2000 - 2008. Analysis 1,3 and 5, which refer to a longer period, have shown an average exposure in real estate securities of 15%. Analyses 2, 4 and 6, which take into consideration only the period 2000 – 2008, have shown, instead, an average percentage of 14%. The percentages obtained for the local markets depend on the different return risk relationships of the national asset classes: in my analysis the average results tend to fall in a range between 14 and 15%. This brings me to the conclusion that for internationally diversified portfolios an optimal strategy could be to keep the indirect property investment within the 14-15% range. On the other hand, the Capital Asset Pricing Model has shown that in national diversified portfolios the optimal percentages may vary from 0 to 43%, with the majority of the countries falling within a 5-25% range.

5.3. Real Estate-only Portfolio Analysis

In this section I analyze real estate securities-only portfolios over both the period 1993 – 2008 and the sub-period 2000 – 2008. The study aim is to quantify the diversification benefits, if any. For this purpose I build three different portfolios: an European, an American/Asiatic and a worldwide portfolio; the first two portfolios include 5 countries, the third, instead, is composed by 10 countries, spread over 4 continents.

Exhibit 17 (Optimal Portfolios Return – Risk Relationship. Time period: 1993 – 2008)

FTSE EPRA/NAREIT	Return	Risk
Belgium	8%	11%
France	17%	18%
Germany	0%	23%
UK	9%	17%
Switzerland	12%	13%
US	15%	15%
Canada	12%	16%
Australia	13%	12%
Singapore	14%	40%
Japan	10%	28%
Optimal Portfolio - European Union	15%	14%
Optimal Portfolio - America/Asia	14%	10%
Optimal Portfolio - Worldwide	13%	9%

Exhibit 17 summarizes the results obtained over the main period: it shows that, on average, portfolios with different kinds of investments yield higher returns, posing lower risks than the individual assets within the portfolio. These benefits raise when assets present low correlations: otherwise, it would have been impossible to smooth out unsystematic risk events. Thanks to the low correlation between REITs worldwide, the diversification gains are possible. Let's consider, for instance, the case of a German private investor who invests in local real estate securities only: over the course of 15 years this investment would yield approximately 0%, posing an extremely high level of risk. By investing either in an European or in a global diversified portfolio, he would gain a much higher return, bearing a by far lower risk. Another significant example comes from the perspective of a Singaporean investor. In the past 15 years, the local real estate securities have obtained good performances, with an average total return of 14% and a risk of 40%, which is a very high value. He would have obtained same or slightly lower performances through an investment in the American/Asiatic or worldwide diversified portfolio. The former would have posed a 30% minor risk; the latter would have decreased the risk of 31%. In both cases the difference results to be very significant.

Exhibit 18 (Optimal Portfolios Return – Risk Relationship. Time period: 2000 – 2008)

FTSE EPRA/NAREIT	Return	Risk
Belgium	10%	11%
France	20%	20%
Germany	0%	25%
UK	12%	18%
Switzerland	8%	9%
US	17%	16%
Canada	17%	14%
Australia	10%	12%
Singapore	15%	32%
Japan	17%	28%
Optimal Portfolio - European Union	16%	15%
Optimal Portfolio - America/Asia	17%	13%
Optimal Portfolio - Worldwide	17%	13%

Same benefits are underlined in Exhibit 18. The study is focused on the sub-period and puts into evidence even more significant benefits, not only between optimal portfolios and individual assets, but also between the optimal portfolios when compared each other: the worldwide portfolio, in fact, yields 100 basis points higher return than the European portfolio, posing 200 basis points lower risk. On the other hand, the performances of the global portfolio are in line with those obtained in the American/Asiatic portfolio.

5.4 Conclusion

In chapter 5, I analyzed the optimal allocations in real estate securities and diversification benefits more thoroughly. The correlation matrix in the first part was used to determine the degree of integration of real estate with bond, stock and cash assets. The portfolio optimization analysis was used to quantify the optimal allocations for national and international diversified portfolios. Finally a real estate-only portfolio analysis was conduct. I will now briefly summarize my findings.

The worldwide correlation matrix has determined the integrations of the assets all over the world. My study shows that, over the period 1993 – 2008, the correlations of real estate securities with the other assets range, on average, from -0.06 (with the cash assets) to 0.32 (with the stock assets). Over the sub-period 2000 – 2008, instead, the correlation coefficients range, on average, between -0.17 (with the cash assets) and 0.43 (with the stock assets). Both the analyses found that the

NAREIT indices can be very well fit in mixed asset diversified portfolios. The correlation analysis has shown evident diversification benefits.

In section 5.2 I have found that the optimal range that should be allocated in internationally diversified portfolio is in between 14 and 15%. For nationally diversified portfolios the optimal allocation range turned out to be within an average range of 5 - 25%.

Finally I have estimated the optimal real estate-only portfolios. The study found that it can be worth it to diversify these kinds of portfolios outside the investor's country, given that, on average, a regional diversification should offer better performances than individual asset portfolios in terms of both higher returns and lower risk.

6. Conclusions

The main contributions of my thesis are the time frame used and the focus on indirect real estate-only investments. Other studies on this topic generally use at most a 10 year time horizon, which could turn out not to be very statistically robust. Furthermore, previous studies on the optimal percentages that should be invested in real estate, tend to analyze real estate as a unique asset class of direct and indirect real estate. The focus on indirect property investments could give the start to further research. Moreover, thanks to the increasing availability of data for real estate securities, new studies can be run using more countries and longer time horizon. Further research could also include more sophisticated econometric models and portfolio optimization techniques.

Over the past 15 years, real estate securities have been increasingly considered a valid form of investment in terms of return risk relationship. Always more investment management companies have focused their core business on indirect real estate securities, investing throughout Europe and the rest of the world. The analysis of real estate only portfolios give reason to these kinds of investment entities: real estate only portfolios not only seem possible in terms of diversifications, but also in terms of competitive return risk relationship.

My thesis also verifies the investment percentage that would be optimal to invest in real estate securities, from a mixed asset diversified portfolio perspective. The analysis of benchmark indices brought me to the conclusion that internationally diversified mixed asset portfolio should have an exposure in indirect property companies that ranges between 14 and 15%. On the other hand, nationally mixed asset diversified portfolio should take into consideration a wider range, which in turn could vary between 5 and 25%. This is because national portfolios result to be more significantly affected by local events. The analysis of the national allocations found that above/below range percentages are possible, depending on country specific trends and events, but the majority of the countries fall within the 5-25% range. My study gave me an insight of the return and risk structures of different asset classes and of how the regions could interact worldwide. The main conclusion of my thesis would hardly suggest to have an exposure in real estate securities major than 25% in both national and international mixed asset portfolios.

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