Portfolio Allocation for Korean Investors in the US Real Estate Market

by

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B.E., Architectural Engineering, 2012

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Submitted to the Program in Real Estate Development in Conjunction with the Center for Real Estate in Partial Fulfillment of the Requirements for the Degree of Master of Science in Real Estate Development

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ABSTRACT

The purpose of this research was to explore portfolio diversification by property type for Korean institutional investors in the U.S. real estate market. In the process, we analyzed the rapidly increasing Korean investment in the U.S. real estate market and identified the points cross-border investors should consider for proper asset diversification by property type.

One of the main reasons investors make cross-border investments is to diversify their portfolios. Thus, cross-border investors need to properly diversify their investments by considering correlations between foreign and domestic properties. However, Korean institutional investors have shown an apparent preferential tendency for the U.S. real estate market, much more than other cross-border investors, and as such, they risk underperforming compared to investors with more diversified portfolio strategies.

Therefore, in this research, 12 optimal portfolios were calculated by applying Markowitz's modern portfolio theory. Following this, the Sharpe ratios of calculated models without limitations of investment were compared to investment solely in Korean properties and U.S. office properties by Korean institutional investors.

These analyses revealed considerable inefficiencies in the current international investment trend of Korean institutional investors. In addition, the comparisons of the optimal portfolios with correlations from more recent market data suggested that if Korean institutional investors continue investing in only office properties in the U.S. real estate market, their investment inefficiencies will become much larger than they currently are. Thus, we concluded that they should diversify their investment in U.S. residential, industrial, and retail properties and Korean properties rather than just investing in U.S. office properties and Korean properties.

Thesis Supervisor: Walter Torous
Title: Senior Lecturer

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Thank you all.

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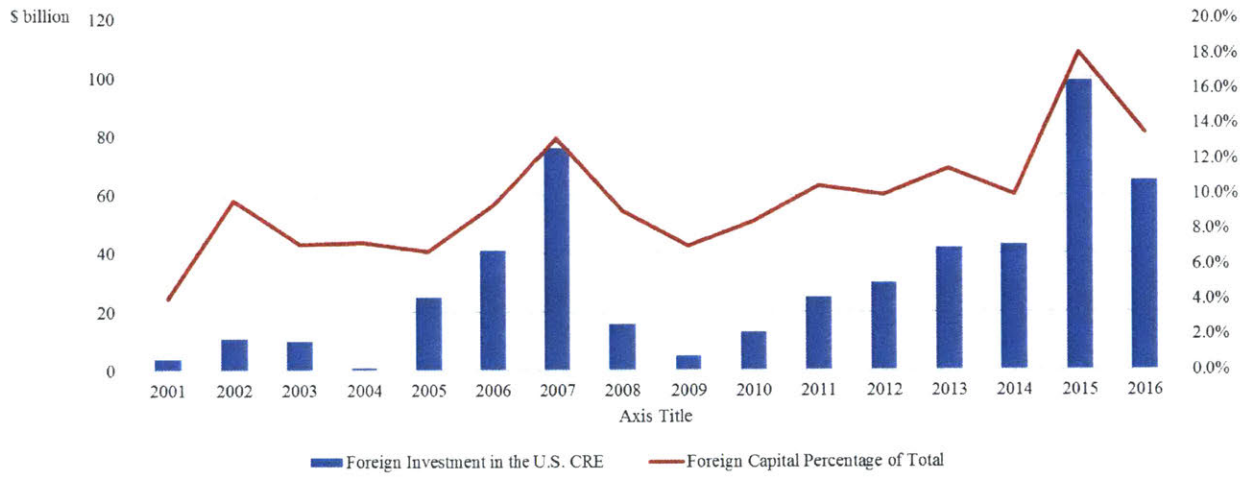
Chapter 1. Introduction

International investment has rapidly increased in the U.S. commercial real estate market since 2009. According to JLL, in 2009, right after the 2008 financial crisis, foreign investment in the U.S. real estate market was only $5 billion. However, by 2015, it was more than $90 billion, which is even larger than the investment before the crisis. This is because institutional investors with abundant capital due to low interest policies of major economies have expanded their investments in the global real estate market.[1] Investors have preferred the U.S. real estate market because they expect higher returns and the liquidity and transparency but low volatilities that the U.S. market offers, relative to other global markets, according to National Real Estate Investor New Letter[2].

Exhibit 1. U.S Commercial Real Estate Acquisitions by Foreign Buyers



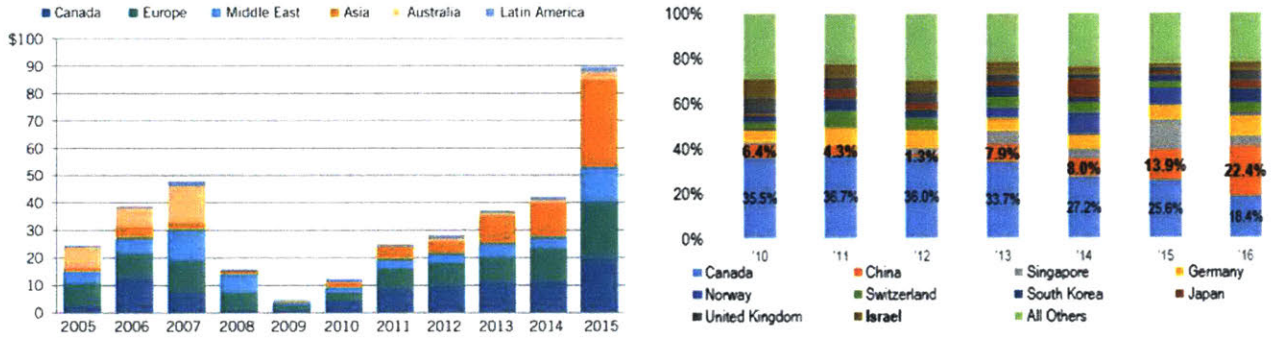
(Source: JLL)

The surge of global investment in American properties is largely attributable to a rush of investment from Asia. As shown in exhibit 1, Asian investors in pre-crisis years accounted for a

[1] Global Outlook Report, PGIM. 2016
[2] "Foreign Investment in U.S. Real Estate Assets to Hit Record High", National Real Estate Investor New Letter 2015

mere 2 to 3 percent of the total cross-border investment in the U.S. property market. Since 2010, however, their footprint has grown exponentially. In 2015, Asian countries made up over 30 percent of the total foreign investment in the U.S. real estate market. Among the most prominent were Chinese investors. Their investment in 2011 was only $1 billion, but it grew to $4 billion in 2014 and to the tune of 16 billion dollars in 2015 and 2016.

Exhibit 2. Cross-border Capital Investment in the U.S. CRE Market



(Source: RCA)

The buying spree has also been joined by South Koreans. Since shifting to high gear in 2010, Korean investors have expanded their presence in the U.S. property market remarkably, with their total investment reaching $1 billion in 2014. On an annual average, they are now investing $4.5 billion in properties in America, making South Korea the fifth largest investor after China, Canada, Singapore and Germany and the fastest growing investor in the past two to three years. Though this investment has been overshadowed by China's larger investment, it has still had quite the impact on the U.S. market

One of the main reasons for cross border investments is to diversify their portfolios. Therefore, cross-border investors should consider not only expected returns and risk-return ratios, but also correlations between foreign assets and domestic assets so that they can minimize a level of risk at a target return. However, compared to domestic investors, foreign investors have disadvantages investing their money due to a lack of information, difficulty in managing

from abroad and so on.[3] Thus, inexperienced international investors could have trouble composing an optimal portfolio and make suboptimal decisions in a foreign market. Although Korean investment in the U.S. real estate market has grown rapidly, trends regarding their investment in the U.S. real estate market could have inefficiencies in terms of allocating their assets because they are relatively new investors in the U.S. real estate market.

There has been some research for portfolio allocation in the global stock and bond markets for Korean institutional investors because they have invested in these markets longer than they have invested in the global real estate market. Also, various indexes representing stock and bond markets have made it easier to analyze optimal portfolios. For the real estate market, where problems of asymmetric information are severe, optimal portfolio research was inadequate.

Therefore, in this research, Korean institutional investors' recent investment transaction history in the U.S market and their investment trends were examined and analyzed in terms of asset diversification to find any inefficiencies. Following this, various portfolio modelings were conducted for the ideal diversification proportions by property type for Korean investors in the U.S market. This is to answer the question, "how much does proper asset diversification by property type benefit Korean institutional investors in the U.S. real estate market?" Furthermore, this will identify what points cross-border investors should consider for proper asset diversification by property type.

[3] "International Capital Flows under Asymmetric Information and Costly Monitoring: Implications of Debt and Equity Financing", Rebecca M. Neumann, 1999

Chapter 2. The Trends of Korean Investment in the U.S. Real Estate Market

2-1. Rapid Increasing Investment and Preference for Office Properties

Until 2013, the international real estate investment of Korean institutional investors did not exceed $500 million a year. Since 2013, however, the international real estate investment of Korean institutional investors has increased explosively, creating new records each year. Let's look at the changes in the size of new private equity funds for international real estate investment.[4] In 2012, the size of new private equity funds for international real estate investment was only $177 million, but it increased in 2016 to $6.2 billion, about 35 times more over a decade. As a result, international investment exceeded domestic investment for the first time in 2016.

Exhibit 3. Increases in Korean Private Equity Fund Investment in International Real Estate

(Source: Korean Financial Investment Association)

[4] According to the Hyundai Research Institute, Korean institutional investors have mainly used private equity funds for international investment.

Exhibit 4. Korean Equity Investment in the U.S. Real Estate Market (2016.1Q -2017.2Q)[5]

#	Year	Location	Property Type	Renter or Building name	Property Price ($Million)	Management Company or Investor
1	2016	Seatle	Distribution Center	Fedex	443	Mirae Asset Management
2	2016	Texas	Distribution Center	Amazon	104	Merits
3	2016	Guam	Hotel		127	Igis Asset Management
4	2016	Hawaii	Hotel	Hyatt	783	Mirae Asset Management
5	2016	Texas	Multi family		300	Kium
6	2016	Chicago	Office	BMO harris	330	Samsung Securities Co.
7	2016	Dallas	Office	KPMG plaza	217	Kium
8	2016	Dallas	Office	State farm	826	Mirae Asset Management
9	2016	New Jersey	Office	Novonordisk	417	Hana Asset Management
10	2016	Philadepia	Office	IRS	383	Korea Investment & Securities
11	2016	Seatle	Office	Amazon	252	Mirae Asset Life Insurance
12	2016	Seatle	Office	Safeco Plaza	383	Merits
13	2017	Atlanta	Office	State farm	287	Mirae Asset Management
14	2017	Washington D.C	Office	NASA	386	Hana Asset Management
					5,239	

(Source: Korean Financial Investment Association, Each asset management company, E-daily)

Exhibit 5. Korean Debt Investment in the U.S. Real Estate Market (2016.1Q -2017.2Q)[6]

#	Investment Type	Year	Location	Property Type	Renter or Building name	Investment ($Million)	Management Company or Investor
1	Mezzanine	2016	Las Vegas	Hotel	Cosmopolitan	81	Hyudau Investment Asset Management
2	Mezzanine	2016	San diego	Hotel		84	Mirae Asset Life Insurance
3	Mezzanine	2016	Sanfrancisco	Hotel		104	Simone Asset Management
4	Mezzanine	2016	New York	Office	Hudson Yard	313	Shinhan
5	Mezzanine	2016	New York	Office	85 10th Avenue	130	Igis Asset Management
6	Mezzanine	2016	New York	Office	AXA Equitable Center	235	Igis Asset Management
7	Mezzanine	2016	New York	Office	485 lexington Av	104	Samsung SRA Asset Management
8	Mezzanine	2017	Boston	Office	state street bank	100	KTB
9	Mezzanine	2017	LA	Office	Gas company	130	National Pension Service
10	Mezzanine	2017	New York	Office		174	Simone Asset Management
11	Mezzanine	2017	New York	Office	Paypal	52	KTB
12	Mezzanine	2017	New York	Office	850 Third Avenue	71	KTB
13	Senior Debt	2016	Miami	Hotel	Marriott	100	Kium
14	Senior Debt	2016	New York	Hotel	Marriott	96	KTB
15	Senior Debt	2016	Washington D.C	Hotel	Ritz-Carlton	57	Vestas Asset Management
16	Senior Debt	2016	Miami	Office	Courvoisier	104	Igis Asset Management
17	Senior Debt	2016	New York	Office	Trinity Place	100	KTB
18	Senior Debt	2016	Washington D.C	Office	Atlantic	209	Igis Asset Management
19	Senior Debt	2016	Washington D.C	Office	Woodys	240	Igis Asset Management
20	Senior Debt	2017	New York	Office	One world	550	Kium
						3,036	

(Source: Korean Financial Investment Association, Each asset management company, E-daily)

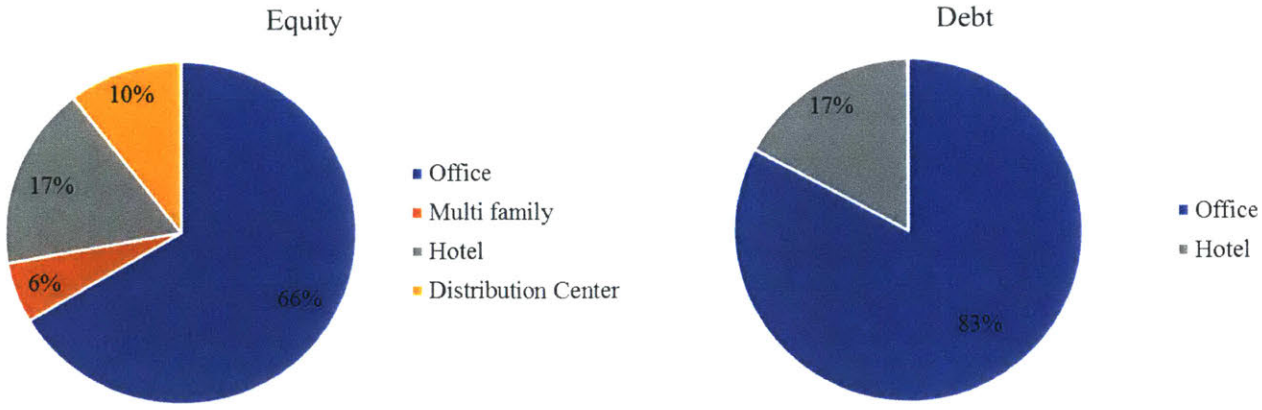
[5] Excluding small projects (under $100 million property price)

[6] Private funds for debt investment in the U.S. real estate market sold by the 8 leading Korean asset management companies.

Recent cases of international real estate investment by Korean institutional investors have been examined in order to understand these trends in more detail. Further, 35 cases of international real estate equity investment and 21 cases of real estate debt investment from Q1 2016 through Q2 2017 were collected. According to these collected cases, half of the international real estate equity investments by Korean institutional investors were investments in the U.S. market. Furthermore, in the case of international real estate debt investment, 90% of investments were in the U.S. market.

Exhibits 5 and 6 show the gathered cases of Korean equity and debt investment in the U.S. real estate market from the first quarter of 2016 through the second quarter of 2017. The most noticeable trend that can be seen through these exhibits is that Korean institutional investors prefer to invest in office properties in the U.S commercial real estate market. 66% of their equity investments and 83% of their debt investments from the data were office market investments. This is not a very recent trend. As a matter of fact, according to Deloitte, 76% of all Korean investment in the U.S. market from 2009 to 2015 was made in office buildings. In other words, Korean institutional investors have mainly invested in office properties since entering into the U.S. real estate market.

Exhibit 6. Korean Investment in the U.S. CRE Market by Property Type from Q1 2016 through Q2 2017



This property type preponderance is uncommon for international investors in the U.S. real estate market. For example, Chinese and Singaporean investors, the two Asian countries with larger investment in the U.S. real estate market than South Korea, do not focus on office property investments. According to RCA, Chinese investors, who invested about $31 billion in the U.S. real estate market in 2015-2016, invested 35% and 30% in the hotel and industrial markets respectively. Their office investment was about 28%, less than their hotel and industrial investment. Also, in the case of Singaporean investment in the U.S. market, industrial market investment was higher than office market investment.

Exhibit 8. Cross-border Investment by Property Sector

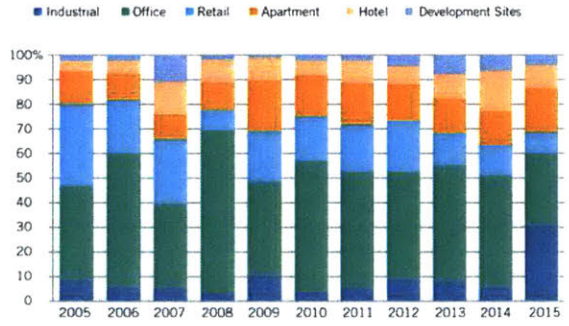
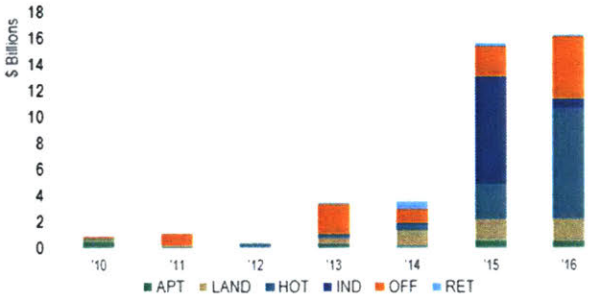


Exhibit 7. Chinese investment in the U.S. CRE by property sector



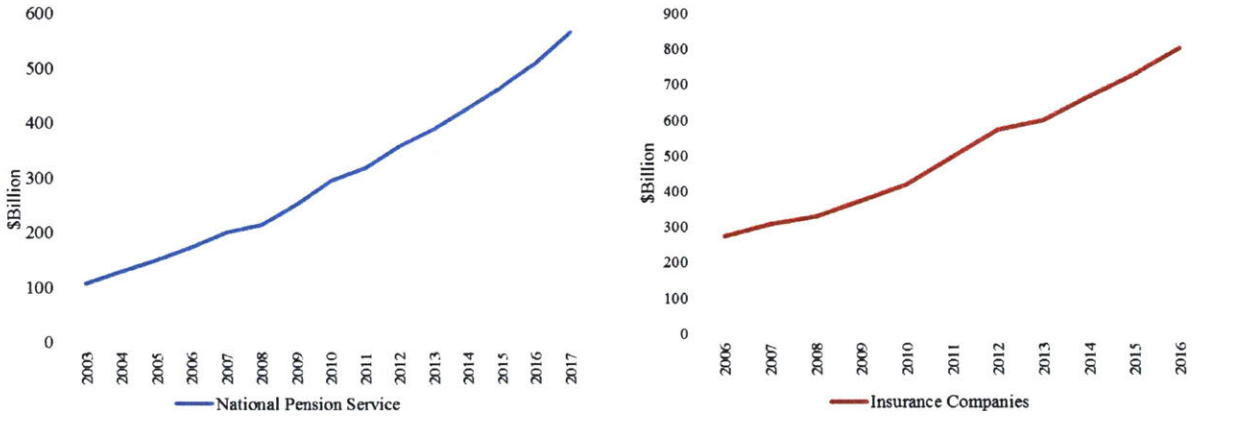
(Source: RCA)

Another characteristic of this data is that the second largest Korean investment by property type, following office properties, was investment in hotel properties. Also, hotel equity investments from the collected data were principally located in Guam and Hawaii, geographically closer to South Korea and visited by a number of Koreans every year. On the other hand, debt investments were geographically focused in and around New York City, while equity investments did not have a specific regional bias.

2-2. Cause Analysis of Korean Investment Trends in the U.S Real Estate Market

The reasons why Korean institutional investors have expanded their international real estate investment are simple. The total assets of institutional investors have increased sharply, while the average returns on investment in domestic bonds, stock, and real estate markets have continued to decrease. From 2003 to 2007 (i.e. before the 2008 financial crisis), average bond and real estate market ROIs in South Korea were 4.7% and 10.0% respectively. But from 2012 to 2016 (i.e. after the 2008 financial crisis), they dropped to just 4.1% and 5.1%. The average ROIs in the U.S. real estate market, of course, have also declined after the financial crisis of 2008, but they remain higher than ROIs in the Korean real estate market, so investment in the U.S. real estate market has increased.

Exhibit 8. Increases in the Total Assets of Korean Institutional Investors



(Source: NPS, Financial Supervisory Service)

As previously mentioned, Korean investors prefer the U.S. office market, unlike other international investors. To find out why this disproportionate weight exists, several interviews were conducted with managers from 3 leading Korean asset management companies[7]. They

[7] All interviewees are managers with more than 3 years of international investment experience at asset management companies. Two of the interviewees work at top 3 management companies (in terms of international real estate investments in Korea in 2016). The other manager works at an asset management company specialized in international real estate investment.

explained that Korean institutional investors prefer office property investment because of a lack of international investment experience and data. They prefer properties which are relatively easy to acquire information about, do financial analysis for and manage from abroad. To this effect, office buildings are more convenient to manage because they are located in big cities and have a few reliable long-term tenants, while retail and residential buildings have multiple tenants who change frequently. It is assumed that Korean investors have invested in Hawaii or Gaum, both geographically closer to South Korea, as mentioned, because of the same reasons.

Moreover, most major international real estate investors in South Korea are investors like National Pension Service (NPS)[8] and large insurance companies who are conservative and tend to avoid unknown risks and new investments. However, if a property has a reliable long-term tenant already, it is relatively easy to make investment decisions. For this reason, asset management companies that are looking for new projects and managing funds prefer choosing prime office buildings located in large cities because it is easy to recruit investors and handle projects. The majority of U.S. office buildings that have recently been invested in by Korean investors were leased out to large corporations with stable earnings such as Amazon and Fedex, or governmental organizations such as NASA and the IRS[9]. Furthermore, one of the interviewees replied that Korean institutional investors mainly invested in office properties in the Korean real estate market as well due to the immaturity of other Korean property markets. Thus, they feel more comfortable investing in the same market abroad.

However, if Korean institutional investors can benefit more from proper portfolio allocation in diversified property types in the U.S. (regardless of why Korean institutional investors currently invest mainly in the U.S. office market), it can be said that there is inefficiency in their current investment trends.

[8] A public pension fund in South Korea. It is the one of the 3 largest in the world with $560 billion in assets

[9] Refer to exhibit 5

Chapter 3. Data Review and Expectations for Optimal Portfolios

In this chapter, the historical returns, volatilities and correlations of asset classes are analyzed to find out the effect of each asset class in an optimal portfolio for Korean institutional investors in the U.S. real estate market. Also, Korean institutional investors have mainly invested in the Korean and U.S. bond and stock markets. Thus, returns, volatilities and correlations of each property type were compared to those of the bond and stock markets. Following this, the role of each asset in a portfolio for Korean institutional investors is discussed based on their returns, volatility and correlations.

3-1. Used Data

To obtain an optimal portfolio, an expected return and standard deviation of each asset in the portfolio and correlations of assets is needed.[10] These values can be obtained from proper historical return on asset data. Portfolio models in this research include only real estate assets in South Korea and the U.S. because this research focuses on portfolio allocations by property type for Korean institutional investors in the U.S. real estate market. However, as it was mentioned, for better understanding, investments in the U.S. and Korean bond and stock markets were also analyzed. Thus, historical return data for both the U.S. and Korean real estate, bond and stock markets was collected.

There have been various indexes by property type for the U.S real estate market. However, there is only one reliable and historic real estate index in the Korean real estate market, the Korea Appraisal Board Index. Therefore, the most similar reliable index representing the U.S. real estate market, NCREIF Property Index (NPI), was used in this research. Also, the Korea Appraisal Board Index has only office and retail indexes in terms of property type, while NPI has office, retail, residential, industrial and hotel indexes. Thus, just the Korean office and retail, and the U.S. office, retail, residential, industrial and hotel markets were included for analyzing optimal portfolios in this research.

[10] Refer to chapter 4-1 for equation details.

In terms of the period of the data, recent 15 years data from the first quarter of 2002 through the first quarter of 2017 was used (except for data for the Korean stock market because the reliable index started at the second quarter of 2004). Exhibit 8 shows the summary of the used data.[11]

Exhibit 9. Used Data

Market	Country	Data	Source	Term
Real Estate	South Korea	Quarterly return for investments in office and retail buildings	Korea Appraisal Board	1Q 2002 ~ 1Q 2017
	U.S.	Quarterly return for investments in office, retail, hotel, industrial and residential buildings	NCREIF Property Index (NPI)	1Q 2002 ~ 1Q 2017
Bond	South Korea	Quarterly return for investments in the Korean bond market	KIS All Bond Index	1Q 2002 ~ 1Q 2017
	U.S.	Quarterly return for investments in the U.S. bond market	Bloomberg Barclays U.S. Aggregate Total Return	1Q 2002 ~ 1Q 2017
Stock	South Korea	Quarterly return for investments in the Korean Stock market	KOSPI 200 Index and Dividend Yield	2Q 2004 ~ 1Q 2017
	U.S.	Quarterly return for investments in the U.S. stock market	S&P 500 Index Total Return	1Q 2002 ~ 1Q 2017

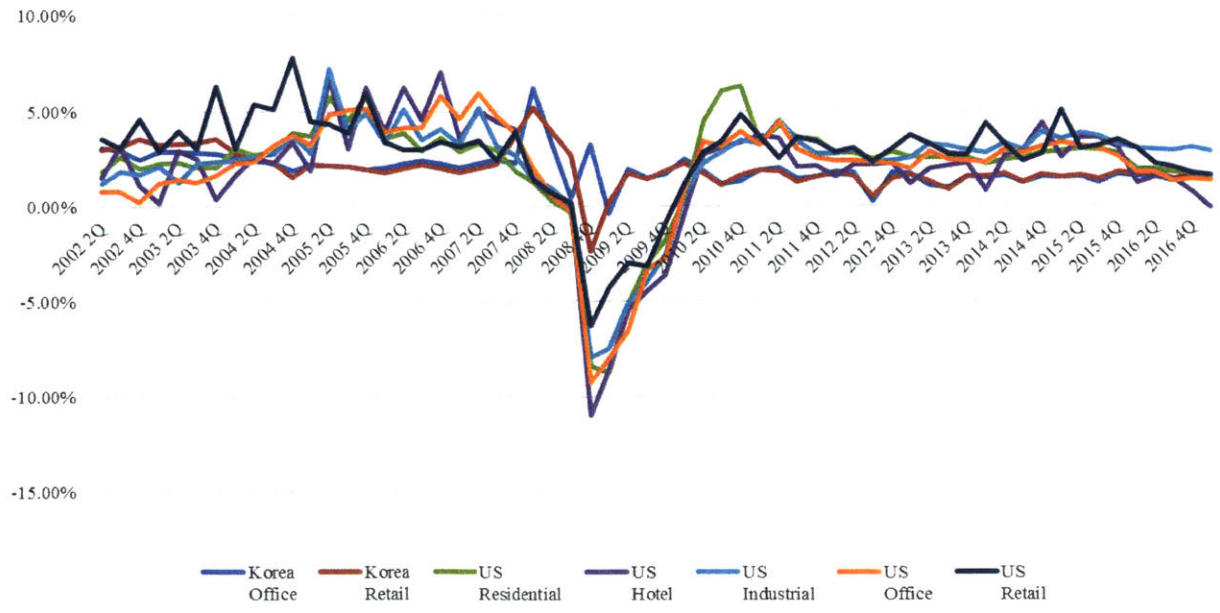
[11] Refer to appendix 1 for data details and equations for indexes.

All the data above was distributed through reputable organizations. Also, it was attempted to collect data which was calculated in as similar a way as possible. For example, to represent the U.S. stock market to find the return on investor's positions, the S&P 500 Index Total Return, which includes dividend and dividend reinvestment, was used rather than the S&P 500 Index. However, in Korea, there is no representative stock index including dividend and dividend reinvestment, so the KOSPI 200 Index plus dividend and dividend reinvestment calculated by myself was used.

3-2. Return and Volatility Analysis

For an optimal portfolio analysis, the most important data is the return histories of assets because volatilities and correlations, which are required values for portfolio analysis, are calculated from changes in returns. Thus, before portfolio analysis, return analysis is conducted first to set the criteria and assumptions for this portfolio modeling and to fathom the potential of assets in optimal portfolios. Exhibit 12 shows changes in the quarterly return of investment in each property from the second quarter of 2002 through the first quarter of 2017.

Exhibit 10. Quarterly Returns for Korean and U.S. Properties from 2002 to 2017



(Source: Korea Appraisal Board, NCREIF)

Exhibit 9 shows the following notable facts.

- The returns on almost every property type had a positive value except for the second quarter of 2008 through the fourth quarter of 2009, during which the 2008 financial crisis occurred.
- The returns on investments in Korean office and retail markets usually move together and the returns on investments in the U.S properties usually move together.
- The returns on investments in the Korean office and retail markets were generally less than the returns on investments in the U.S. real estate market but lower in volatility. Particularly at the time of the 2008 financial crisis, the decline was much less and the recovery much faster than the U.S. real estate market.
- The asset class which has the highest return changed over time.
- After the 2008 financial crisis, there was a decrease both in returns and volatilities. More information can be found in Exhibit 13.

Exhibit 11. Average Quarterly Returns and Volatilities for Property types

			Korea Office	Korea Retail	US Residential	US Hotel	US Industrial	US Office	US Retail
Whole Period	2002. 2Q ~ 2017. 1Q	Return	1.93%	1.94%	2.14%	1.84%	2.25%	2.00%	2.73%
		Volatility	0.89%	1.04%	2.73%	3.13%	2.65%	2.86%	2.35%
Before the Financial Crisis	2002. 2Q ~ 2008. 1Q	Return	2.43%	2.35%	3.45%	4.13%	3.74%	4.15%	4.00%
		Volatility	1.02%	0.89%	1.19%	1.76%	1.36%	1.11%	1.53%
After the Financial Crisis	2010. 1Q ~ 2017. 1Q	Return	1.48%	1.50%	2.84%	2.18%	2.99%	2.53%	2.97%
		Volatility	0.39%	0.32%	1.22%	1.14%	0.67%	0.81%	0.87%
Excluding the Financial Crisis	2002. 2Q ~ 2008. 1Q 2010. 1Q ~ 2017. 1Q	Return	1.99%	2.04%	2.58%	2.49%	2.86%	2.57%	3.18%
		Volatility	0.84%	0.86%	0.94%	1.65%	1.06%	1.34%	1.21%

Comparing the return and volatility of each asset class after the 2008 financial crisis, the volatility of U.S. residential buildings rose only slightly, by 0.03% and volatilities of all other assets in the U.S. and South Korea dropped by about 0.6%. Moreover, the quarterly returns of each asset after the financial crisis dropped at least 0.6% and as much as 2.0%. This means that ROIs have fallen but have stabilized in the Korean and U.S. real estate markets after the crisis. Since the returns and volatilities of properties before and after the financial crisis are quite different, the optimal portfolio modeling for this research was conducted separately, with data from the last 15 years (from Q2 2002 through Q1 2017) and data solely from after the crisis (from Q1 2010 through Q1 2017). Further, the 2008 financial crisis period, where returns were

negative and volatilities large, is excluded in the calculations using data from the last 15 years because of the event's great rarity historically.

When excluding the data from the 2008 financial crisis, the return for every asset increases and the volatilities of every asset decreases. In particular, the returns and volatilities of the U.S. real estate market changed significantly. In contrast, the returns and volatilities of Korean properties did not change much when excluding the data from the 2008 financial crisis because the Korean commercial real estate market was not effected as severely by the 2008 financial crisis.

3-3. Correlation Analysis

As mentioned, since the returns and volatilities of properties before and after the financial crisis are quite different, the correlations of assets were also analyzed separately, with data from the last 15 years (from Q2 2002 through Q1 2017) and data solely from after the crisis (from Q1 2010 through Q1 2017).

A) Correlation between Asset Classes from Q2 2002 through Q1 2017

Exhibit 14 shows the correlations between Korean assets and U.S. assets from the second quarter of 2002 through the first quarter of 2017. Portfolio models in this research include only real estate assets in South Korea and the U.S., but investments in the U.S. and Korean bond and stock markets were also analyzed for better understanding of the potential of each asset class in Korean institutional investors' actual portfolios.

Exhibit 12. Correlations of Assets in the U.S. and Korean Market from Q2 2002 through Q1 2017

	Korea Office	Korea Retail	Korea Bond	Korea Stock	US Residential	US Hotel	US Industrial	US Office	US Retail	US Bond	US Stock
Return (Yearly)	8.08%	8.07%	5.34%	9.79%	9.20%	8.03%	9.55%	8.55%	11.60%	4.62%	8.88%
Volatility (Yearly)	2.80%	2.76%	2.72%	25.66%	9.70%	10.83%	9.59%	10.40%	8.56%	2.99%	19.56%
Korea Office	1.00	0.61	0.54	-0.39	0.04	0.08	0.02	0.06	0.08	0.39	-0.62
Korea Retail	0.61	1.00	0.34	-0.10	0.31	0.38	0.30	0.32	0.41	0.39	-0.33
Korea Bond	0.54	0.34	1.00	-0.62	-0.21	-0.25	-0.35	-0.31	-0.14	0.55	-0.51
Korea Stock	-0.39	-0.10	-0.62	1.00	0.04	0.02	-0.04	0.02	0.00	0.02	0.62
US Residential	0.04	0.31	-0.21	0.04	1.00	0.91	0.94	0.94	0.87	-0.12	0.09
US Hotel	0.08	0.38	-0.25	0.02	0.91	1.00	0.94	0.95	0.81	-0.11	0.00
US Industrial	0.02	0.30	-0.35	-0.04	0.94	0.94	1.00	0.96	0.84	-0.25	0.05
US Office	0.06	0.32	-0.31	0.02	0.94	0.95	0.96	1.00	0.83	-0.16	0.04
US Retail	0.08	0.41	-0.14	0.00	0.87	0.81	0.84	0.83	1.00	-0.15	0.09
US Bond	0.39	0.39	0.55	0.02	-0.12	-0.11	-0.25	-0.16	-0.15	1.00	-0.33
US Stock	-0.62	-0.33	-0.51	0.62	0.09	0.00	0.05	0.04	0.09	-0.33	1.00

The correlation between asset classes from Q1 2002 through Q1 2017 has the following characteristics:

1. The correlation between real estate properties in Korea and the U.S. are both close to 1. Specifically, the correlations between property types in the U.S. is 0.90 on average, which is higher than the 0.61 correlation between the Korean office and retail markets.

2. The correlations between properties in Korea and every property in the U.S. are similar, and Korean retail properties are more closely correlated with the U.S. properties than they are with Korean office properties. In addition, U.S. retail and hotel properties have a higher correlation with Korean properties than with other U.S. properties but the differences are not as severe.
3. The U.S. stock market has the highest correlation (0.62) with the Korean stock market. The U.S. bond market has the highest correlation (0.55) with the Korean bond market.

Taking these facts into consideration, if all other conditions are the same, it is more advantageous for proper portfolio allocation to invest in the same property type in the both the Korean and U.S. markets, rather than to invest in different real estate properties in the same market. However, in the case of bond and stock investment, it is more advantageous for proper portfolio allocation to invest in different real estate properties in the same market, rather than to invest in the same asset type in both the Korean and U.S. markets due to high correlation between both markets.

B) Correlation between Asset Classes from Q1 2010 through Q1 2017

As mentioned in Chapter 2, the returns and volatilities of each property type have changed considerably as of the financial crisis in 2008. Therefore, the correlations between asset classes from Q1 2010 to Q1 2017 are dealt with separately.

Exhibit 13. Correlations of Assets in the U.S. and Korean Markets from Q1 2010 through Q1 2017

	Korea Office	Korea Retail	Korea Bond	Korea Stock	US Residential	US Hotel	US Industrial	US Office	US Retail	US Bond	US Stock
Return (Yearly)	6.04%	6.11%	4.78%	3.30%	12.13%	9.38%	12.52%	10.72%	12.62%	3.68%	14.04%
Volatility (Yearly)	0.64%	0.62%	2.13%	11.81%	3.61%	2.87%	1.99%	2.47%	1.95%	3.52%	8.93%
Korea Office	1.00	0.92	0.59	0.02	0.07	0.08	0.20	0.16	0.11	0.78	-0.27
Korea Retail	0.92	1.00	0.38	0.03	0.06	0.11	0.30	0.16	0.15	0.61	-0.24
Korea Bond	0.59	0.38	1.00	0.13	0.71	0.53	-0.26	0.64	0.39	0.76	-0.11
Korea Stock	0.02	0.03	0.13	1.00	0.23	-0.54	-0.90	-0.42	-0.45	-0.01	0.64
US Residential	0.07	0.06	0.71	0.23	1.00	0.58	0.17	0.75	0.50	0.55	-0.13
US Hotel	0.08	0.11	0.53	-0.54	0.58	1.00	0.55	0.81	0.31	0.24	-0.83
US Industrial	0.20	0.30	-0.26	-0.90	0.17	0.55	1.00	0.57	0.14	-0.13	-0.82
US Office	0.16	0.16	0.64	-0.42	0.75	0.81	0.57	1.00	0.51	0.39	-0.64
US Retail	0.11	0.15	0.39	-0.45	0.50	0.31	0.14	0.51	1.00	-0.02	-0.70
US Bond	0.78	0.61	0.76	-0.01	0.55	0.24	-0.13	0.39	-0.02	1.00	-0.10
US Stock	-0.27	-0.24	-0.11	0.64	-0.13	-0.83	-0.82	-0.64	-0.70	-0.10	1.00

The overall trend seems similar to the correlations between asset classes from Q1 2002 through Q1 2017, but there are a couple of significant differences.

1. The correlation between real estate properties in Korea increased drastically from 0.61 to 0.92, while the correlation between real estate properties in the U.S. decreased drastically from 0.90 to 0.49.
2. Correlations between Korean properties and U.S. properties have declined. This means that the correlation between the U.S. real estate market and the Korean real estate market is greatly reduced.
3. The correlation between the real estate markets of each country has decreased, but the correlation between the bond and stock markets of each country has increased slightly.

Generally, the lower the correlation between the asset classes, the better the portfolio allocation can be expected to be. Thus, the above changed correlations suggest that asset allocation by property type in the U.S. real estate market became more important because the correlations of properties in the U.S. have generally declined since the 2008 financial crisis. In addition, Korean investors can obtain more advantages by diversifying their assets in the U.S. real estate market, more than in the past since the correlation between properties in Korea and the U.S. has decreased.

Chapter 4.

Analysis of Portfolio Allocation by Property type for Korean Investors in the U.S. Real Estate Market

4-1. Brief Review of Modern Portfolio Theory and the Sharpe ratio

Modern Portfolio Theory

Modern portfolio theory (MPT)[12] is a theory intended to guide risk-averse investors on how best to allocate their assets to maximize expected returns at a given level of market risk. MPT takes into consideration the inherent risk of investing and seeks to minimize this risk while maximizing the risk-return ratio. According to MPT, there is an "efficient frontier", expressed as a line showing the maximum possible returns at a given level of risk.

A major benefit of MPT is that it allows investors to evaluate not just a singular investment's risk and return characteristic but also how that investment affects the portfolio's overall expected risk and returns. This theory can be used to guide investors in how best to build their portfolios with various assets in order to maximize their returns at a given level of risk. In addition, MPT can assist investors in designing portfolios with a specific level of expected return, while exposing them to the minimal risk possible at that level of return. According to MPT, what matters is not each individual investment's return but rather how that investment behaves in the context of the entire portfolio. MPT uses statistical measures such as correlation and variance to enable investors to calculate this greater effect. The variances of each asset and the correlations between assets determine each portfolio's overall risk. The relative equations are as such:

[12] Portfolio Selection, Harry Markowitz, 1952

Expected Return

$$\mathrm{E}(R_P) = \sum_i \omega_i \, \mathrm{E}(R_i)$$

R_i = *the return on asset i*

ω_i = *the proportion of asset i in the portfolio*

Portfolio Return Variance

$$\sigma_p^2 = \sum_i \omega_i^2 \, \sigma_i^2 + \sum_i \sum_{j \neq i} \omega_i \, \omega_j \sigma_i \sigma_j \rho_{ij}$$

ρ_{ij}= the correlation coefficient

σ_i = the standard deviation of asset *i*

Portfolio Return Volatility

$$\sigma_\rho = \sqrt{\sigma_\rho^2}$$

In order to calculate the risk of a three-asset portfolio, for example, an investor would need to use each of the three assets' variances and three correlation values, since there are three possible two-asset combinations between three assets. The portfolio's standard deviation, representing it's overall risk, will be lower than what would be calculated by a weighted sum unless all the correlations of assets in the portfolio are exactly 1.

Sharpe ratio

The Sharpe Ratio, developed by William Sharpe in 1966, is a mean for calculating risk-adjusted return, and has become the industry standard for such calculations. The Sharpe ratio

indicates the difference between an asset's return and the risk-free rate[13] of return divided by the standard deviation of the asset's returns. The greater the value of the Sharpe ratio, the greater the expected return will be at a given risk. The Sharpe ratio equation is as follow.

The Sharpe ratio

$$S_a = \frac{E[R_a - R_f]}{\sigma_a}$$

R_a = the asset return

R_f = the risk-free rate of return

[13] U.S treasury bonds are often considered a risk-free investment. However, in this research, 3-year Korean Government Bonds were used as the risk-free rate instead because the portfolios in this research are for Korean investors.

4-2. Assumptions and Criteria for Portfolio Analysis and Modeling

Every portfolio modeling in this research assumes the following:

- Korean institutional investors hedge currency-risk and the cost of currency hedging reduces quarterly returns by 0.250%.
- Investment in the U.S. real estate market reduces quarterly returns by 0.254%[14] more than investment in the Korean real estate market for Korean institutional investors because of management costs.
- The interest rate of South Korea Government 3-year Bonds (1.7% yearly and 0.4223% quarterly, as of June 2017) was used as the risk-free rate in this research.
- The 2008 financial crisis is regarded as an exceptional event, so data for returns and volatilities for ex-post portfolio analysis excludes data from during this crisis.

4-3. Ex-post Portfolio Analysis for Korean Investment in 2015

As mentioned in Chapter 2-1, the investment of Korean institutional investors in the U.S. real estate market has increased, especially in 2015, and has occurred mainly in the U.S. office market. Thus, two optimal portfolios are organized in this chapter under the assumption that the present year is 2015, when Korean investment in the U.S. real estate market rose sharply. The first optimal portfolio assumes that Korean investors invested in Korean and U.S. property types without restriction, and the second optimal portfolio assumes that Korean investors diversified investment only in the Korean markets and the U.S. office market. Consequently, how much profit each portfolio could make is based on actual records until the first quarter of 2017. The differences between the portfolios were also looked into. Data from the last 10 years in 2015 (Q3 2005 - Q2 2015) was used for the modeling.

[14] One of Korea's leading asset management companies had 1.02% more fees for international real estate investments than the average Korean real estate investment fees in 2016.

Exhibit 16 shows that the expected return on the U.S. office market was higher than the expected return on other markets. Despite the high rate of return, however, the composition of the optimal portfolio without restriction did not include office properties because of high volatility in the U.S. office market. In contrast, U.S. residential, industrial and retail properties were included in the case of the optimal portfolio without restriction.

Exhibit 14. Ex-post Portfolio Analysis for Korean Investment in 2015

	Korea Office	Korea Retail	US Residential	US Hotel	US Industrial	US Office	US Retail
Return (Quarterly)	1.71%	1.69%	2.73%	2.63%	2.75%	2.86%	2.77%
Volatility (Quarterly)	0.50%	0.53%	1.20%	1.60%	0.90%	1.18%	0.89%

	Sharpe Ratio	Expected Return (Quarterly)	Standard Deviation	Portfolio Composition						
				Korea Office	Korea Retail	US Residential	US Hotel	US Industrial	US Office	US Retail
Investments in all U.S. properties	**3.68**	2.18%	0.48%	0.00%	54.38%	12.05%	0.00%	18.39%	0.00%	15.18%
Investments in U.S office properties only	**2.77**	2.01%	0.57%	47.28%	26.44%	0.00%	0.00%	0.00%	26.28%	0.00%
Difference	**0.91**	0.17%	-0.10%	-47.28%	27.94%	12.05%	0.00%	18.39%	-26.28%	15.18%

The gap of the Sharpe ratio between the two portfolios was 0.91. In other words, if investment is restricted to the U.S. office market, it generates numerous inefficiencies in spite of its high expected return. How much profit could these two portfolios make if they had been diversified like the modeling suggested up to this point? The calculation results based on actual returns from Q3 2015 through Q1 2017 are as follows:

Actual quarterly return for the portfolio without restriction: 1.98%

Actual quarterly return for the portfolio with U.S. office properties only: 1.57%

If Korean institutional investors invested in various property types -- not only the office market but also residential, industrial and retail properties in 2015 -- they would have been able

to earn 0.41% more revenue per quarter until Q1 2017. Thus, Korean institutional investors should have invested in different properties rather than just U.S. office properties in 2015.

4-4. Ex-ante Portfolio Analysis with Various Assumptions and Scenarios.

This chapter contains an analysis to find out the optimal portfolios for Korean institutional investors under various scenarios. In every scenario, the expected returns are based on the returns for each asset after the 2008 financial crisis, but the expected volatilities are based on the returns for each asset from Q1 2002 through Q1 2017 (not including data from during the 2008 financial crisis). However, each scenario has slightly different expected returns for property types. Also, during the past 2 years, the average returns for U.S. industrial properties have been abnormally higher than returns for other properties in the U.S. real estate market. One of the limitations of modern portfolio theory is that when one asset has a much higher risk-return ratio than other assets, that asset dominates optimal portfolios. Thus, the expected returns for industrial properties used in these ex-ante analyses were intentionally reduced, as they would have atypically influenced the returns for other properties in the U.S.

In terms of correlations of assets used in scenarios, as mentioned, since the returns and volatilities of properties before and after the financial crisis are quite different, correlations of assets were also analyzed separately, with data from the last 15 years (from Q2 2002 through Q1 2017) and data solely from after the crisis (from Q1 2010 through Q1 2017).

Exhibit 15. Actual Correlations over the past 15 years (Q2 2002 – Q1 2017)

	Korea Office	Korea Retail	US Residential	US Hotel	US Industrial	US Office	US Retail
Korea Office	1.00	0.61	0.04	0.08	0.02	0.06	0.08
Korea Retail	0.61	1.00	0.31	0.38	0.30	0.32	0.41
US Residential	0.04	0.31	1.00	0.91	0.94	0.94	0.87
US Hotel	0.08	0.38	0.91	1.00	0.94	0.95	0.81
US Industrial	0.02	0.30	0.94	0.94	1.00	0.96	0.84
US Office	0.06	0.32	0.94	0.95	0.96	1.00	0.83
US Retail	0.08	0.41	0.87	0.81	0.84	0.83	1.00

Exhibit 16. Actual correlations over the Post-crisis years (Q1 2010 – Q1 2017)

	Korea Office	Korea Retail	US Residential	US Hotel	US Industrial	US Office	US Retail
Korea Office	1.00	0.92	0.07	0.08	0.20	0.16	0.11
Korea Retail	0.92	1.00	0.06	0.11	0.30	0.16	0.15
US Residential	0.07	0.06	1.00	0.58	0.17	0.75	0.50
US Hotel	0.08	0.11	0.58	1.00	0.55	0.81	0.31
US Industrial	0.20	0.30	0.17	0.55	1.00	0.57	0.14
US Office	0.16	0.16	0.75	0.81	0.57	1.00	0.51
US Retail	0.11	0.15	0.50	0.31	0.14	0.51	1.00

Using these assumptions and criteria, different portfolio analyses with 6 different scenarios were conducted. Also, under each scenario, both the optimal portfolio without restrictions and the optimal portfolio with the restriction of investment in U.S. properties other than office buildings were conducted to measure inefficiencies. Thus, a total of 12 portfolio analysis were conducted in this chapter.

Exhibit 17. Scenarios for Ex-Ante Analysis

#	Base Data for Correlation	ROI for U.S. office properties	ROI for U.S. other properties
1	Data from 1Q 2002 through 1Q 2017	Same as past 7 years	Same as past 7 years
2		Higher than past 7 years	Same as past 7 years
3		Higher than past 7 years	Lower than past 7 years
4	Data after the 2008 financial crisis	Same as past 7 years	Same as past 7 years
5		Higher than past 7 years	Same as past 7 years
6		Higher than past 7 years	Lower than past 7 years

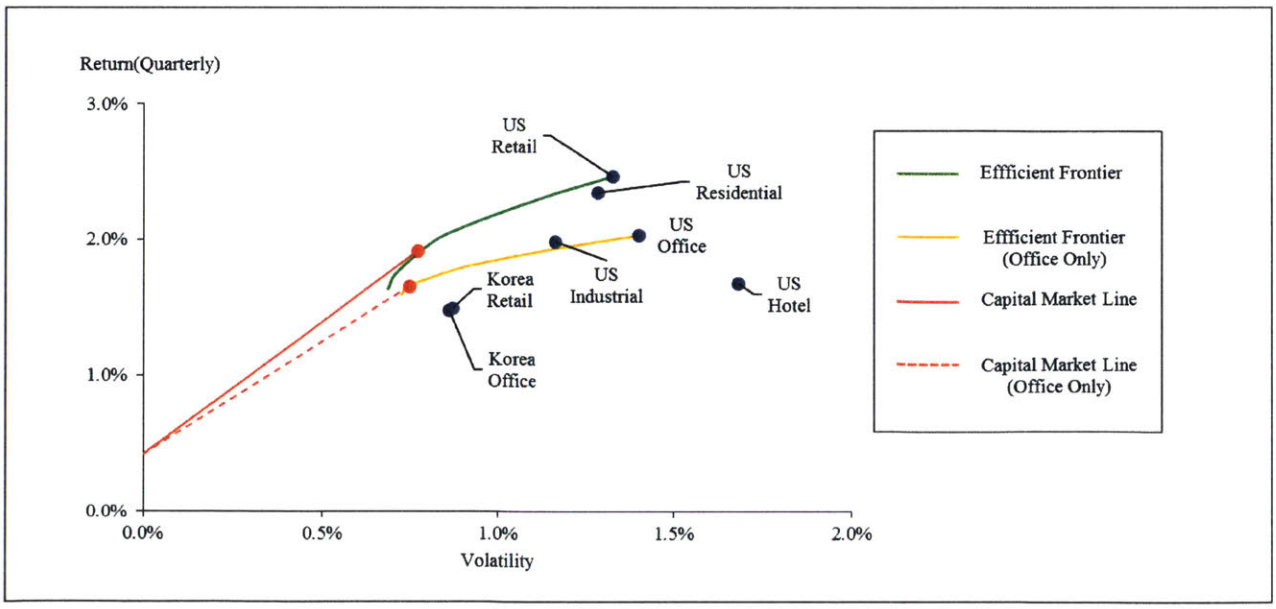
Scenario 1.

The first scenario assumes that correlations of assets will be the same as the correlations during the 15 years from Q1 2002 through Q1 2017, and the return for each asset will be same as it was during the 7 years from Q1 2002 through Q1 2017. Under this assumption, the optimal portfolio without restrictions includes investments in U.S. residential and retail properties. However, the optimal portfolio with the restriction of investment in U.S. properties other than office buildings includes investment in the Korean retail market. The Sharpe ratio of the portfolio without restriction is 1.93, which is 0.28 higher than the portfolio with restriction. Thus, under this assumption, Korean investors should invest in the U.S. retail and residential markets to maximize their profit at a given risk.

Exhibit 18. The Summary of the Optimal Portfolio under Scenario 1.

	Korea Office	Korea Retail	US Residential	US Hotel	US Industrial	US Office	US Retail
Return (Quarterly)	1.48%	1.50%	2.34%	1.68%	1.98%	2.03%	2.46%
Volatility (Quarterly)	0.86%	0.87%	1.29%	1.68%	1.17%	1.40%	1.33%

	Sharpe Ratio	Expected Return (Quarterly)	Standard Deviation	Portfolio Composition						
				Korea Office	Korea Retail	US Residential	US Hotel	US Industrial	US Office	US Retail
Investments in all U.S. properties	**1.93**	1.91%	0.77%	52.89%	0.00%	23.91%	0.00%	0.00%	0.00%	23.21%
Investments in U.S office properties only	**1.65**	1.66%	0.75%	51.62%	16.65%	0.00%	0.00%	0.00%	31.74%	0.00%
Difference	**0.28**	0.26%	0.03%	1.27%	-16.65%	23.91%	0.00%	0.00%	-31.74%	23.21%



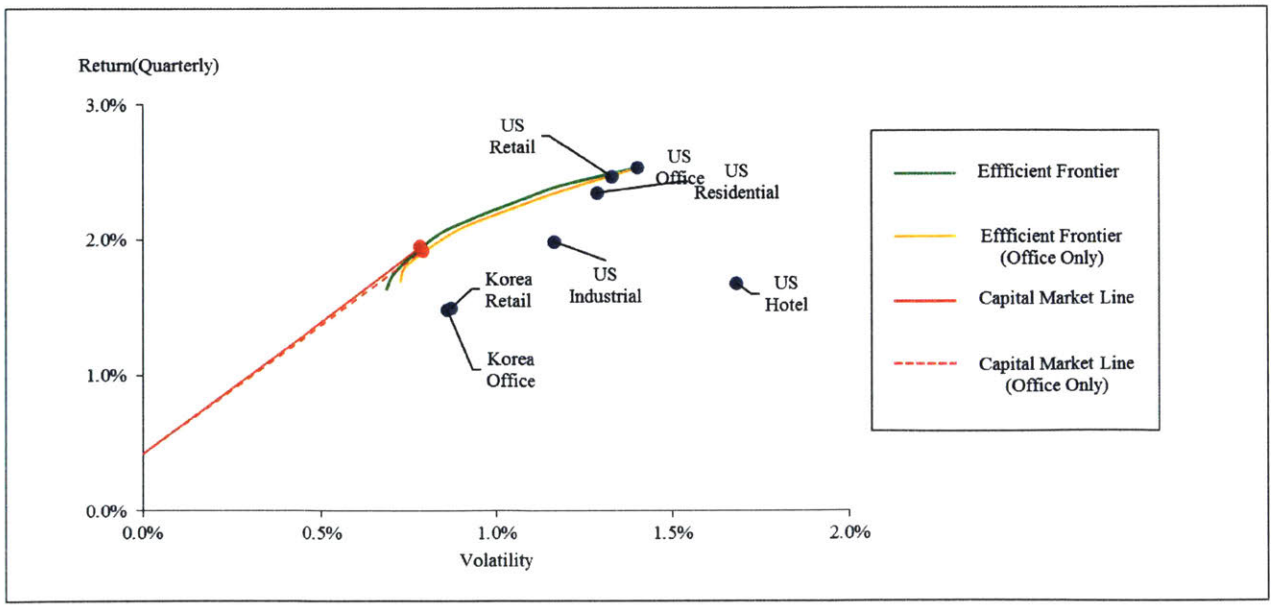
Scenario 2.

The second scenario assumes that correlations of assets will be the same as the correlations during the 15 years from Q1 2002 through Q1 2017, and the return for office properties is higher than any other properties, and the returns for other properties will be the same as the current market trends. Under this assumption, the optimal portfolio without restrictions includes investments in U.S. residential, office and retail properties. However, the optimal portfolio with the restriction includes investment in the Korean retail market. The Sharpe ratio of the portfolio without restriction is 1.94 which is 0.05 higher than the portfolio with restriction. Thus, under this assumption, Korean investors should invest in the U.S. retail and residential market.

Exhibit 19. The Summary of the Optimal Portfolio under Scenario 2.

	Korea Office	Korea Retail	US Residential	US Hotel	US Industrial	US Office	US Retail
Return (Quarterly)	1.48%	1.50%	2.34%	1.68%	1.98%	2.53%	2.46%
Volatility (Quarterly)	0.86%	0.87%	1.29%	1.68%	1.17%	1.40%	1.33%

	Sharpe Ratio	Expected Return (Quarterly)	Standard Deviation	Portfolio Composition						
				Korea Office	Korea Retail	US Residential	US Hotel	US Industrial	US Office	US Retail
Investments in all U.S. properties	**1.94**	1.94%	0.78%	52.94%	0.00%	7.26%	0.00%	0.00%	17.44%	22.36%
Investments in U.S office properties only	**1.89**	1.92%	0.79%	52.08%	6.39%	0.00%	0.00%	0.00%	41.53%	0.00%
Difference	**0.05**	0.03%	-0.01%	0.86%	-6.39%	7.26%	0.00%	0.00%	-24.10%	22.36%



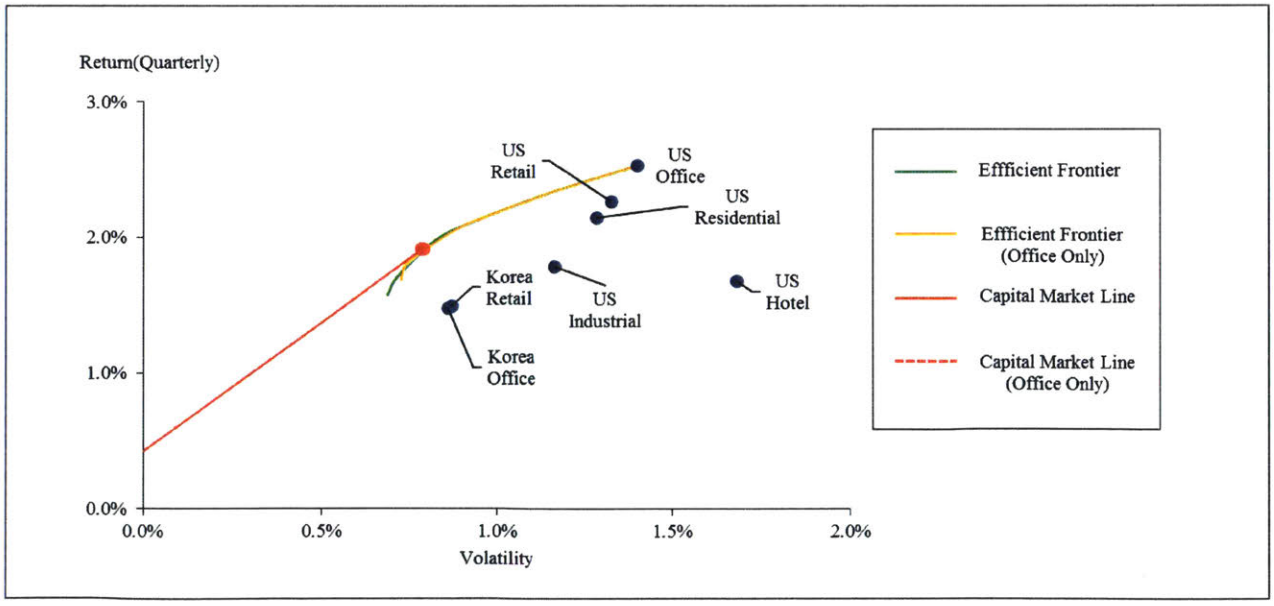
Scenario 3.

The third scenario assumes that correlations of assets will be the same as the correlations during the 15 years from Q1 2002 through Q1 2017, the return for office properties will be higher than any other properties, and the returns for other properties will be lower than current market trends. Under this assumption, the optimal portfolio without restrictions includes investments in U.S. office and retail properties. However, the Sharpe ratio of the portfolio without restriction is 1.90 which is only 0.01 higher than the portfolio with restriction. Thus, under this assumption, Korean investors do not need to invest in the U.S. retail and residential markets to maximize their profit at a given risk.

Exhibit 20. The Summary of the Optimal Portfolio under Scenario 3.

	Korea Office	Korea Retail	US Residential	US Hotel	US Industrial	US Office	US Retail
Return (Quarterly)	1.48%	1.50%	2.14%	1.68%	1.78%	2.53%	2.26%
Volatility (Quarterly)	0.86%	0.87%	1.29%	1.68%	1.17%	1.40%	1.33%

	Sharpe Ratio	Expected Return (Quarterly)	Standard Deviation	Portfolio Composition						
				Korea Office	Korea Retail	US Residential	US Hotel	US Industrial	US Office	US Retail
Investments in all U.S. properties	**1.90**	1.91%	0.79%	53.02%	3.26%	0.00%	0.00%	0.00%	34.54%	9.18%
Investments in U.S office properties only	**1.89**	1.92%	0.79%	52.08%	6.39%	0.00%	0.00%	0.00%	41.53%	0.00%
Difference	**0.01**	0.00%	0.00%	0.94%	-3.13%	0.00%	0.00%	0.00%	-6.99%	9.18%



Summary of the Results of Optimal Portfolios under Scenarios 1, 2 and 3

Take scenarios 1, 2 and 3 together, which assume that correlations of assets will be the same as those during the past 15 years (from Q1 2002 through Q1 2017). Under every scenario, the optimal portfolios with and without restriction suggest different proportions of asset composition. For example, every optimal portfolio without restriction includes investments in U.S. retail properties. In contrast, the optimal portfolios with the restriction of investment in U.S. properties other than office buildings suggest investment in the Korean retail market.

Also, the Sharpe ratios of the optimal portfolios without restriction were higher than those with restriction. It means that Korean investors should diversify their assets amongst various property types in the U.S real estate market. However, if the return for the U.S office market is better than the average return during the past 7 years and returns for the other U.S. properties are down below the average return during the past 7 years, the advantages of portfolio allocation will become insignificant.

Scenarios 4, 5 and 6 share the same common assumptions with scenarios 1, 2 and 3 respectively, but are based on more recent market trends (from Q1 2010 through Q1 2017). As mentioned, the correlations after the crisis are lower than those before the crisis. The lower the correlation between the asset classes, the better the portfolio allocation can be expected to perform. Therefore, recent markets suggest an even greater advantage from diversified assets. Let's look at the results of scenarios 4, 5 and 6, and compare them to the results of scenarios 1, 2 and 3.

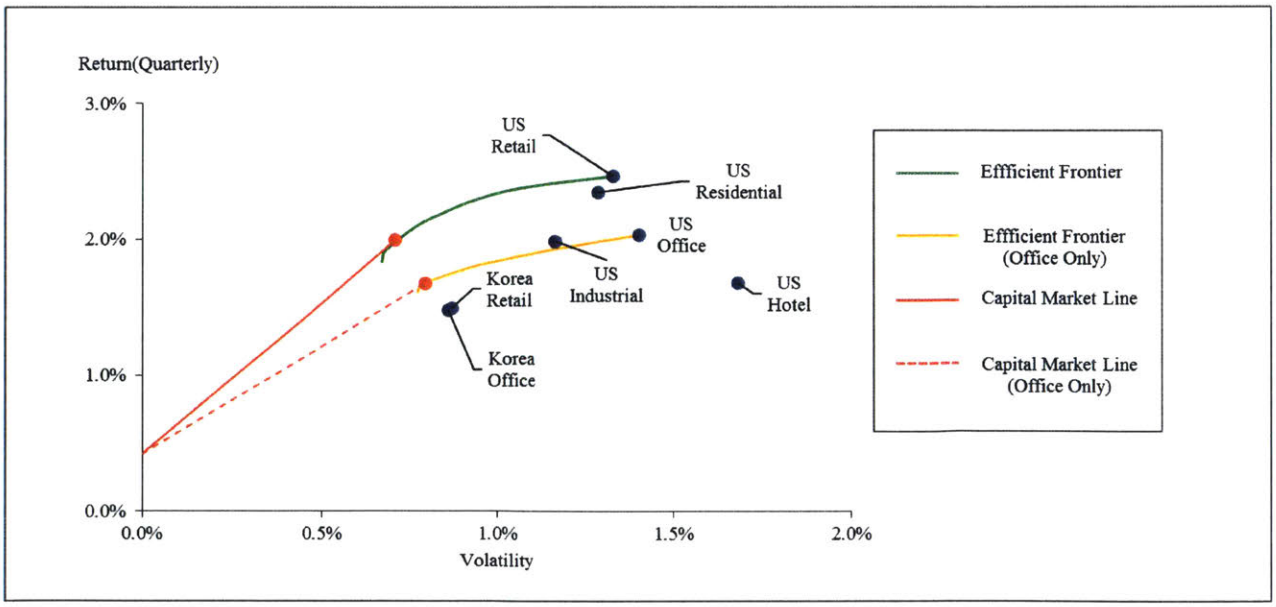
Scenario 4.

This scenario assumes that the correlations of assets will be the same as the correlations during the 7 years from Q1 2010 through Q1 2017, and the returns for all property types will be the same as the current market trends. Under this assumption, the optimal portfolio without restrictions includes investments in U.S. residential, industrial and retail properties. However, the optimal portfolio with the restriction of investment in U.S. properties other than office buildings includes investment in the Korean retail market. The Sharpe ratio of the portfolio without restriction is 2.21, which is 0.64 higher than the portfolio with restriction. Thus, under this assumption, Korean investors should follow the optimal portfolio without restriction.

Exhibit 21. The Summary of the Optimal Portfolio under Scenario 4

	Korea Office	Korea Retail	US Residential	US Hotel	US Industrial	US Office	US Retail
Return (Quarterly)	1.48%	1.50%	2.34%	1.68%	1.98%	2.03%	2.46%
Volatility (Quarterly)	0.86%	0.87%	1.29%	1.68%	1.17%	1.40%	1.33%

	Sharpe Ratio	Expected Return (Quarterly)	Standard Deviation	Portfolio Composition						
				Korea Office	Korea Retail	US Residential	US Hotel	US Industrial	US Office	US Retail
Investments in all U.S. properties	**2.21**	1.99%	0.71%	33.42%	0.00%	20.55%	0.00%	24.49%	0.00%	21.54%
Investments in U.S office properties only	**1.58**	1.67%	0.79%	32.36%	33.05%	0.00%	0.00%	0.00%	34.60%	0.00%
Difference	**0.64**	0.32%	-0.09%	1.06%	-33.05%	20.55%	0.00%	24.49%	-34.60%	21.54%



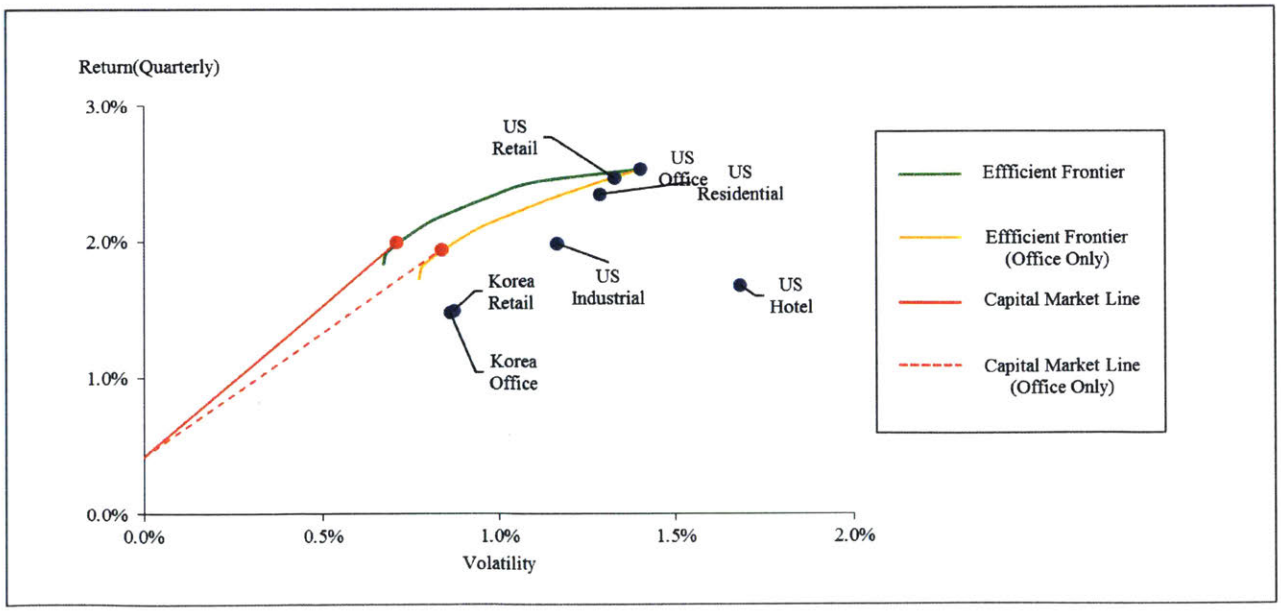
Scenario 5.

This scenario assumes that the correlations of assets will be the same as the correlations during the 7 years from Q1 2010 through Q1 2017, the return for office properties will be higher than any other properties, and the returns for other properties will be the same as current market trends. Under this assumption, the optimal portfolio without restrictions includes investments in U.S. residential, industrial and retail properties. However, the optimal portfolio with the restriction of investment in U.S. properties other than office buildings includes investment in the Korean retail market. The Sharpe ratio of the portfolio without restriction is 2.21 which is 0.40 higher than the portfolio with restriction. Thus, under this assumption, Korean investors should invest in the U.S. retail and residential market.

Exhibit 22. The Summary of the Optimal Portfolio under Scenario 5

	Korea Office	Korea Retail	US Residential	US Hotel	US Industrial	US Office	US Retail
Return (Quarterly)	1.48%	1.50%	2.34%	1.68%	1.98%	2.53%	2.46%
Volatility (Quarterly)	0.86%	0.87%	1.29%	1.68%	1.17%	1.40%	1.33%

	Sharpe Ratio	Expected Return (Quarterly)	Standard Deviation	Portfolio Composition						
				Korea Office	Korea Retail	US Residential	US Hotel	US Industrial	US Office	US Retail
Investments in all U.S. properties	**2.21**	1.99%	0.71%	33.42%	0.00%	20.55%	0.00%	24.49%	0.00%	21.54%
Investments in U.S office properties only	**1.82**	1.94%	0.84%	28.02%	28.40%	0.00%	0.00%	0.00%	43.58%	0.00%
Difference	**0.40**	0.05%	-0.13%	5.40%	-28.40%	20.55%	0.00%	24.49%	-43.58%	21.54%



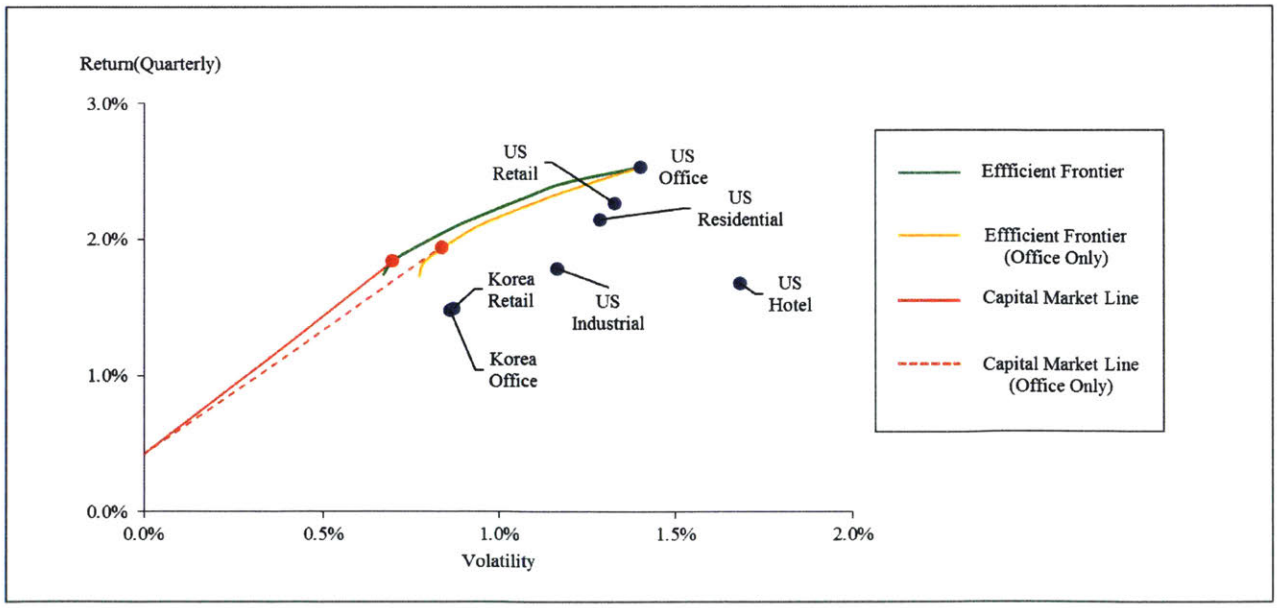
Scenario 6.

This scenario assumes that the correlations of assets will be the same as the correlations during the 7 years from Q1 2010 through Q1 2017, the return for office properties will be higher than any other properties, and the returns for other properties will be lower than current market trends. Under this assumption, the optimal portfolio without restrictions includes investments in U.S. residential, industrial and retail properties. The Sharpe ratio of the portfolio without restriction is 2.03 which is only 0.21 higher than the portfolio with restriction. Thus, under this assumption, Korean investors do not need to invest in the U.S. retail and residential markets to maximize their profits at a given risk.

Exhibit 23. The Summary of the Optimal Portfolio under Scenario 6

	Korea Office	Korea Retail	US Residential	US Hotel	US Industrial	US Office	US Retail
Return (Quarterly)	1.48%	1.50%	2.14%	1.68%	1.78%	2.53%	2.26%
Volatility (Quarterly)	0.86%	0.87%	1.29%	1.68%	1.17%	1.40%	1.33%

	Sharpe Ratio	Expected Return (Quarterly)	Standard Deviation	Portfolio Composition						
				Korea Office	Korea Retail	US Residential	US Hotel	US Industrial	US Office	US Retail
Investments in all U.S. properties	**2.03**	1.84%	0.70%	37.72%	0.00%	19.73%	0.00%	21.78%	0.00%	20.77%
Investments in U.S office properties only	**1.82**	1.94%	0.84%	28.02%	28.40%	0.00%	0.00%	0.00%	43.58%	0.00%
Difference	**0.21**	-0.10%	-0.14%	9.71%	-28.40%	19.73%	0.00%	21.78%	-43.58%	20.77%



Summary of the Results of Optimal Portfolios under Scenarios 4, 5 and 6

Take scenarios 4, 5 and 6 together, which assume that the correlations of assets will be the same as those during the past 7 years (Q1 2010 through Q1 2017). Under each scenario, optimal portfolios without restriction include investments in U.S. residential, industrial and retail properties. In contrast, the optimal portfolios with the restriction of investment in U.S. properties other than office buildings suggest investment in the Korean retail market.

Also, the Sharpe ratios of the optimal portfolios without restriction were much higher than those with restriction. This means that Korean investors should diversify their assets by property type in the U.S real estate market. Even if returns for the U.S office market are much better than the average return during the past 7 years and returns for the other U.S. properties are down below the average return during the past 7 years, the advantages of portfolio allocation are still significant.

Differences When Using Correlations of Assets from Recent Market Trends

The results of scenarios 4, 5 and 6 (using recent 7-year correlations) look similar to the results from scenarios 1, 2 and 3 (using recent 15-year correlations). In both cases, inefficiencies in Korean investment in the U.S. real estate market were found. However, there are several notable differences.

Exhibit 24. Optimal Portfolios with Correlations (Data from Q1 2002 through Q1 2017)

Correlation	#	Sharpe Ratio	Expected Return (Quarterly)	Standard Deviation	Portfolio Composition						
					Korea Office	Korea Retail	US Residential	US Hotel	US Industrial	US Office	US Retail
The past 15 years (1Q 2002 through 1Q 2017)	1	**1.93**	1.91%	0.77%	52.89%	0.00%	23.91%	0.00%	0.00%	0.00%	23.21%
	2	**1.94**	1.94%	0.78%	52.94%	0.00%	7.26%	0.00%	0.00%	17.44%	22.36%
	3	**1.90**	1.91%	0.79%	53.02%	3.26%	0.00%	0.00%	0.00%	34.54%	9.18%
After the 2008 financial crisis (1Q 2010 through 1Q 2017)	4	**2.21**	1.99%	0.71%	33.42%	0.00%	20.55%	0.00%	24.49%	0.00%	21.54%
	5	**2.21**	1.99%	0.71%	33.42%	0.00%	20.55%	0.00%	24.49%	0.00%	21.54%
	6	**2.03**	1.84%	0.70%	37.72%	0.00%	19.73%	0.00%	21.78%	0.00%	20.77%

Exhibit 25. Optimal Portfolios with Correlations from Recent Market Trends (Q1 2010 through Q1 2017)

Correlation	#	Sharpe Ratio	Expected Return (Quarterly)	Standard Deviation	Portfolio Composition						
					Korea Office	Korea Retail	US Residential	US Hotel	US Industrial	US Office	US Retail
Without Restriction	4	**1.58**	1.67%	0.79%	32.36%	33.05%	0.00%	0.00%	0.00%	34.60%	0.00%
	5	**1.82**	1.94%	0.84%	28.02%	28.40%	0.00%	0.00%	0.00%	43.58%	0.00%
	6	**1.89**	1.92%	0.79%	52.08%	6.39%	0.00%	0.00%	0.00%	41.53%	0.00%
With Restriction (only investment in the Korean market and the U.S office market)	4	**2.21**	1.99%	0.71%	33.42%	0.00%	20.55%	0.00%	24.49%	0.00%	21.54%
	5	**2.21**	1.99%	0.71%	33.42%	0.00%	20.55%	0.00%	24.49%	0.00%	21.54%
	6	**2.03**	1.84%	0.70%	37.72%	0.00%	19.73%	0.00%	21.78%	0.00%	20.77%

First of all, when using correlations from recent market data (scenarios 4, 5 and 6), the gaps between the Sharp ratios of the optimal portfolios with or without restrictions are much higher than those under scenarios 1, 2 and 3. Thus, it could be said that in the recent market, if Korean institutional investors keep investing in only office properties in the U.S. real estate market, their investment inefficiencies are much larger than in the past.

If the expected return for the U.S office market improves far more than now and returns for the other U.S. properties go down (scenario 3), Korean investors will not need to invest in properties other than office properties in the U.S. real estate market. However, when using correlations from recent market data, even if the expected return for the U.S office market improves far more than now and returns for the other U.S. properties go down (scenario 6), Korean investors would still benefit by investing in properties other than office properties in the U.S. real estate market. Thus, correlation from recent market trends increases the chance to take advantages of diversifying assets for Korean institutional investors.

Moreover, when using correlations from recent market data (scenarios 4, 5 and 6), the optimal portfolios suggest a more diversified portfolio. For example, the optimal portfolios under scenarios 1, 2 and 3 suggest allocating more than 50% of assets in the Korean office market. In contrast, the optimal portfolios under scenarios 4, 5 and 6 suggest evenly distributing assets in the Korean office market and the U.S retail, residential and industrial market. Exhibits 28 through 33 show this difference. The 3 exhibits on the left represent asset compositions of portfolios with correlations from 15-year data, and the 3 exhibits on the right represent asset

compositions with correlations from recent markets. It is easy to notice that the 3 exhibits on the right suggest more diversified portfolios.

These results stem from changes in correlations. As mentioned in chapter 3, recent correlations within Korean properties increased, while recent correlations between the Korean market and the U.S market decreased. These lower recent market correlations mean that Korean institutional investors can reap even greater advantages by diversifying their portfolios.

Exhibit 26. Scenario 1 - Asset Composition

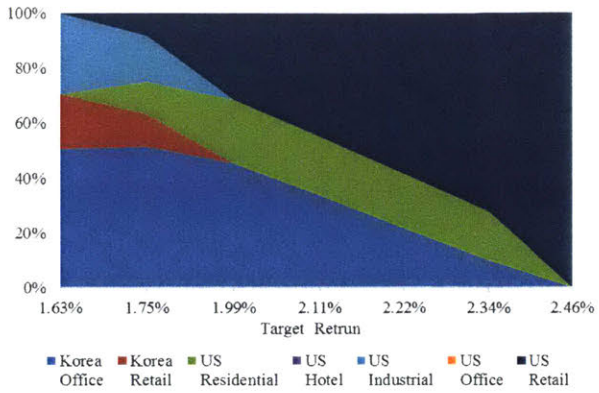


Exhibit 27. Scenario 4 - Asset Composition

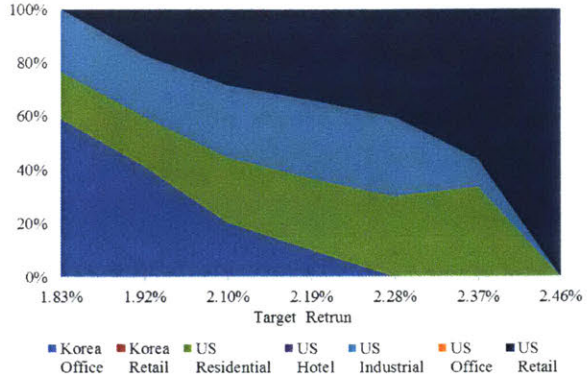


Exhibit 28. Scenario 2 - Asset Composition

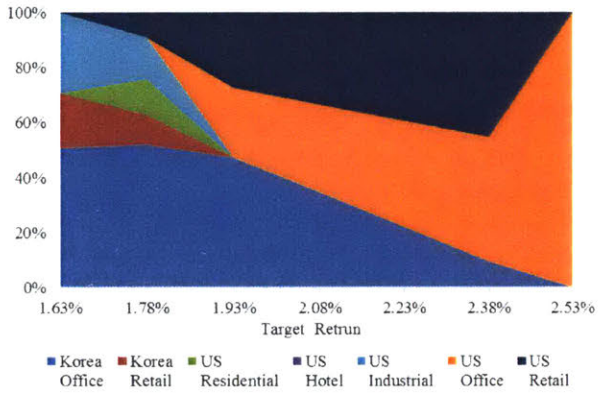


Exhibit 29. Scenario 5 - Asset Composition

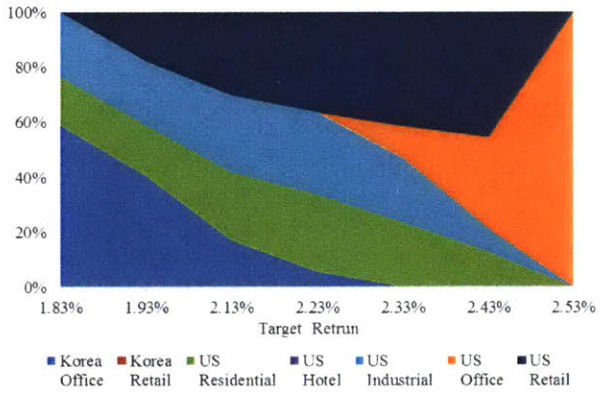


Exhibit 30. Scenario 3 - Asset Composition

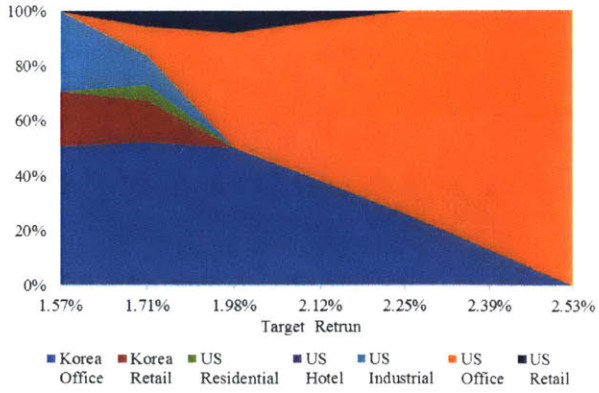
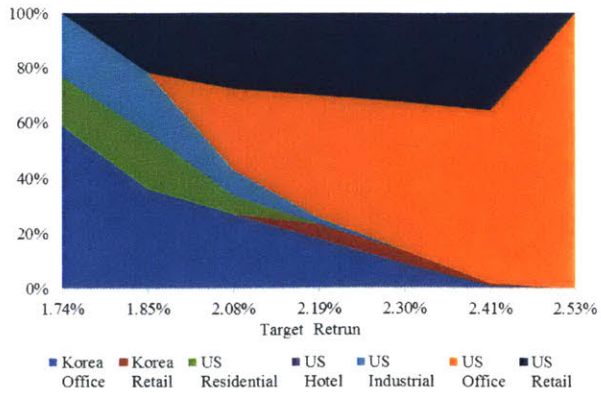


Exhibit 31. Scenario 6 - Asset Composition



Chapter 5. Conclusion

5-1. Limitations of this Research and Further Research Questions

There are a couple of limitations to this study. First, as this research is based on Markowitz's modern portfolio theory, it shares all of portfolio theory's limitations.

Second, each index represents its market differently and is based on different calculations. For instance, the basic principles of the NCREIF Index and the Korea Appraisal Board Index are identical, but there are differences in their specific calculation methods. Also, the number of properties listed in each index is significantly different. Therefore, it is difficult to compare the NCREIF Index with the Korea Appraisal Board Index fairly.

Moreover, Korean property types other than office and retail properties were excluded in this research because reliable and historical hotel or industrial indexes do not exist in Korea so far. Also, real estate market indexes in South Korea employed in this study have large smoothing effects which underestimate the volatilities of returns compared to reality. Thus, Korea needs to improve its current indexes to better represent the entire real estate market, and furthermore, it needs to develop an index for hotel and industrial properties.

In addition, it is necessary to perform further studies on the considerations and additional costs by property type for international investment. As mentioned in chapter 2, the reason why Korean investors prefer the U.S. office market is partly due to management costs. More precise optimal portfolios could be estimated if these additional costs were known.

Despite these limitations, it was certainly confirmed that risk can be minimized at a given expected return through proper portfolio allocation by property type in all portfolios examined. Thus, if the above limitations are supplemented and additional research is performed, then more accurate optimal portfolios can be produced and the current inefficiencies for Korean investors in the U.S real estate market minimized.

5-2. Summary of the Analysis Results

The purpose of this research was to analyze the rapidly increasing Korean investment in the U.S. real estate market and explore portfolio diversification by property type for Korean institutional investors in the U.S. real estate market. Chapter 2 showed the apparent preferential tendency of Korean institutional investors for U.S. office properties. The effects of property diversification in the U.S. real estate market were estimated through analyzing the correlations of assets in Chapter 3. In Chapter 4, optimal portfolios were calculated by applying Markowitz's modern portfolio theory. The Sharpe ratios identified in all six calculated models without limitations of investment were found to be higher than those for investment solely in Korean office and retail properties and U.S. office properties by Korean institutional investors. This suggested considerable inefficiencies in the current investment trends of Korean institutional investors. In addition, correlations between U.S. retail and residential properties and Korean properties suggested more advantages from proper portfolio allocation. In other words, Korean institutional investors should move beyond U.S. office market-focused investment and invest money in other U.S. properties.

Up until recently, the investments of individual Korean institutional investors in the U.S. real estate market were not substantial. Thus, it would have been difficult to organize a proper portfolio in the U.S. real estate market, because the size of each asset in the real estate market was extremely large relative to each asset in the stock and bond markets. However, total assets of Korean institutional investors are growing significantly, and this explosive growth is expected to be maintained for the foreseeable future. [15] If the U.S. real estate market keeps up its current constant returns, Korean investment in the U.S. real estate market should also show continuous growth. Therefore, Korean institutional investors will have to seek multiple portfolios according to types, regions, and investment methods to maximize their profits, and we hope this research can help them in this endeavor.

[15] For example, the total assets of the biggest Korean investor, National Pension Service, is $560 billion in 2016, and is expected to reach $850 billion in 2020 and $1750 billion in 2030 according to NPS.

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Appendix 1. Real Estate Indexes Used

The Korea Appraisal Board Index.

Start date: Q1 2002

Index Period: Quarterly

Category: Office, large retail and small retail properties

Calculation:

Total Return = Income Return + Capital Value Return

Income Return = NOI / Beginning Market Value

Capital Value Return =

(Ending Market Value - Beginning Market Value) / Beginning Market Value

The NCREIF property index (NPI)

Start date: 1979

Index period: Quarterly

Category: Office, retail, industrial, residential and hotel properties

Calculation:

Total Return = Income Return + Capital Value Return

Income Return =

NOI / (Beginning Market Value + 1/2 Capital Improvements - 1/2 Partial Sales - 1/3 NOI)

Capital Value Return =

[(Ending Market Value - Beginning Market Value) + Partial Sales - Capital Improvements] /

[Beginning Market Value + 1/2 Capital Improvements - 1/2 Partial Sales - 1/3 NOI]

The NPI rate of return formula assumes:

- NOI is received at the end of each month during the quarter.
- Capital Expenditures occur at mid-quarter.
- Partial Sales occur at mid-quarter.
- A partial sale is the sale of a portion of the property such as excess land

Appendix 2. Interview Guidelines and Questions for Chapter 2-2

Interviews were conducted by international call between the U.S. and South Korea.

The main question in the interview was, "Why have Korean institutional investors mainly invested in U.S. office properties, rather than other U.S. properties?" The questions were focused on the characteristics of Korean investors, rather than the characteristics of international investors and each property type, because other cross-border institutional investors distribute their assets in U.S. hotel, retail and industrial properties.

The questions were as follows:

- Why have Korean institutional investors increased international real estate investment?
- Why do Korean institutional investors prefer the U.S. real estate market?
- Why have Korean institutional investors mainly invested in U.S. office properties, rather than in other U.S. properties?
- Do you think that Korean investors will keep increasing their investment in the U.S. real estate market?
- What do you think about the reasons why Korean institutional investors have mainly invested in U.S. office properties, as opposed to other U.S. properties?
- Do you think that Korean investors will keep investing mainly in office properties in the U.S.?

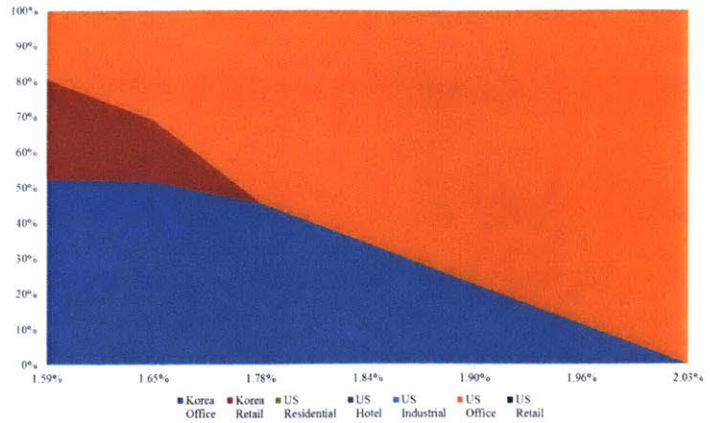
All interviewees said that Korean institutional investors will increase their investment in the other types of properties.

Appendix 3. - Comparisons of Asset Compositions of the Efficient Frontier with and without Restriction of Investment in U.S. Properties other than Office Properties.

From the next page.

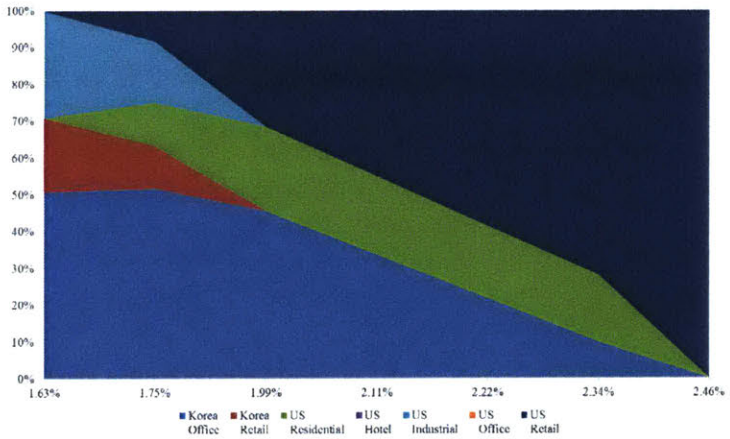
Scenario 1

A) Asset Compositions of the Efficient Frontier with Restriction of Investment in U.S. Properties other than Office Properties.



#	Expected Retrun	Standard Deviation	SHARPE	Korea Office	Korea Retail	US Residential	US Hotel	US Industrial	US Office	US Retail
1	1.59%	0.7264%	1.57056	52%	28%	0%	0%	0%	19%	0%
2	1.65%	0.7446%	1.61597	52%	17%	0%	0%	0%	31%	0%
3	1.78%	0.8769%	1.51426	46%	0%	0%	0%	0%	54%	0%
4	1.84%	0.9840%	1.41277	34%	0%	0%	0%	0%	66%	0%
5	1.90%	1.1112%	1.30708	23%	0%	0%	0%	0%	77%	0%
6	1.96%	1.2519%	1.20998	11%	0%	0%	0%	0%	89%	0%
7	2.03%	1.4027%	1.12429	0%	0%	0%	0%	0%	100%	0%

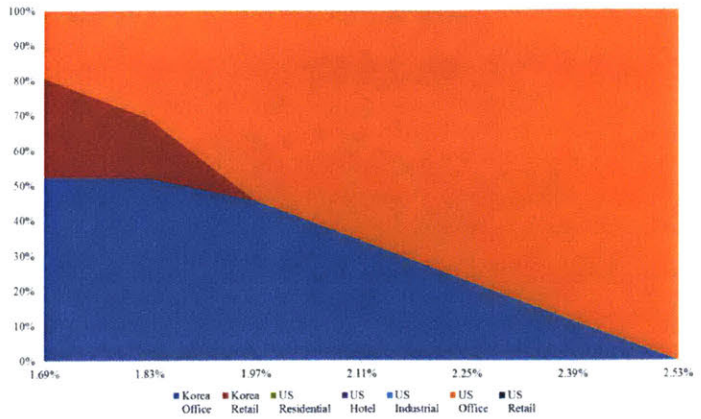
B) Asset Compositions of the Efficient Frontier without Restriction



#	Expected Retrun	Standard Deviation	SHARPE	Korea Office	Korea Retail	US Residential	US Hotel	US Industrial	US Office	US Retail
1	1.63%	0.6864%	1.71937	51%	20%	0%	0%	29%	0%	0%
2	1.75%	0.7092%	1.83164	52%	11%	12%	0%	17%	0%	8%
3	1.99%	0.8164%	1.88237	46%	0%	23%	0%	0%	0%	31%
4	2.11%	0.9147%	1.80993	34%	0%	21%	0%	0%	0%	45%
5	2.22%	1.0367%	1.71167	22%	0%	20%	0%	0%	0%	58%
6	2.34%	1.1749%	1.61145	10%	0%	18%	0%	0%	0%	72%
7	2.46%	1.3287%	1.51441	0%	0%	0%	0%	0%	0%	100%

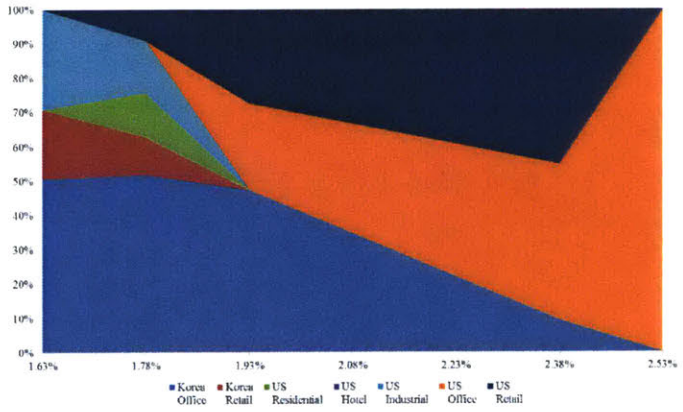
Scenario 2

A) Asset Compositions of the Efficient Frontier with Restriction of Investment in U.S. Properties other than Office Properties.



#	Expected Retrun	Standard Deviation	SHARPE	Korea Office	Korea Retail	US Residential	US Hotel	US Industrial	US Office	US Retail
1	1.69%	0.7264%	1.70402	52%	28%	0%	0%	0%	19%	0%
2	1.83%	0.7443%	1.85108	52%	17%	0%	0%	0%	31%	0%
3	1.97%	0.8753%	1.73388	46%	0%	0%	0%	0%	54%	0%
4	2.11%	0.9825%	1.68697	34%	0%	0%	0%	0%	66%	0%
5	2.25%	1.1098%	1.61946	23%	0%	0%	0%	0%	77%	0%
6	2.39%	1.2514%	1.54799	11%	0%	0%	0%	0%	89%	0%
7	2.53%	1.4027%	1.48075	0%	0%	0%	0%	0%	100%	0%

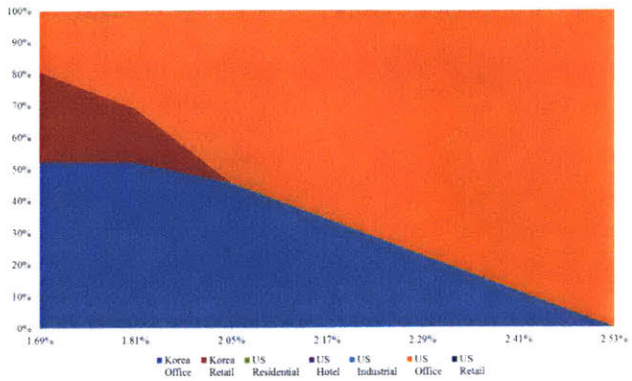
B) Asset Compositions of the Efficient Frontier without Restriction



#	Expected Retrun	Standard Deviation	SHARPE	Korea Office	Korea Retail	US Residential	US Hotel	US Industrial	US Office	US Retail
1	1.63%	0.6864%	1.71937	51%	20%	0%	0%	29%	0%	0%
2	1.78%	0.7118%	1.86794	52%	11%	13%	0%	15%	0%	9%
3	1.93%	0.8237%	1.79568	47%	0%	0%	0%	0%	25%	27%
4	2.08%	0.9235%	1.76354	35%	0%	0%	0%	0%	32%	33%
5	2.23%	1.0488%	1.69532	22%	0%	0%	0%	0%	39%	39%
6	2.38%	1.1917%	1.61753	9%	0%	0%	0%	0%	45%	45%
7	2.53%	1.4027%	1.48075	0%	0%	0%	0%	0%	100%	0%

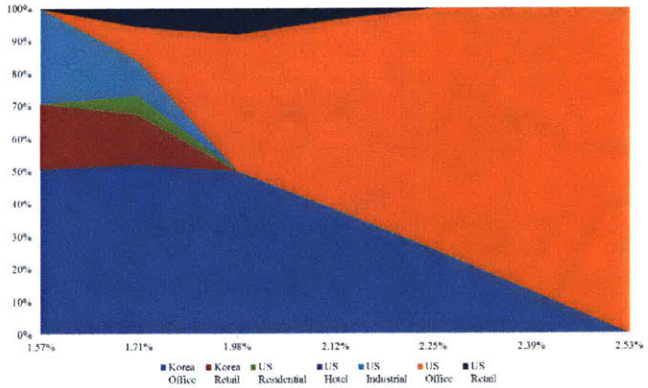
Scenario 3

A) Asset Compositions of the Efficient Frontier with Restriction of Investment in U.S. Properties other than Office Properties.



#	Expected Retrun	Standard Deviation	SHARPE	Korea Office	Korea Retail	US Residential	US Hotel	US Industrial	US Office	US Retail
1	1.69%	0.7264%	1.70402	52%	28%	0%	0%	0%	19%	0%
2	1.81%	0.7443%	1.82424	52%	17%	0%	0%	0%	31%	0%
3	2.05%	0.8753%	1.82519	46%	0%	0%	0%	0%	54%	0%
4	2.17%	0.9825%	1.74798	34%	0%	0%	0%	0%	66%	0%
5	2.29%	1.1098%	1.65546	23%	0%	0%	0%	0%	77%	0%
6	2.41%	1.2514%	1.56396	11%	0%	0%	0%	0%	89%	0%
7	2.53%	1.4027%	1.48075	0%	0%	0%	0%	0%	100%	0%

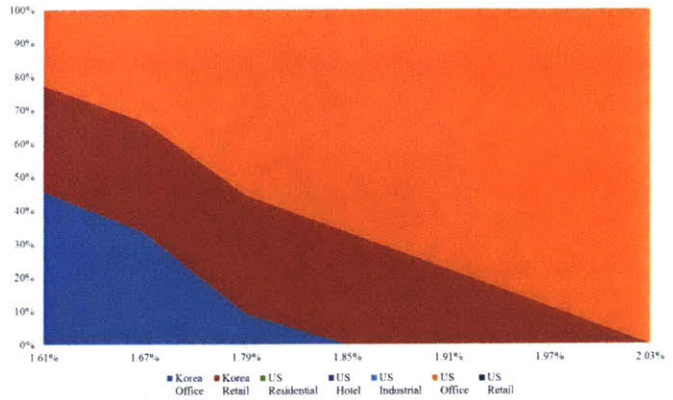
B) Asset Compositions of the Efficient Frontier without Restriction



#	Expected Retrun	Standard Deviation	SHARPE	Korea Office	Korea Retail	US Residential	US Hotel	US Industrial	US Office	US Retail
1	1.57%	0.6864%	1.63411	51%	20%	0%	0%	29%	0%	0%
2	1.71%	0.7148%	1.76024	52%	15%	6%	0%	11%	11%	6%
3	1.98%	0.8252%	1.85541	50%	0%	0%	0%	0%	42%	8%
4	2.12%	0.9346%	1.78426	38%	0%	0%	0%	0%	58%	3%
5	2.25%	1.0730%	1.68131	26%	0%	0%	0%	0%	74%	0%
6	2.39%	1.2312%	1.57620	13%	0%	0%	0%	0%	87%	0%
7	2.53%	1.4027%	1.48075	0%	0%	0%	0%	0%	100%	0%

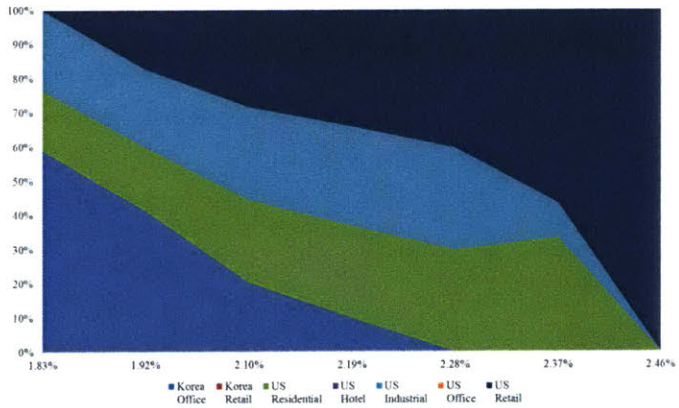
Scenario 4

A) Asset Compositions of the Efficient Frontier with Restriction of Investment in U.S. Properties other than Office Properties.



#	Expected Retrun	Standard Deviation	SHARPE	Korea Office	Korea Retail	US Residential	US Hotel	US Industrial	US Office	US Retail
1	1.61%	0.7735%	1.49946	46%	32%	0%	0%	0%	23%	0%
2	1.67%	0.7911%	1.54141	33%	33%	0%	0%	0%	34%	0%
3	1.79%	0.9200%	1.45504	9%	35%	0%	0%	0%	55%	0%
4	1.85%	1.0197%	1.37119	0%	34%	0%	0%	0%	66%	0%
5	1.91%	1.1358%	1.28347	0%	22%	0%	0%	0%	78%	0%
6	1.97%	1.2647%	1.19981	0%	11%	0%	0%	0%	89%	0%
7	2.03%	1.4027%	1.12429	0%	0%	0%	0%	0%	100%	0%

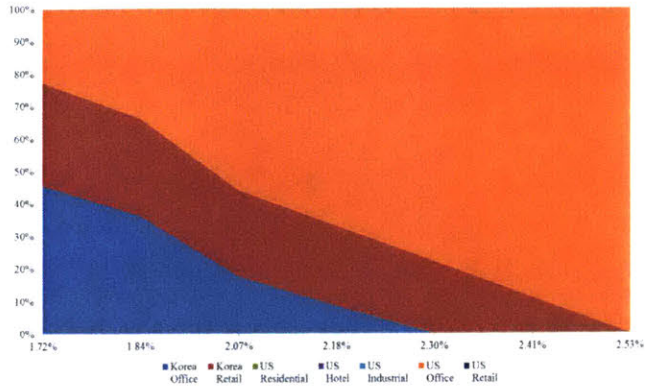
B) Asset Compositions of the Efficient Frontier without Restriction



#	Expected Retrun	Standard Deviation	SHARPE	Korea Office	Korea Retail	US Residential	US Hotel	US Industrial	US Office	US Retail
1	1.83%	0.6719%	2.05827	52%	0%	16%	0%	21%	0%	0%
2	1.92%	0.6839%	2.15361	41%	0%	18%	0%	23%	0%	17%
3	2.10%	0.7734%	2.13666	20%	0%	24%	0%	27%	0%	28%
4	2.19%	0.8441%	2.06434	10%	0%	27%	0%	29%	0%	34%
5	2.28%	0.9272%	1.97622	0%	0%	30%	0%	30%	0%	40%
6	2.37%	1.0607%	1.81224	0%	0%	33%	0%	10%	0%	56%
7	2.46%	1.3287%	1.51441	0%	0%	0%	0%	0%	0%	100%

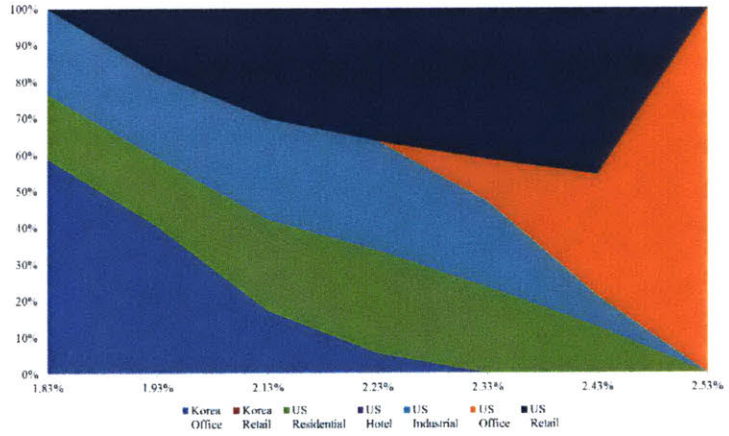
Scenario 5

A) Asset Compositions of the Efficient Frontier with Restriction of Investment in U.S. Properties other than Office Properties.



#	Expected Retrun	Standard Deviation	SHARPE	Korea Office	Korea Retail	US Residential	US Hotel	US Industrial	US Office	US Retail
1	1.72%	0.7735%	1.64654	46%	32%	0%	0%	0%	23%	0%
2	1.84%	0.7913%	1.75456	36%	30%	0%	0%	0%	34%	0%
3	2.07%	0.9214%	1.75594	18%	26%	0%	0%	0%	56%	0%
4	2.18%	1.0217%	1.69582	8%	25%	0%	0%	0%	67%	0%
5	2.30%	1.1379%	1.62352	0%	22%	0%	0%	0%	78%	0%
6	2.41%	1.2658%	1.55021	0%	11%	0%	0%	0%	89%	0%
7	2.53%	1.4027%	1.48075	0%	0%	0%	0%	0%	100%	0%

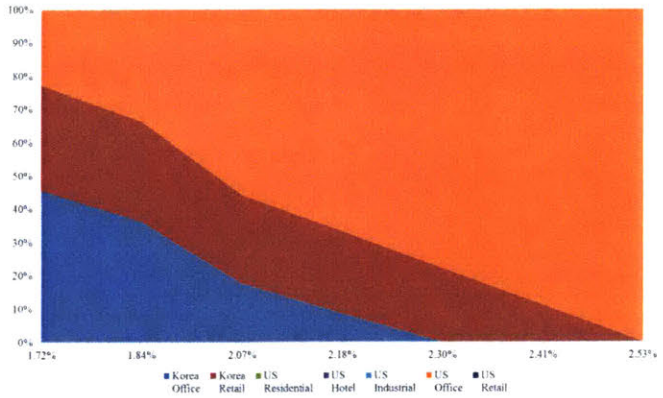
B) Asset Compositions of the Efficient Frontier without Restriction



#	Expected Retrun	Standard Deviation	SHARPE	Korea Office	Korea Retail	US Residential	US Hotel	US Industrial	US Office	US Retail
1	1.83%	0.6719%	2.05827	52%	0%	16%	0%	21%	0%	0%
2	1.93%	0.6864%	2.15902	40%	0%	19%	0%	23%	0%	18%
3	2.13%	0.7938%	2.11679	17%	0%	25%	0%	28%	0%	30%
4	2.23%	0.8770%	2.02918	6%	0%	28%	0%	30%	0%	36%
5	2.33%	0.9752%	1.92643	0%	0%	24%	0%	23%	12%	41%
6	2.43%	1.0952%	1.80591	0%	0%	13%	0%	8%	33%	46%
7	2.53%	1.4027%	1.48075	0%	0%	0%	0%	0%	100%	0%

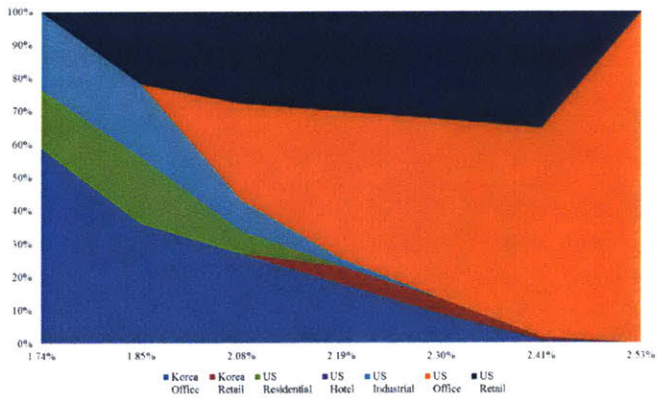
Scenario 6

A) Asset Compositions of the Efficient Frontier with Restriction of Investment in U.S. Properties other than Office Properties.



#	Expected Retrun	Standard Deviation	SHARPE	Korea Office	Korea Retail	US Residential	US Hotel	US Industrial	US Office	US Retail
1	1.72%	0.7735%	1.64654	46%	32%	0%	0%	0%	23%	0%
2	1.84%	0.7913%	1.75456	36%	30%	0%	0%	0%	34%	0%
3	2.07%	0.9214%	1.75594	18%	26%	0%	0%	0%	56%	0%
4	2.18%	1.0217%	1.69582	8%	25%	0%	0%	0%	67%	0%
5	2.30%	1.1379%	1.62352	0%	22%	0%	0%	0%	78%	0%
6	2.41%	1.2658%	1.55021	0%	11%	0%	0%	0%	89%	0%
7	2.53%	1.4027%	1.48075	0%	0%	0%	0%	0%	100%	0%

B) Asset Compositions of the Efficient Frontier without Restriction



#	Expected Retrun	Standard Deviation	SHARPE	Korea Office	Korea Retail	US Residential	US Hotel	US Industrial	US Office	US Retail
1	1.74%	0.6719%	1.91538	52%	0%	16%	0%	21%	0%	0%
2	1.85%	0.7031%	1.99078	36%	0%	20%	0%	22%	0%	22%
3	2.08%	0.8631%	1.88345	27%	0%	7%	0%	9%	29%	28%
4	2.19%	0.9625%	1.80603	18%	5%	0%	0%	2%	44%	30%
5	2.30%	1.0727%	1.72580	9%	5%	0%	0%	0%	54%	32%
6	2.41%	1.1942%	1.64476	1%	1%	0%	0%	0%	63%	35%
7	2.53%	1.4027%	1.48075	0%	0%	0%	0%	0%	100%	0%