What are the relevant factors and risk characteristics that determined the return in the direct and indirect property market?

An empirical investigation from Q3 1995 till Q1 2008

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Abstract:

This paper examines a statistical comparison between the unsecuritized (direct) commercial property market and the securitized (indirect) property markets. In this thesis we use constrained cross-sectional regression to disentangle the effects of various factors on the direct and indirect Real Estate Market. The factors that are considered are the common factor, pure country factor, pure property type factor and a size factor. This study is intended to add to the current literature in two aspect's. First, the comparison between two markets is on a global level. Second, this study using a factor model to compare the pure factors between the direct and indirect market. We found empirical evidence of the importance of the common, region, sector and size factor. For the direct market investing in multiple regions will lead to the largest risk reduction. While for the indirect market, property type allocation is the most effective allocation strategy. The result of the pure factors is in most cases very different for the direct market when compared to the indirect market. We conclude that most differences are caused by the actual platform on which the assets are traded. In terms of long term investment, listed real estate can be classified as the asset class "Real Estate". However, this strong relation for long investment horizon does not mean a fully synchronous return development. There also exists a significant price discovery between the two markets.

ACTIVE REAL ESTATE MANAGERS WILL have to decide according to which factor they want to make an investment. It is then very essential to know what the relevant factors and risk characteristics are that determined the return in the real estate market. A better knowledge of the risk factors that driving real estate returns is crucial. Exposure to the real estate market can be achieved via two principal modes of investment direct (physical) and indirect (securitized or financial). Direct real estate investment involves the acquisition and management of actual physical properties. Indirect investment involves buying shares of real estate investment funds.

This thesis begins by analyzing the theoretical relationship between the direct and the indirect real estate market. It is reasonable to assume that there are links between the performance of direct and indirect real estate markets. Consider the direct market where we could obtain instantaneous information about transaction prices or appraisal based prices and an indirect market which shares are traded of indirect real estate investment companies. However, in general we would expect performance measures in the direct sector to match closely those in the indirect sector. If they did not, arbitrage would be possible between the two markets.

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The aim of this thesis is to analyze the performance and performance drivers in the global real estate market. The focus of the theses is analyzing the differences between the "pure" effects of the factors between the direct and indirect real estate market. The answer to this question has important implications for portfolio management. Therefore, the key issue to be investigated is: What factors determine the return on direct and indirect property markets? The end result will present an approach to explain the decomposition of property type returns.

This paper is organized as follows. In the following section we discuss related research on the relation between the direct and indirect property market. The second part contains the presentation of data and the evaluation of our risk assessment methods for real estate portfolios. After which the results are presented and we conclude with closing remarks in the last section.

1 Literature Review

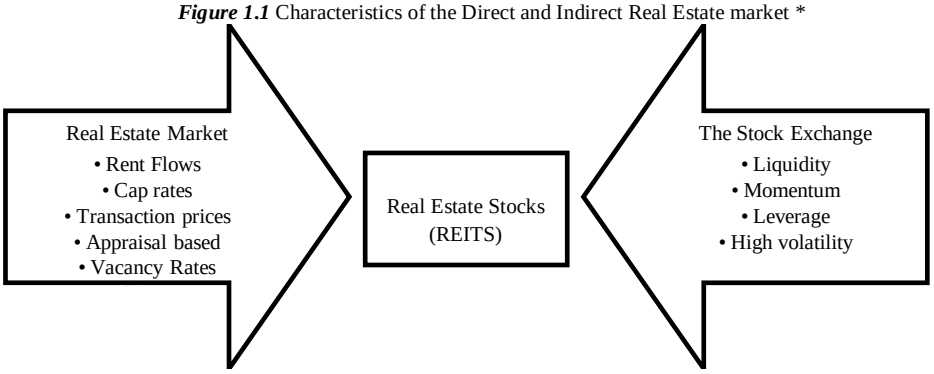
The concept of real estate as a financial asset has a history that exceeds any other asset class within finance. Large profits have been earned in the real estate industry in its long history. According to Brounen (2008) the size of the real estate market by the end of 2007 is estimated around 24 trillions US dollars. In two thirds of all cases, these buildings are owned by their users, which prohibits outside investors from participating. This leaves 10 trillions of "investable" real estate assets. These assets are currently occupied by tenants who pay their monthly rents and thereby provide the real estate investor a stream of cashflows, and thus a source of financial returns. The "investable" real estate market consists of 9 trillion of direct real estate assets and 1 trillion of indirect real estate.

Investing in a real estate asset has always required a significant amount of capital. Unlike equities or bond, the direct purchase of property assets is expensive. Only large investors are able to construct well-diversified portfolios. In most cases investors may find that the returns in their direct portfolios are dominated by only a few assets. In order to alleviate this capital requirement, investors initiated "partnerships' in which they combine their individual funds and skills. Through participation in these partnerships, individual investors obtain access to the returns that are realized in the real estate market. The growing involvement of outside investors has professionalized the real estate market by realizing that committed financial resources are used more efficiently. Since typical partnerships contain only a small group of investors, individuals still need to invest large amounts of capital in order to participate in these types of investment collaborations. The next and final stage of the real estate investment evolution was achieved when partnerships evolved into larger organizations that started to issue securities to the public. The proceeds of such security issuances were employed for expanding their real estate investment activities, offering security holders their share of the resulting profits in returns.

The indirect real estate market is a recent phenomenon. In 1990, this market consisted of less than 80 firm's globally, and no more than 70 billions of market value denominated in US dollars. The indirect sector by all measures is considered marginal by both investors and academics. As a result, the academic literature on listed real estate is in its infancy yet growing.

In the securitization process of direct real estate into real estate stocks listed on the stock exchanges, two separate worlds merge, as depicted in figure 1.1.

Figure 1.1 Characteristics of the Direct and Indirect Real Estate market *



On the one hand, investors in the indirect real estate market would like to understand the dynamics of real estate markets. Given that the listed real estate funds invest their funds in the direct real estate markets, investors should understand the driving forces behind vacancy rates, rent yields, cap rates and residual values. At the same time, prices of listed real estate stock will be affected with the daily sentiments of financial markets as soon as they are listed. Investors demand discounts if trading liquidity is low, and will chase momentum across sectors, which eventually results in premiums and discounts over asset values. From figure 1.1 we can see that the performance of listed real estate is influenced by the direct real estate market and the stock exchange.

The last twenty years institutional investors around the globe have increased their interest in the indirect real estate market and started using securitized real estate as a cost-efficient, more liquid real estate exposure. Traditional and modern economic perspectives have different views on whether the chosen platform for investing in real estate should matter.

As stated by Giliberto and Mengden (1996) they believe that the different pricing mechanisms used in each market disguise the relationship between public and private market real estate performance. According to Pagliari, Scherer and Monopoli (2005) "it is what's underneath the wrapper that matters in the long run". Seiler, Webb and Mayer (1996) examine the characteristics of the returns on the private and public real estate market. They concluded that the returns on private and public markets behave differently from one another and should be treated as separated asset classes from a real estate portfolio perspective. Booth and Marcato (2004) find that there is no strong relationship between the direct and indirect

property market, when monthly data is used but when annual data is used they find a strong relation between the direct and indirect real estate market. The most plausible explanation for this is that monthly, valuation based returns do not reflect underlying market movements as fully as annual indices because of the problem of valuation smoothing, which are exacerbated when shorter valuation are used. They therefore suggest that the monthly index of unlevered indirect real estate markets provided useful information in order to understand the short-term movements in the direct market.

Brounen (2008) concludes that the indirect real estate market introduces a low-cost, trading-market dimension, and a high transparency which is not presented in the direct real estate market. This difference in trading-mechanism causes significant variations in market performance of the direct and indirect real estate markets, which clouds their relationship and raises the question whether real estate shares offer the exposure to the real estate markets returns that investors seek. A good illustration of the difference in pricing mechanism is done by Giliberto and Mengend (1996): "Some say that comparing REITs to direct returns is like comparing apples to oranges. We disagree and think that the comparison provides and apples to apples comparison, albeit with a twist. In one case, the apple prices are observed daily in a local supermarket. In the other case, one has to drive 100 miles to an orchard to get the prices. This analogy does not imply that one market is the true apple market and the other is not.

Most studies which compare the direct and indirect markets find a weak link between the two markets. This makes that many investors conclude that real estate shares are no good exposure to real estate. However, the fact that listed real estate investment companies hold high percentages of real estate related assets should results in a high correlation between their returns and the development of the underlying real estate markets.

Academic research so far has offered an interesting insight between returns in the direct and indirect market. The area of linkages between the direct and indirect property market has attracted considerable research interest in recent years. Much of the recent research has shown that the indirect market and the direct property market are more closely related than previously thought. The majority of the available research studies analyzed the link between securitized and unsecuritized real estate and its underlying property on an aggregated level, which might distort the relationships due to differences in market allocations across the different property type sectors. In this thesis we abstract from this bias by applying a multi-factor approach on individual observations. The pure factors are adjusted to the difference in property type and region compositions.

2 Data

The international direct and indirect property dataset used in this study is obtained from several databases. The cross-sectional analysis is only possible when every region is represented by at least one observation, in other words the shortest time-series meeting this condition becomes the limiting factor. The database starts in the third quarter of 1995 until the end of 2007 and consists of quarterly data on property type, market cap and the main property type. The total returns are calculated on quarterly basis and all returns are in local currency. Two series of returns are derived, one characterizing an investor who hedges his foreign investments. For the other return series we use unhedged returns. It is clear that in the case of unhedged returns, currency movements will affect the factors. This means, an exposure to a given country entails an exposure to the country's currency risk. The unhedged return series makes sense for a well diversified international portfolio the currency risk tends to be diversified away. Hedged returns series are obtained from local prices together with the interest rate differential. Denoting r^* the short-term 3-month interest rate for the foreign country, and r the domestic US short term rate. The hedged returns may be expressed in the following way: $R_{i,t}^{loc} / R_{i,t-1}^{loc} + (1+r)/(1+r^*)$, where $R_{i,t}^{loc}$ is the local return in local currency at time t. The unhedged returns are defined as $R_{i,t}^{\$} / R_{i,t-1}^{\$}$, where $R_{i,t}^{\$}$ is the adjusted return in US dollars at time t

Table 1.1 *Number* of observations by region and property type.*

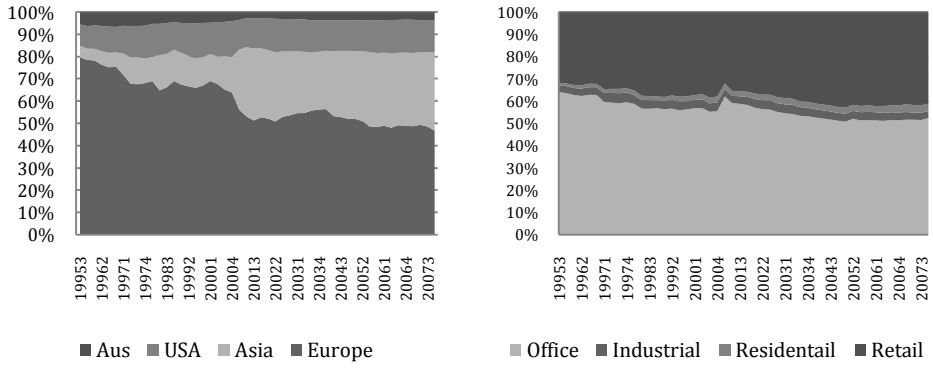
Direct data	Number of observations	Data Source	Current Market Cap
Continetal Europe	108	JLL	1,100
United States	78	NCREIF	258
Asia	56	JLL	627
Australia	16	IPD	62
All Regions	258		2,047
Indirect data	**Number of observations**	**Data Source**	**Current Market Cap**
Continetal Europe	77	GPR	68
United States	132	GPR	132
Asia	30	GPR	44
Australia	16	GPR	32
All Regions	255		276

*The table shows the number of observations represented by region and data source. The current market cap values are in billions of U.S. dollars, on Q4 2007.

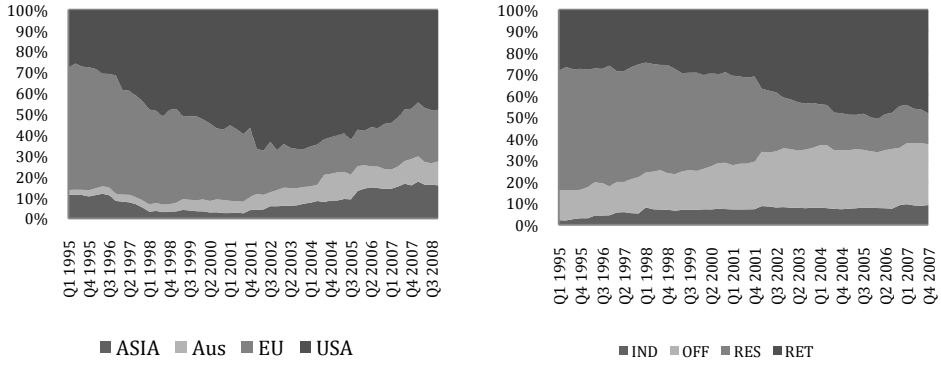
In the table 1.1 we give an overview of the different dataset used for the direct and indirect global property market. In table above we have included the capital values in billions of U.S. dollars and the number of observations for each region.
The direct property market is represented by a total number of observations of 258, with a total market value of 2,047 billion U.S dollar on Q4 2007. For the indirect property market the total number of observations is 255 with a total market value of 276 billion U.S. dollars at the end of 2007. In the figures below we give an overview of the relative weights for the regions and property types during the

sample period. It is clear there are major differences between the two markets in terms of property type holdings. For the direct market retail and office are the major property types. From these figures we can conclude that the direct market is biased toward main property types such as office and retail. This means that if particular asset types differ in their risk return characteristics then investment performance is not fully comparable. The majority of the relative weights in both markets is from the United States and Continental Europe.

Figure 1.2 The relative weights of the regions and property types for the Direct and Indirect property market. This figure shows the relative weight of the regions and property types in US dollar for the period Q3 1995 till Q1 2008. The weights depend on the number of observations and the market value.



*This figure shows the relative weights for the direct property market. Source: JLL, IPD and NCREIF.



*This figure shows the relative weights for the indirect property market. Source: GPR, DataStream

2.1 Direct property data

The Jones Lang LaSalle (JLL) dataset offers quarterly data for European and Asian cities in the following sectors: retail, industrial, residential and office. The total return index is based on rents, yields and capital values. The data are proxies of average effective rents and yields for institutional high quality real estate.
The total return series from the National Council of Real Estate Investment Fiduciaries (NCREIF) index consist of data from the U.S. Appraisal based index. NCREIF provides return data if there are more than four property investment in an MSA[2]. Which results in an index with a wide geographical spread. However for global analysis we would need comparable cities on an international scale. We therefore select only the top 25 cities by market value.

For Australia we use total return series provided by the Property Council Investment Performance index provided by IPD. The Property Council Investment Performance index is the major source of empirical time-series data on direct commercial property returns in Australia. The data has been selected on the basis of quality and availability. Table 1.2 shows key statistics of total returns in the local currency by region and by property type. The returns are calculated on a quarterly basis from the city data. The total number of observations for the direct property market is 11,377 with the majority of the observations being in the U.S and Continental Europe. The average return and risk is highest for Continental Europe (12,92%). The average return for all regions (12.71%) and this is a higher average return then for the region: Asia, United States and Australia.

If we look at the property type level residential property has the lowest risk level compared to other property types. Retail property has the highest averages return (12,9%) and also the highest risk level compared with other property types. The reduction of risk due to diversification is not as evident in the direct real estate market when compared to the stock market. There are some regions and property types that have a lower standard deviation than the global market, despite the fact that they are less diversified. This is an indication that the amount of diversification in the direct market may not be as large as for the stock market.

[2] MSA is a Metropolitan Statistical Area.

Table 1.2. Summary statistics of equally weighted (1) and value weighted (2) sample total returns in local currency, by region and property type *

Direct data		Number of observations	Mean	Standard deviation
Continetal Europe	(1)	3,397	12.92%	4.92%
	(2)		11.92%	5.13%
United States	(1)	5,757	3.47%	0.11%
	(2)		7.51%	0.25%
Asia	(1)	1,069	7.24%	5.80%
	(2)		3.07%	1.29%
Australia	(1)	770	11.46%	1.08%
	(2)		2.89%	1.00%
All Regions	(1)	11,024	12.71%	3.66%
	(2)		11.67%	3.57%
Direct data		Number of observations	Mean	Standard deviation
Industrial	(1)	2,944	12.51%	1.10%
	(2)		12.69%	1.83%
Office	(1)	3,556	11.64%	2.55%
	(2)		10.69%	3.98%
Residential	(1)	1,583	10.82%	1.01%
	(2)		11.85%	0.85%
Retail	(1)	2,941	12.50%	2.48%
	(2)		13.03%	3.93%
All Regions	(1)	11,024	12.71%	3.66%
	(2)		11.67%	3.57%

*The table contains the number of observations, average annual equally weighted mean, value weighted mean in local currency, and the standard deviations of the annualized return variables in our study. The equally weighted (1) statistics were obtained after pooling all observations over the whole time-series. For the value weighted statistics returns (2) are size weighted by their market cap to create an index of quarterly returns. Mean and standard deviations are based on quarterly log-returns. The average total return for Continental Europe and Australia are not correct for appraisal smoothing in this table. The period ranges from Q3 1995 to Q4 2007. Sources: JLL, IPD, NCREIF.

For appraisal based indices such as the NCREIF Index and the Property Council Investment Performance index, it has long been recognized that these indices are smoothed and are lagged. Mostly due to the combined effects of appraisers partial adjustments at the disaggregate level as well as temporal aggregation in the construction of the index at the aggregate level. This causes indices such as the above to have a relatively low volatility and positive autocorrelation in the return series. As a result the above indices do not illustrate real market returns in the direct property market. However, for an analysis between direct and indirect market comparable returns are essential. To recover the underlying real market returns from the appraisal-based data we used the approach of Geltner (1993).

To summarize the proposed procedure for recovering an estimate of the real underlying market return the approach is specified as follows:

$$R_t^U = \frac{1}{\alpha} \times [R_t^* - (1-\alpha) \times R_{t-1}^*]$$

$$\alpha = 1 - \rho \qquad (1)$$

The first-order autoregressive function *(1)* is the basis upon which we propose to recover an estimate of the actual real market returns R_t^U from the smoothed return series R^*. To implement above described procedure we needed an estimation of α. The parameter α has a value between 0 and 1 whose value is quantified based on a structural analysis of the sources and nature of the smoothing in the observable return series. The autocorrelation in the US Total Return series is for the sample period around 0.68. For the Australian total return series the autocorrelation is lower around 0.60. Therefore we use the value $\alpha = 0.32$ to unsmooth the U.S. returns series, and the value of $\alpha = 0.40$ to unsmooth the Australian Total Returns. When the US total return data series are unsmoothed, the mean log-return decreases slightly to 10.9 %. The standard deviation of the unsmoothed US return series is 1.9%. This increases to 8.2% as a result of the unsmoothing process. The mean log return for the Australian total return series is around 11.51 % with a standard deviation of 4.8%. While this unsmoothing procedure is essentially subjective, the recovered real market returns series shows in both samples a higher variability then of the unadjusted appraisal-based data, and get rid of most, though not all, of the positive autocorrelation in the appraisal based returns series.

2.2 Indirect property data

The Global Property Research (GPR) database provides indirect international property data. The database consist of international real estate stocks and includes for each company information as the country of origin, the type of fund and the main property type in which the company invest, the structure of the company and the market capitalization. The database provides property type information for the following sectors, office, retail, residential, industrial, hotel, health care, other and diversified. An issue is that Global Property Research provides information only on core property types which we. This means that it is possible that non core property types have risk return attributes that differ significantly from the core properties types which we cannot compare. For comparability reasons with the direct property market, we only select the property types such as office, retail, residential and industrial. The observations represented are from the regions: Europe, North America, Australia and Asia. In this thesis we have excluded development and hybrid companies from the analysis. Total returns are in local currency, calculated on quarterly basis and are taken from Thomson Financial DataStream.

Table 1.3 shows the key statistics of the total returns in local currency by region and by property type. The total number of observations for the indirect property market is 7,731 with the majority of the observations in the United States and Continental Europe. The average return is the highest for the Australia (16.56%). The average return for all observations is for the indirect market (11.78%).

If we look at the property type level it is evident that residential property and industrial property has the lowest risk level compare to the other property types. Industrial property has the highest averages return (13.81%). The average return for all region is (11.78%) and is higher than the returns of Asia and Continental Europe. Moreover, the risk of all regions combined (4.5%) is lower than the risk for any individual region. This indicates that there is potential for the diversification in the indirect market.

Table 1.3. Summary statistics of equally weighted (1) and value weighted (2) sample total returns in local currency, by region and property type.*

Direct data		Number of observations	Mean	Standard deviation
Continetal Europe	(1)	3,466	7.99%	5.27%
	(2)		3.01%	6.96%
United States	(1)	3,158	15.47%	6.29%
	(2)		16.62%	6.81%
Asia	(1)	688	1.17%	11.04%
	(2)		4.50%	10.70%
Australia	(1)	419	16.56%	6.08%
	(2)		20.41%	7.93%
All Regions	(1)	7,731	11.78%	4.50%
	(2)		13.94%	5.50%
Direct data		Number of observations	Mean	Standard deviation
Industrial	(1)	588	13.81%	5.10%
	(2)		16.48%	6.77%
Office	(1)	3,141	11.20%	4.47%
	(2)		13.08%	5.88%
Residential	(1)	1,502	2.29%	5.15%
	(2)		9.02%	6.21%
Retail	(1)	2,450	13.46%	5.27%
	(2)		17.37%	5.99%
All Regions	(1)	7,731	11.78%	4.50%
	(2)		13.94%	5.50%

*The table contains the number of observations, average annual equally weighted mean, value weighted mean in local currency, and the standard deviations of the annualized return variables in our study. The equally weighted (1) statistics were obtained after pooling all observations over the whole time-series. For the value weighted (2) statistics returns are size weighted by their market cap to create an index of quarterly returns. The statistics were obtained after pooling all observations over the whole time-series. In this table the total returns are not corrected for the effects of leverages. Means and standard deviation are based on quarterly log-returns. The period ranges from Q3 1995 to Q4 2007. Source: GPR, and DataStream.

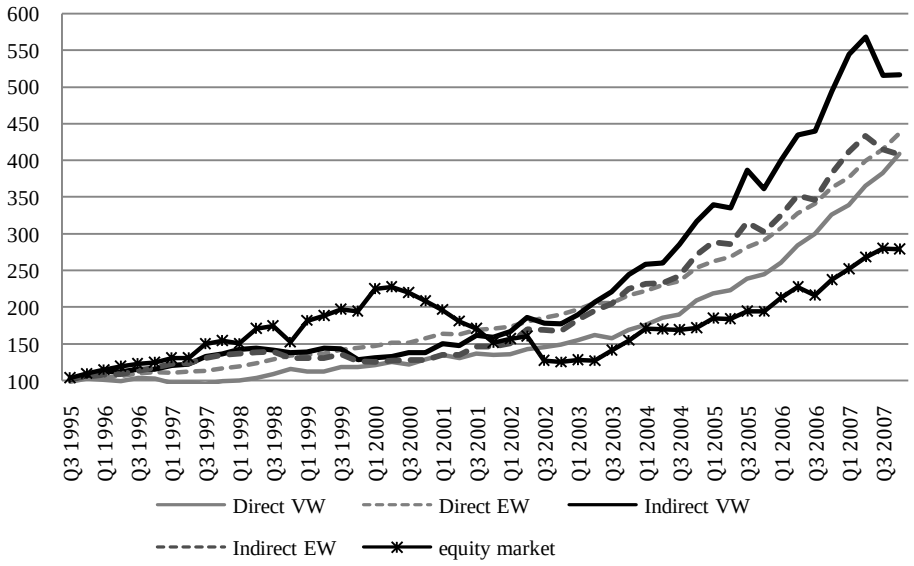
To compare the returns and the value drivers of the direct with the indirect properties represented by REITs traded on the stock exchanges, we need to unlever the indirect returns. The reason for this is to remove the effect of debt on both the asset and liability sides of the REIT balance sheets. This unlevering has been accomplished by the use of the following weighted average cost of capital (WACC) model:

$$R_{p,t} = \{R_{E,t} - [1 - (P/E)_t]R_{D,t}\}/(P/E)_t \qquad (2)$$

Where $R_{p,t}$ is the estimated unlevered property return at time *t*. The levered return to REITs shareholders is measured by $R_{E,t}$ and the market return for long-term Government debt $R_{D,t}$ is used as an approximation for the costs of debt. $(P/E)_t$

In figure 1.1, we plot a time series of the cumulated log total return in the direct real estate markets versus the total returns of the indirect real estate markets.

Figure 1.1 Cumulated Total log-returns for the direct and indirect global market*



*This figure shows the cumulated global Total log-return for the direct and indirect property market, both in local currency and the cumulated return from the MSCI global equity index. The Total log-returns for the direct market and indirect market in this figure are not corrected for appraisal smoothing and leverage effects. The average log returns are calculated on equally weighted basis. Source: GPR, DataStream, JLL, IPD and NCREIF.

At first sight it is clear that in both markets – the direct and the indirect property market appear to move generally together. Both real estate markets showed during the period Q31995 till Q4 2007 a strong upward trend. The correlation between the global direct (EW) and indirect (EW) market is around 0.09 percent. While the correlation between the indirect (EW) market and the Global MSCI index is around 0.43 percent. From this high correlation between listed real estate and the global

equity market, one would easily jump to the conclusion that securitized real estate cannot serve as a proper substitutes for the exposure to the direct real estate market.

The direct real estate market shows little variability. The reason for this is the smoothing effect of appraisals, as has been widely suggested in the literature or by other yet unexplained factors. Furthermore the volatility in the indirect property market is higher than the volatility for the direct property market. As leverages in the indirect market increases the returns it also raises the volatility in the indirect market, making a comparison between the two markets difficult. As explained by Riddiough, Moriary and Yeatman (2005) liquidity is an important risk pricing factor. Ownership of indirect real estate through listed shares provides significantly greater liquidity than direct (private) asset ownership. Given the fact that investors value liquidity, all else equal, indirect returns should be lower than direct returns. Another reason for the high volatility in the listed real estate market is that liquidity introduces excess volatility into the share returns.

When correcting for smoothing and leverage the difference in volatility between both markets decreases substantially. Unsmoothing the returns of the direct appraisal based total returns series has almost doubled the volatility for these returns. According to Booth and Marcato (2004) removing the leverage effect of the indirect property market should not necessarily change the correlation structure with the direct market. Because leverage is only a factor that increases the volatility of returns from the equity of a real estate company compared with the volatility of returns from the underlying assets. The leverages ratios are necessary in order to remove the impact of leverage from the indirect total returns. Due to the fact of data problems it is unfortunately not possible to unlever the indirect total returns.

3 Methodology

When constructing a portfolio of publicly traded real estate stocks, much emphasis is placed on the analysis of the correlation coefficients between countries or continents. These correlation analyses are useful, but it would be important to disentangle the effects of various factors on real estate returns.

The objective of the thesis is to determine the pure effects of various factors on international real estate security returns. What are the pure factors and risk characteristics that determine the return in the property market ? And what are the differences between the direct and indirect return?

An important issue is to disentangle region factors from sector factors. It is crucial to separate these various influences and eliminate the interaction between them.
This goal is clearly not reached when region indices are used as proxies for region factors, industry indices for industry factors. For instance, if the property type composition differs across regions, then region indices contain property type effects and the property type indices, region effects.

To illustrate this point we may take the following example. Returns on the Australian property market may differ from returns on a global property type index. First, the returns may differ because the property type composition of the Australian index is different from the property type composition of the world index. On average, if Residential stocks underperform the world index and office stock over perform it, then the overall effect will be positive for Australia because this region index has proportionally more commercial office property and less commercial residential property than the world index. Second, returns on the Australian index and the world index may differ because returns on Australian companies are different from returns belonging to the same industry group but located in a different region.

For these reasons we apply a multi-factor approach on individual observations. Country, industry style effects can be more easily separated by using individual observations than indices. With this methodology, the Australian effect can be interpreted as the outperformance of a property diversified portfolio relative to the world index. By property type diversified we mean that the Australian portfolio has the same property type composition as the world index. Similarly the office effect is the outperformance of a geographically diversified office portfolio relative to the world index.

In general terms, multi-factor models specify the return on asset *i* at time *t* as the sum of the product of *K* factor returns and "factor loadings". The factor loadings are known in advance, the stock market capitalization[3], the country or sector belonging of a stock. The methodology seeks to estimate the returns on these factors. In this study we examine region and property type factors, as well the Size factor.

[3] The observations market cap is used for the value weighted sample. The factor loadings in the equally weighted sample are estimated in the following way: $1/N_t$

The model, is specified as followed:

$$R_{i,t} = F_t + \sum_{k=1}^{N^C} D_i^{C_k} F_t^{C_k} + \sum_{k=1}^{N^S} D_i^{S_k} F_t^{S_k} + SZ_{i,t} F_t^{SZ} + \varepsilon_{i,t}$$ [4] *(1)*

where $R_{i,t}$ is the return on stock *i* at time *t*. N^C and N^S are the number of regions and property factors respectively. $D_i^{C_k}$, and ($D_i^{S_k}$) is a dummy variable, set to one if stock *i* belongs to a Region (property type) *k*, with *k*= 1,….. , N^C and N^S. $SZ_{i,t}$ is the Size exposure of stock *i* at time *t*. In the equation above, the unknowns are F_t (the return on the Common factor, which is equivalent to the weighted average of all stock returns), $F_t^{C_t}$(the returns on the country factors), $F_t^{S_t}$(the return on the property type factors), $F_t^{SZ_t}$(the return on the size factor). The interpretation of the pure factors is as follows. The factors are pure in the sense that they are not influenced by any of the other factors. An interpretation of the pure factor is that the return on an European property would equal the sum of the common factor and the pure European factor has the same property type, size characteristics as the world. Finally $\varepsilon_{i,t}$ is the stock specific- return, which means the return on stock *i* at the time *t* regardless of its country, sector or size exposure.

In order to estimate the above model and ensure that the world portfolio has zero exposure to each factor, we need to impose some additional restrictions on the parameters.

$$\sum_{t=1}^{N^C} \left(\sum_{i=1}^{N_t} \omega_{i,t} D_t^{C_k} \right) F_t^{C_k} = 0$$

$$\sum_{t=1}^{N^S} \left(\sum_{i=1}^{N_t} \omega_{i,t} D_t^{S_k} \right) F_t^{S_k} = 0$$

$$\sum_{t=1}^{N_t} \omega_{i,t} SZ_{i,t} F_t^{SZ} = 0$$

(2)

The constraints in (2) can be summarized in the following way: the weighted average of the returns to each factor category (region, sectors and size) should equal zero. With these constraints, a portfolio replicating the world index has zero exposure to each factor. Every quarter, property returns are regressed against property sector dummy variables (residential, industrial, office and retail), region dummy variables (Australia, Europe, United Kingdom and Asia) and a size factor. The factors are estimated every period independently from observations for other

[4] The model is fully described in the Appendix 1C.

time periods. The cross-sectional regression may be run to get the factor returns by using either a value-weighted OLS regression method or an equal weighted OLS.

$$SZ_{i,t} = \frac{\frac{MC_{i,t}}{TMC_t} - u_t}{a_t} \qquad (3)$$

The size exposure $SZ_{i,t}$ has to be defined through the stock weights $\omega_{i,t}$, according to the standardization rule in equation (3). Where $u_t = \sum_{i=1}^{Nt} \omega_{i,t} \frac{MC_{i,t}}{TMC_t}$ and a_t is chosen such that $max_i(SZ_{i,t})$ = 1. In other words, u_t is the weighted average of the weights of the observations at time *t*, and a_t is a scaling factor ensuring an economic interpretation of the magnitude of the Size factor. This method results in a model that has a zero exposure to the Size factor and the largest constituent has an exposure of 1.

The cross-sectional regression is estimated by different weighting schemes. First, we use a weighted least square instead of ordinary least squares because variance is not constant across cross-section. This means that each observation is weighted by its market capitalization weights. Second we use an equally weighted weighting scheme to estimate the regression. In this estimation each observations is equally weighted. We also estimate the cross-sectional regression with a log value weighted regression schemes. $\omega_{i,t}$ is the weight of stock *i* at time *t* such that $\sum_{i=1}^{N_t} \omega_{i.t} = 1$ will be defined according to the different weighting schemes applied to the cross-sectional regressions. Indeed, $\omega_{i,t}$ is the market cap of stock *i* at time *t* $(MC_{i,t}/TMC_t)$ if a value-weighted scheme is used, while it is equal to $1/N_t$ if an equal-weighted scheme is applied. For the log value-weighted regression schemes the weight of stock *i* at time *t* is defined in the following way $ln(MC_{i,t}/TMC_t)$. The cross-sectional regression is run for the direct and indirect property market, quarter by quarter from Q3 1995 through Q4 2007.

4 Results

4.1 The pure factors

The log-mean and standard deviation for pure factors are reported in Table 4.1 and 4.2. The table shows the mean log- pure factors for five different samples: hedged/unhedged, equal weighted, value weighted regression and log value weighted regression. The common factor is equal to the global index or equal to the average of all regions. The pure mean factor for the individual regions indicates over or underperformance relative to the common factor or global index. For example in the hedged equally weighted sample, Asia underperformed in the indirect property market the common factor by 990 basis points during the selected period, given a diversified portfolio with the same property type allocation as the global portfolio.

The results in table 4.1 and 4.2 show that the standard deviation for the regional effect for the direct market is higher than the standard deviation for the property type effect. This demonstrates that average returns over this time period for the property type stay closer together than the average returns between regions. For the indirect market it appears that the differences in volatility level between the regional and property type pure effect is smaller. This shows that returns for regions are more volatile than returns for property types. The higher the volatility level of the region pure factors makes it a more important determinant of the variation in international returns.

If we compare the volatility level of the pure factors between the two markets we can conclude that the volatility in the direct market is smaller than the volatility in the indirect market. The main reason for the higher volatility is the effect of leverages on the capital structure of REITs debt on both the asset and liability sides of the REIT balance sheet.

Table 4.1 and 4.2 gives the results for the pure factors and standard deviation in US dollars (the unhedged sample) and in local currency (the hedged sample). Converting the returns in US dollar reduces the performance of the region Asia and Europe and increases the performance of Australia. The unhedged sample shows for both markets a higher volatility then the hedged sample this is due to the fact of the additional currency risk. The difference in volatility between the hedged and unhedged common pure factor is relatively small so we can conclude from this that an international well diversified portfolio in the direct or indirect property markets the effect of currency risk is very small.

Since the common factor is the global total return, all regions outperform in the indirect property market except Asia and Continental Europe. Australia and the United States show a positive ‘pure’ effect, demonstrating that these regions, with the same allocation to property type as the global allocation, outperform the global

total return in the indirect market. Office real estate has the highest outperformance, followed by Retail. In the direct property market the Australia and the European factor outperformed the common factor for most subsamples. The property types office and residential show small negative pure effects, the other property types show positive pure factors for all subsamples. The results for the common factor in table 4.1 suggest that while real estate is fundamentally local asset, the demand for real estate apparently responds to changes in the global economy. According to the results in table 4.1 the common pure factor or global factor is the important driver of real estate returns. This consistent with the conclusion of Eichholtz (1998) and Rouwenhorst , Goetzmann (1999).

The average return on the size factor is negative for value weighted hedged and unhedged samples for both property markets. This means when all things held constant: large capitalization real estate stocks perform worse than smaller capitalization real estate securities. This result is consistent with the results usually reported in the financial economics literature and also the result of Eichholtz and Huisman (2001). The pure size factor standard deviation is quite large indicating that the size factor is an important risk factor. This means that the volatility of the size factor is such that a portfolio manager that would inadvertently over- or underexpose his or her portfolio to these factors, relative to a benchmark, would take a significant amount of risk.

In the appendix of 1A we show the results for the unsmoothed direct returns series for the different factors. In the appendix only the appraisal based total returns are unsmoothed. When the US total return data series are unsmoothed, the variability of the mean pure US return series is increased for all subsamples. The same result appears for the unsmoothed returns series of the Australian pure factor.

In table 4.1 and 4.2 we report also the median t-statistic of each factor and show if its median value over time is significantly larger than the critical value of 1.96. The t-statistic is calculated from the time-series of t-statistic which are estimated cross-sectionally. From the output we investigate that the common factor is highly significant in both markets. The region factors are generally significant while the sector factors are less significant. The size factor is highly significant for the value weighted sample and insignificant for the equally weighted sample. If we compare the significance level between the direct and indirect market we can conclude that in most subsamples for the country, sector and size factor the significant level in the direct market is higher than for the indirect market.

Table 4.1. Summary statistics for the common factor and the pure country factors.

Unhedged equal-weighted sample	(1)
Unhedged value- weighted sample	(2)
Hedged equal-weighted sample	(3)
Hedged value- weighted sample	(4)
Hedged log value-weighted sample	(5)

		Direct Property market			Indirect Property market		
Factor	Dataset	Pure Factor (%)	*t*	Std. Dev (%)	Pure Factor(%)	*t*	Std. Dev (%)
Common	(1)	13.08%	**(12.35)**	2.59%	15.07%	**(4.94)**	4.42%
	(2)	12.33%	**(8.56)**	2.22%	16.29%	**(5.39)**	5.74%
	(3)	11.62%	**(5.39)**	1.44%	15.68%	**(5.14)**	4.20%
	(4)	12.52%	**(12.21)**	1.89%	16.23%	**(8.48)**	5.34%
	(5)	12.72%	**(5.11)**	1.86%	16.91%	**(3.00)**	5.18%
Europe	(1)	1.10%	**(7.10)**	3.32%	-3.56%	**(2.71)**	3.83%
	(2)	0.17%	**(3.55)**	3.51%	-2.09%	**(1.52)**	3.65%
	(3)	0.57%	**(1.52)**	1.11%	-2.56%	**(2.13)**	3.23%
	(4)	-0.07%	**(2.04)**	1.47%	-1.81%	**(2.77)**	2.80%
	(5)	0.76%	**(2.17)**	1.18%	-2.11%	**(2.14)**	3.23%
United States	(1)	-0.51%	**(5.92)**	1.81%	3.42%	**(3.02)**	4.25%
	(2)	-0.12%	**(4.14)**	1.88%	1.75%	**(1.25)**	3.97%
	(3)	0.07%	**(1.25)**	0.62%	2.42%	**(2.50)**	3.85%
	(4)	0.19%	**(1.80)**	0.90%	1.94%	**(3.51)**	3.48%
	(5)	-0.01%	**(1.82)**	0.64%	2.11%	**(2.56)**	3.85%
Asia	(1)	-4.21%	**(3.33)**	5.39%	-13.83%	**(2.01)**	10.26%
	(2)	-2.02%	**(3.45)**	5.17%	-10.47%	**(1.85)**	10.10%
	(3)	-1.95%	**(1.85)**	3.58%	-9.35%	**(1.98)**	9.35%
	(4)	0.34%	**(2.35)**	4.35%	-7.33%	**(2.80)**	8.55%
	(5)	-2.09%	**(2.47)**	3.73%	-9.79%	**(1.88)**	9.33%
Australia	(1)	2.57%	**(2.01)**	4.39%	9.53%	**(2.09)**	8.51%
	(2)	0.75%	**(2.18)**	4.46%	6.73%	**(1.86)**	8.37%
	(3)	0.88%	**(1.20)**	2.75%	5.98%	**(1.97)**	7.76%
	(4)	-1.15%	**(1.67)**	3.64%	4.34%	**(2.21)**	7.07%
	(5)	0.86%	**(1.71)**	2.86%	6.29%	**(1.87)**	7.72%

*The table contains the annualized mean return, standard deviation and t-statistic for the common factor, the pure country factors. These are time-series moments on pure factor returns for the indirect property market, which are estimated cross-sectionally by the following model: $R_{i,t} = F_t + \sum_{k=1}^{N^C} D_i^{C_k} F_t^{C_k} + \sum_{k=1}^{N^S} D_i^{S_k} F_t^{S_k} + SZ_{i,t} F_t^{SZ} + \varepsilon_{i,t}$. The period ranges from Q3 1995 to Q4 2007.

Table 4.2 Summary statistics for property type factor and the size factors. *

Unhedged equal-weighted sample	(1)
Unhedged value- weighted sample	(2)
Hedged equal-weighted sample	(3)
Hedged value- weighted sample	(4)
Hedged log value-weighted sample	(5)

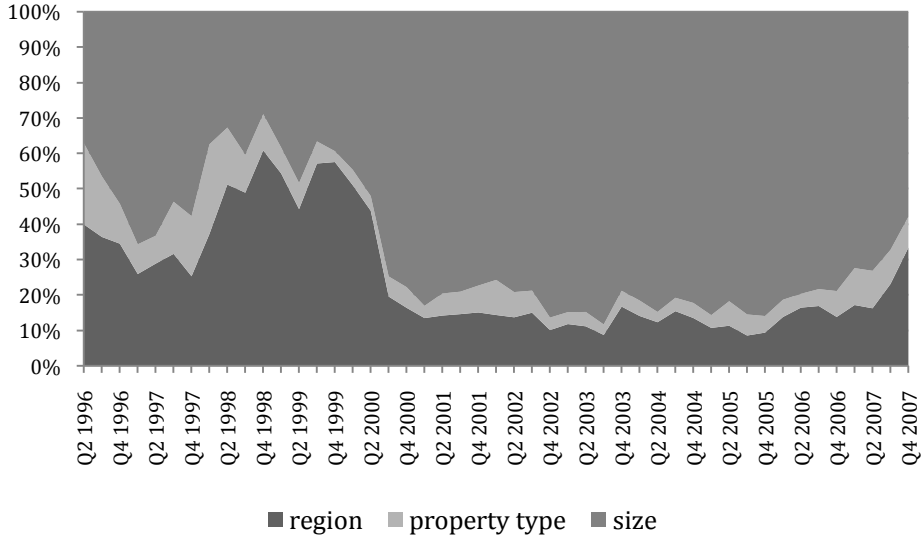
		Direct Property market			Indirect Property market		
Factor	Dataset	Pure Factor (%)	*t*	Std. Dev (%)	Pure Factor(%)	*t*	Std. Dev (%)
Office	(1)	-0.52%	**(1.49)**	0.66%	1.90%	**(1.02)**	2.16%
	(2)	-1.08%	**(1.59)**	0.95%	0.19%	**(1.65)**	1.98%
	(3)	-0.61%	**(1.34)**	0.68%	1.86%	**(0.96)**	2.16%
	(4)	-1.00%	**(1.59)**	0.98%	0.20%	**(1.55)**	1.98%
	(5)	-0.68%	**(1.63)**	0.69%	2.16%	**(0.98)**	2.14%
Retail	(1)	0.61%	**(1.80)**	0.92%	0.63%	**(1.06)**	2.55%
	(2)	1.51%	**(2.09)**	1.39%	2.21%	**(1.34)**	2.61%
	(3)	0.60%	**(1.65)**	0.91%	0.65%	**(1.06)**	2.53%
	(4)	1.32%	**(1.79)**	1.40%	2.00%	**(2.06)**	2.57%
	(5)	0.75%	**(1.85)**	0.93%	0.45%	**(1.06)**	2.52%
Residential	(1)	-0.40%	**(1.10)**	0.28%	-2.10%	**(1.33)**	3.74%
	(2)	-0.76%	**(1.34)**	0.38%	-2.47%	**(1.13)**	3.49%
	(3)	-0.37%	**(0.60)**	0.26%	-1.28%	**(1.04)**	3.64%
	(4)	-0.74%	**(0.83)**	0.30%	-2.25%	**(1.39)**	3.44%
	(5)	-0.38%	**(0.92)**	0.25%	-1.12%	**(0.96)**	3.41%
Industrial	(1)	0.28%	**(0.98)**	0.54%	-1.27%	**(0.88)**	4.09%
	(2)	0.26%	**(1.42)**	0.56%	-0.67%	**(0.46)**	3.72%
	(3)	0.35%	**(0.40)**	0.51%	-2.04%	**(0.87)**	4.04%
	(4)	0.32%	**(0.986)**	0.55%	-0.67%	**(1.41)**	3.69%
	(5)	0.27%	**(0.972)**	0.52%	-2.24%	**(0.89)**	3.89%
Size	(1)	-2.09%	**(1.48)**	4.05%	3.12%	**(0.98)**	9.89%
	(2)	-1.08%	**(1.96)**	0.95%	-1.95%	**(3.01)**	4.91%
	(3)	2.18%	**(3.01)**	3.76%	2.56%	**(0.96)**	9.85%
	(4)	-0.48%	**(1.49)**	3.86%	-1.30%	**(1.99)**	4.89%
	(5)	0.97%	**(1.56)**	2.64%	1.17%	**(0.98)**	7.03%

*The table contains the annualized mean return, standard deviation and median t-statistic for, the pure property-type factors, and the pure size factor. These are time-series moments on pure factor returns for the direct property market, which are estimated cross-sectionally by the following model : $R_{i,t} = F_t + \sum_{k=1}^{N^C} D_i^{C_k} F_t^{C_k} + \sum_{k=1}^{N^S} D_i^{S_k} F_t^{S_k} + SZ_{i,t} F_t^{SZ} + \varepsilon_{i,t}$. The period ranges from Q3 1995 to Q4 2007.

To explore whether the relative importance between the pure factor effects for the region, property types and size factor changes during the sample period we calculate the moving average absolute return. The absolute values of the region and property pure factors are multiplied by their respective market capitalization weights in the global property market on each data point. In figure 4.1 and 4.2 we report the average four quarter moving absolute effect for the direct and indirect market. The size factor is the most important factor in both markets. Therefore it is

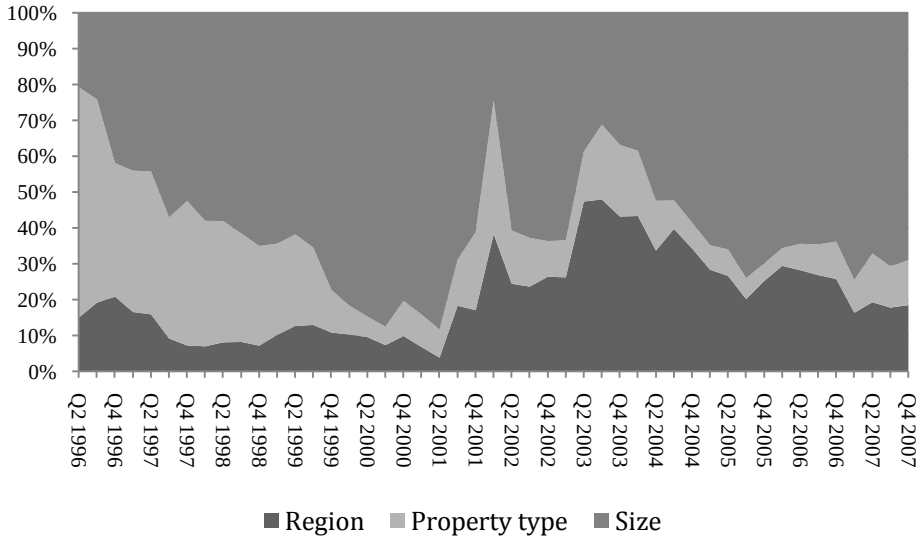
clear that the size factor should be taken into consideration when building real estate portfolios. For the direct market the pure region effect is during the whole sample larger than the pure property type effect. This result is consistent with the results of Heston and Rouwenhorst (1996) they find similar results for the equity market. In the indirect market, property types have more influence on the return than regions between 1995 and 2002. This result is consistent with the recent literature for the equity and property markets that the sector factors are becoming more important. We can conclude for the indirect property market that it is more internationally integrated then the direct property market. This means that a larger part of the returns in the indirect market are generated internationally. This means that the relatively importance of the region factors is likely to decrease as that of property type factors increases. For the indirect market the property type allocation is the most effective allocation strategy. While in the direct property market region allocation is the most important allocation strategy.

Figure 4.1 **A**verage Absolute returns on each factor as a percentage of the sum of the absolute returns for the Direct property market.*



*This figure contains the hedged sample with a value-weighted weighting scheme. On each data, the absolute value of the country and property type factors are multiplied by their market value weights. The figure shows the 4- quarter moving average absolute return for the region, property type and the size factor.

Figure 4.2 **Av**erage Absolute returns on each factor as a percentage of the sum of the absolute returns for the Indirect property market.*



*This figure contains the hedged sample with a value-weighted weighting scheme. On each data, the absolute value of the country and property type factors are multiplied by their market value weights. The figure shows the 4-quarter moving average absolute return for the region, property type and the size factor.

Diversification benefits arise from low correlations between different assets. Correlation coefficients among regions and sectors are the first indication of the relative importance of diversifying by sector and region. The diversifications benefits in the real estate market are well documented. The main sources driving correlations may be due to differences in economic conditions between regions, like variations in regulations, economic policies and growth rates.

Table 4.3 A gives an overview of the correlations between the common factor, the pure region factor, the pure property type effect and the size factor for the hedged sample. In table 4.3 B we present the correlations between the region and property type value weighted indices. The correlations coefficients between the pure region factors are very low. In two cases is the pure region factor highly negatively correlated. This is the case for the correlation between the region Asia and Australia (-0.97 for the direct and indirect market) and between the continents Europe and the USA (-0.85 for the direct market and -0.97 for the indirect market). These results indicate that diversification opportunities exist between continents. This is consistent with the conclusion of Hamelink and Hoesli (2004) and Eichholtz, Huisman, Koedijk and Schuin (1998). The pure property type factors are in most cases low and negatively correlated. The pure property type factors are also low correlated with the size factor.

Table 4.3 A Correlations between the common factor, region, property type and size factors*

Indirect	Common	Asia	Europe	USA	Australia	Industrial	Office	Retail	Residential
Common	1.00								
Asia	-0.03	1.00							
Europe	-0.18	0.01	1.00						
USA	0.33	-0.28	-0.85	1.00					
Australia	-0.06	-0.97	0.01	0.18	1.00				
Industrial	-0.02	-0.25	0.23	-0.10	0.23	1.00			
Office	0.16	-0.07	0.25	-0.31	0.14	-0.17	1.00		
Retail	0.00	0.15	-0.33	0.35	-0.22	-0.13	-0.77	1.00	
Residential	-0.07	0.22	-0.12	0.00	-0.18	-0.89	0.20	-0.20	1.00
Size	0.41	0.01	0.29	-0.17	-0.05	0.38	0.32	-0.30	-0.35
Direct	Common	Asia	Europe	USA	Australia	Industrial	Office	Retail	Residential
Common	1.00								
Asia	-0.14	1.00							
Europe	0.07	-0.23	1.00						
USA	0.06	-0.48	-0.70	1.00					
Australia	0.13	-0.97	0.03	0.61	1.00				
Industrial	0.05	0.00	-0.11	0.12	0.01	1.00			
Office	0.19	0.13	-0.01	-0.20	-0.11	0.10	1.00		
Retail	-0.14	-0.14	0.10	0.09	0.11	-0.59	-0.84	1.00	
Residential	0.13	0.10	-0.05	-0.01	-0.09	0.17	0.17	-0.21	1.00
Size	0.69	-0.28	-0.38	0.60	0.36	0.28	-0.04	-0.14	0.05

Table 4.3 B Correlations by Region and property type indices*

Direct	Asia	Europe	USA	Australia	Industrial	Office	Retail	Residential
Asia	1.00							
Europe	0.11	1.00						
USA	0.23	0.64	1.00					
Australia	0.17	0.45	0.44	1.00				
Industrial	0.18	0.70	0.86	0.50	1.00			
Office	-0.12	0.27	0.19	0.06	0.19	1.00		
Retail	0.52	0.69	0.45	0.41	0.37	0.07	1.00	
Residential	0.32	0.54	0.86	0.30	0.74	0.16	0.49	1.00

Indirect	Asia	Europe	USA	Australia	Industrial	Retail	Residential	Office
Asia	1.00							
Europe	0.43	1.00						
USA	0.35	0.60	1.00					
Australia	0.21	0.24	0.27	1.00				
Industrial	0.19	0.60	0.89	0.21	1.00			
Retail	0.54	0.68	0.92	0.39	0.79	1.00		
Residential	0.34	0.75	0.84	0.32	0.77	0.77	1.00	
Office	0.59	0.71	0.84	0.38	0.70	0.82	0.76	1.00

* Table 4.3 A contains the correlations of the Common, Region, Property type and the Size factor. The correlations are calculated from the for hedged value weighted sample between the period Q3 1995 till Q4 2007. Table 4.3 B contains the correlation of the quarterly value weighted property and country indices for the hedged sample.

Overall we can conclude for both markets that the correlations are generally low or even negative for the regions and property type factors. For the direct market the average cross correlation (-0.37 vs. -0.19) is lower for the pure region factors then for the pure property type factors. In the indirect market the cross correlation (-0.32 vs. -0.41) for the pure property type factors is lower than the cross correlations among pure region factors.

The size factor is in both markets highly correlated with the common or global factor (0.41 for the direct market and 0.69 for the indirect market). For the region and property type factors the correlations between the size factor are generally low (except for the USA in the indirect market). This indicates that, if a portfolio managers believes that a region or property type performs well in the future and a decision is made to overweight this region or property type, it does not imply that a bet is made with respect to size. Table 4.3 B reports the correlation coefficients for the value weighted region and property type return indices. The correlations between the region and property type index are larger than the correlations between the pure factors. This result suggests that correlations among region and sector returns are mainly influenced by the common factor and the size factor. Therefore, we believe that the correlations between the pure factors is the only measure that really matters for an active global real estate investors who wants to make a bets on either region or property type factors.

As noted by Morawski, Rehkugler and Fuss (2008) investment horizon can play an important role in the analysis of relationships between indirect and direct real estate markets. To control for this influence, we examine returns for various holding periods, ranging from one quarter to 5 years. The annual, 3- year and 5-year returns were computed as rolling returns over a moving time window.

Table 4.4 shows the correlations between the direct and indirect property market and the correlation between the indirect real estate market and the MSCI global equity market over the entire sample period. For the quarterly returns, the relation between the indirect property market and the MSCI global equity market is much stronger then the relationship between the direct and indirect property market. However for longer return periods the direct and indirect property returns are higher correlated then for quarterly return periods. While the correlations between the indirect property market and the MSCI global equity market is decreasing for long return periods. From this we can conclude that as the holding period increases, the relationship between the indirect returns and the MSCI global equity market declines. While the relation between direct and indirect returns becomes stronger.

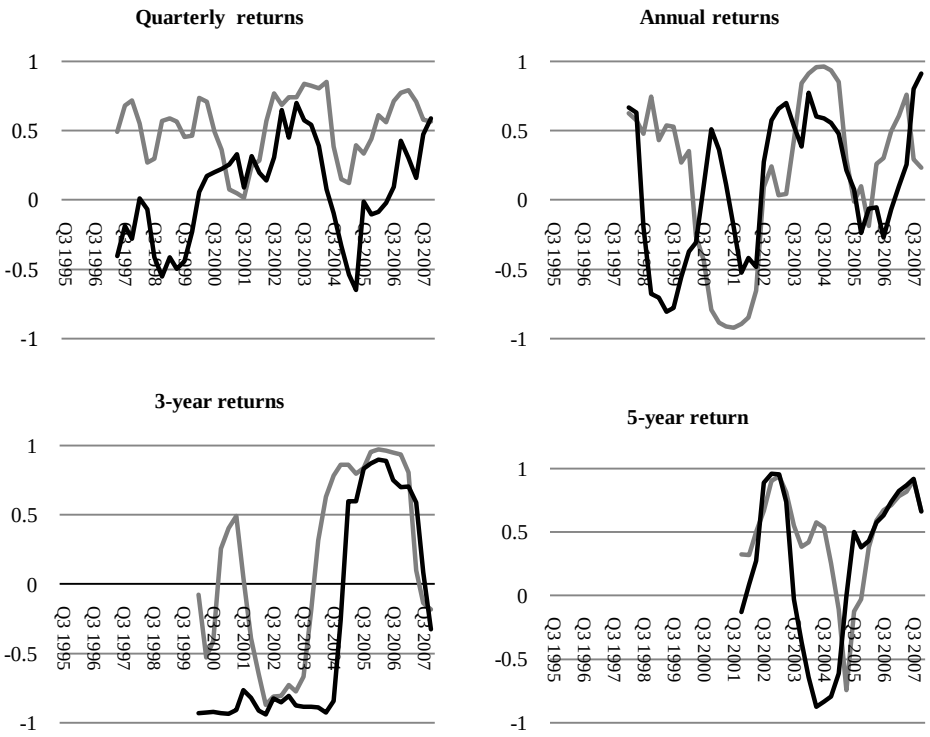
Table 4.4 Return correlations among the Indirect, Direct, and MSCI global Equity indices.*

Correlation between	Quarterly returns	Annual returns	3-year returns	5-year returns
Direct and Indirect	0.09	0.21	0.25	0.33
Indirect and MSCI	0.43	0.22	0.27	0.24

* This table exhibits the correlations between the annual, 3-year and 5-year returns. The returns were computed as rolling returns over a moving time window.

In the figures below, we analyze the changes in the return correlations over time. For this purpose, we calculate the correlation coefficients for rolling time intervals of 2 years period. The returns are again recalculated for various return periods, ranging from one quarter to 5 years. The results are presented in figure 4.3. In the beginning of the sample period, correlations between the quarterly and annual returns and the MSCI global equity indices are small and show a decreasing tendency. The correlations between the direct and indirect property market fluctuate around zero.

Figure 4.3 Return correlations among the direct and indirect Real Estate market, and the MSCI global equity indices.*



*The Rolling 2-year return correlations among the value weighted direct and indirect indices, and MSCI global equity indices. The black line present the correlation among direct and indirect Real estate Market. While the gray line present the correlation between the indirect real estate market and the MSCI global equity market.

For longer holding periods the correlation structure is incredible different. The coefficients for the 3-year and 5-year returns of the indirect property market and the MSCI global equity returns alternating between high and low values. However, the instability of the correlation structure between the direct and indirect property market has a regular pattern, which becomes increasingly apparent for long investment horizons: the coefficient values changes nearly sinussoidally within positive and negative range. According to Morawski, Rehkugler and Fuss (2008) , phases of highly positive or negative correlations do not indicate a substantial similarity or dissimilarity between investment types. This means that a shift in the cycles of the returns of the direct and indirect property market can lead to alternating phases of positive and negative correlations. From our analysis between return series of real estate stocks and direct real estate we can conclude that for long term holding periods a stronger relation exist.

In the output below we focus on the cumulative returns for the various factors. All returns series are calculated from an US investor's view point. Figure 4.3 shows the cumulative log returns for the common factor. The figure gives an overview of the four different samples: hedged, unhedged, equally weighted scheme (EW) and value weighted scheme (VW). There is a strong upward trend in the cumulated returns for the common factor in the direct and indirect property market. In both markets, the cumulative returns moves generally together, suggesting a strong fundamental link across the two market structures. At a finer level some differences appear. While the indirect common property market return is declining in the begin of 2007 for the hedged sample, the cumulative return for the direct market is still rising. This is an indication that the indirect market is leading the direct market. The difference between the cumulated equally weighted weighting scheme (EW) and value weighting scheme (VW) returns is due to the under - or out-performance of large real estate observations to small real estate observations. The difference between the cumulated unhedged common and hedged common cumulative returns is very small, except for the begin of 2007. The hedged indirect cumulative return shows a strong negative trend for the other samples the trend is still positive

Figure 4.3 A *Index* of cumulative hedged log returns on the common factor the direct and indirect property market, Q3 1995 – Q4 2007. This figure contains the hedged sample with an equally weighted weighting scheme (EW) or value weighting scheme (VW).

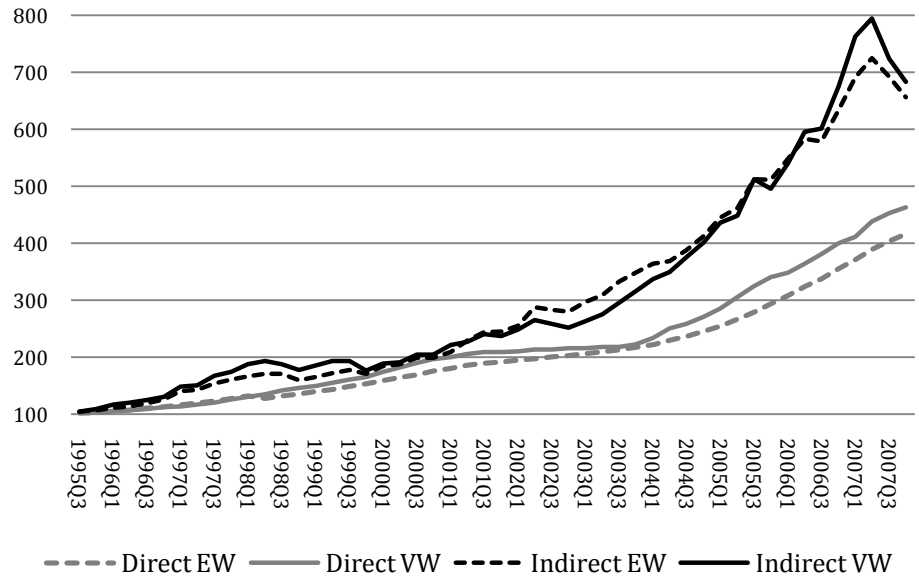


Figure 4.3 B *Index* of cumulative unhedged log returns on the common factor the direct and indirect property market, Q3 1995 – Q4 2007. This figure contains the unhedged sample with an equally weighted weighting scheme (EW) or value weighting scheme (VW).

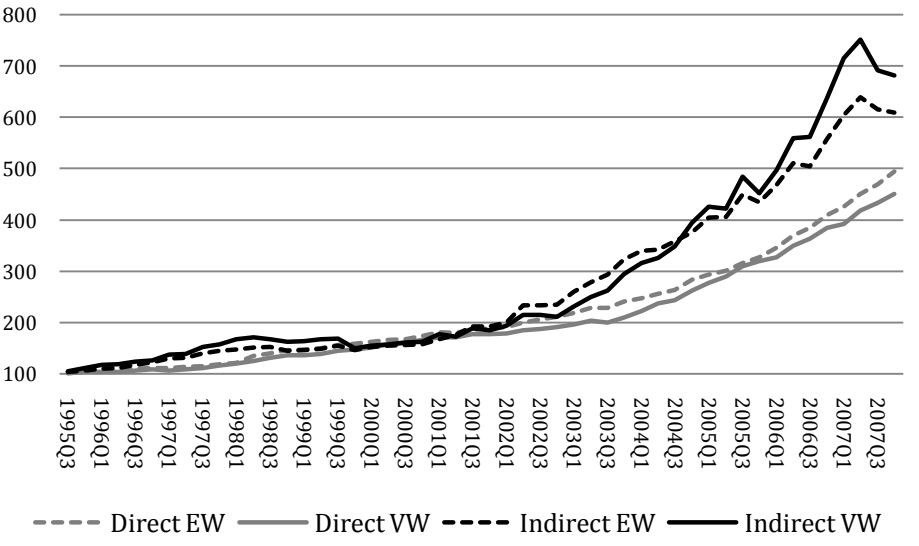
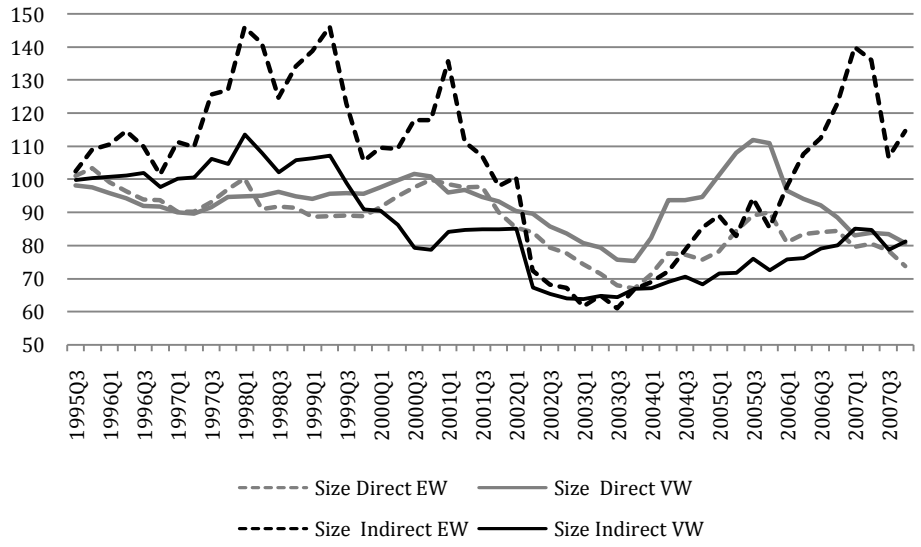


Figure 4.4 reports the cumulated returns on the size factors for both the direct and indirect market. The size returns are pure factor returns, net of all other pure factor returns. The figure shows that the pure cumulative size return has a large volatility during the sample period. The log cumulative returns for the size factor shows a strong negative trend between Q3 2000 and Q2 2003. As large stocks are more exposed to this factor then smaller ones, they will suffer more from this drop in value. As explained, the maximum exposure to size is for the largest real estate stock in the sample at any given quarter one. For smaller stocks the exposure is less, and it is negative for many observations as by construction the weighted average of the exposure to size is zero. The difference between the cumulated direct size factor and indirect factor is quite large between the period 1995 and 2001. During the period Q1 2001 till Q2 2004 the cumulated size return between the two markets is becoming smaller.

Figure 4.4 *Index* of cumulative hedged log returns on the size factor for the direct and indirect property market, Q3 1995 – Q4 2007. This figure contains the unhedged sample with an equally weighted weighting scheme (EW) or value weighting scheme (VW).



Figures 4.5, 4.6, 4.7 and 4.8 show the cumulative returns for the pure region factors: Europe, Asia, Australia and the United States. The cumulated log region returns for the unhedged sample are shown in the appendix 1B. Differences across regions are important despite the fact that factors such as property type, and size have been controlled for. An index value of more than 100 in Q4 2007 indicates that outperformance was achieved between Q3 1995- Q4 2007 for the region with the same property type allocation as the global index. Similarly, for the property type cumulative return, a value higher than 100 in Q4 2007 indicates outperformance. This represents the property type outperformance given a geographically diversified portfolio equal to the global portfolio.

The influence of the Asian crisis in September 1997 becomes apparent in figure 4.5. The return index on the pure Asian factor decreases around 60 % from Q2 1997 till Q1 2001, but then the return index remains stable. From Q3 2005 until the end of the sample the pure Asian factor shows a positive trend. Figure 4.7 shows the Australia pure factor for the hedged and unhedged samples. The pattern of the unhedged samples shows clearly the strong appreciation of the Australian dollar between Q1 1997 and Q3 2000. It is a good illustration how different the results can be according the hedging assumption. In figure 4.6 and 4.8 we can see how different the results are according to their weighting scheme. For the USA and Australian pure region factor we can conclude that small real estate companies outperform large real estate companies.

An other important outcome is the differences between the direct and indirect log cumulative return on the pure country factors. During the selected sample period Q3 1995 - Q4 2007, we investigate that the Asia, Australian, and European direct log cumulative return index outperforms the indirect property markets.

Figure 4.5 A Index of cumulative log returns on the pure Asia factor for the direct and indirect property market, Q3 1995 – Q4 2007. This figure contains the hedged sample with an equally weighted weighting scheme (EW) or value weighting scheme (VW).

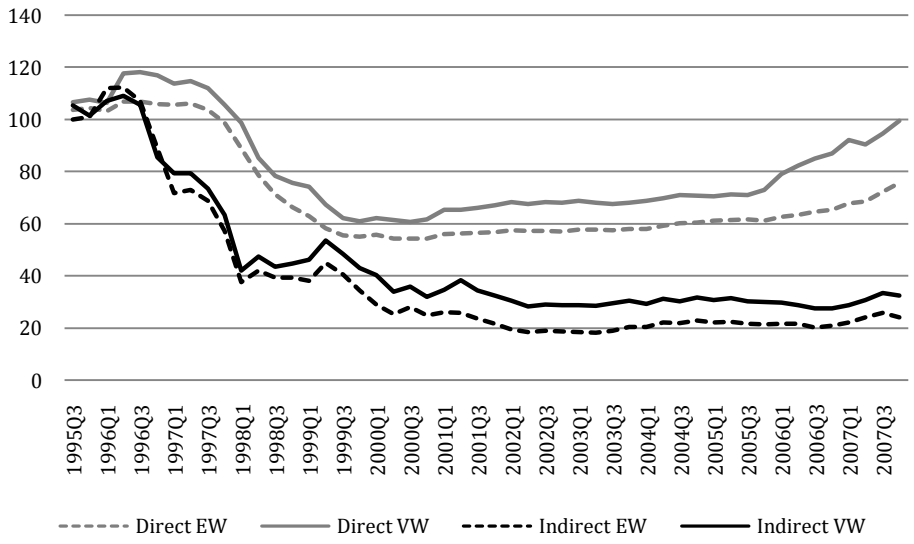


Figure 4.6 A Index of cumulative log returns on the pure USA factor for the direct and indirect property market, Q3 1995 – Q4 2007. This figure contains the hedged sample with an equally weighted weighting scheme (EW) or value weighting scheme (VW)

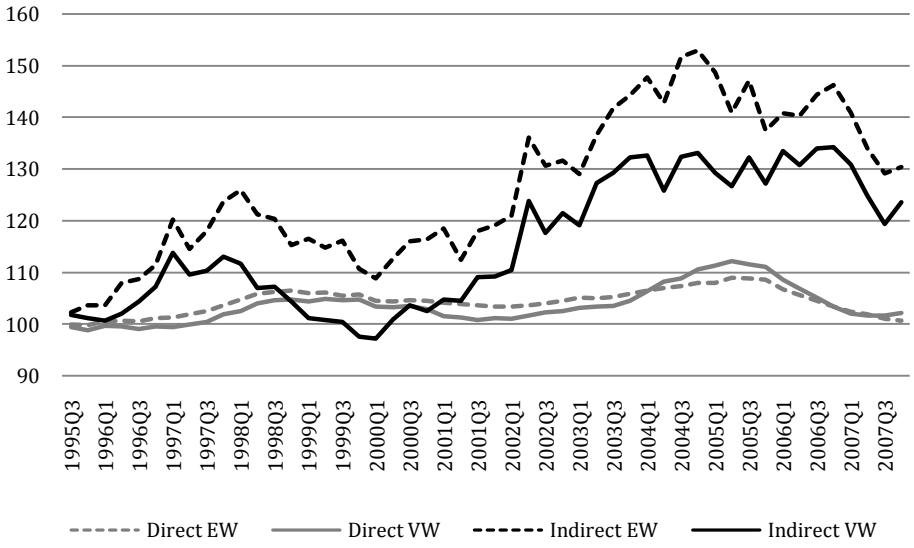


Figure 4.7 A Index of cumulative log returns on the pure Europe factor for the direct and indirect property market, Q3 1995 – Q4 2007. This figure contains the hedged sample with an equally weighted weighting scheme (EW) or value weighting scheme (VW).

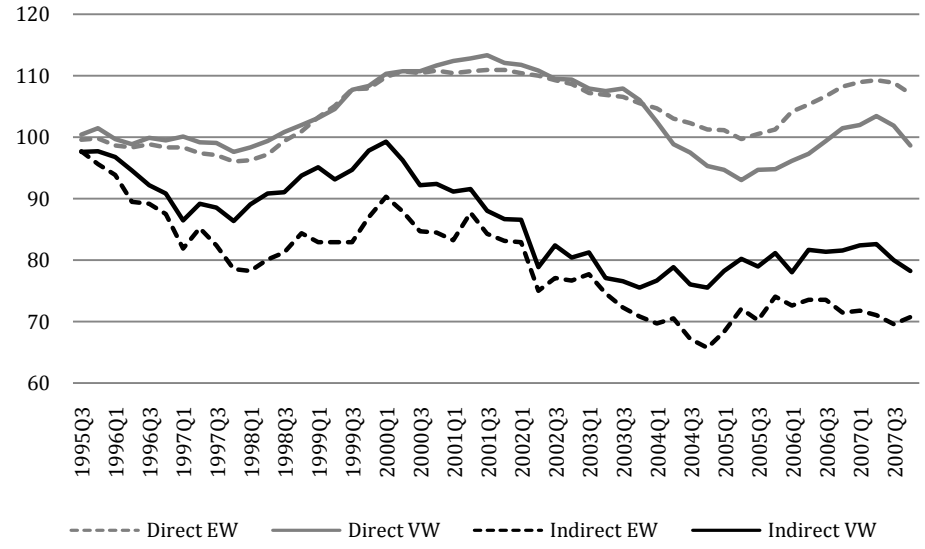


Figure 4.8 *A* Index of cumulative log returns on the pure Australia factor for the direct and indirect property market, Q3 1995 – Q4 2007. This figure contains the hedged sample with an equally weighted weighting scheme (EW) or value weighting scheme (VW).

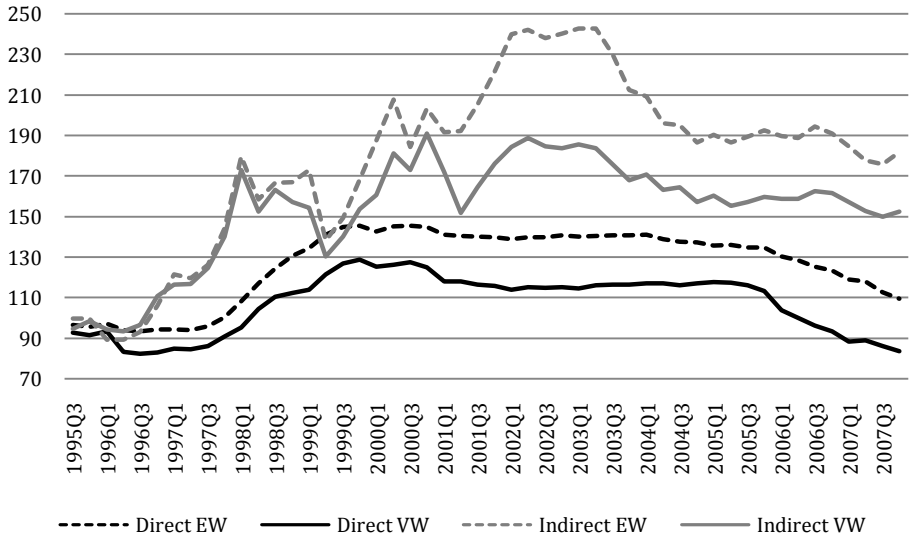
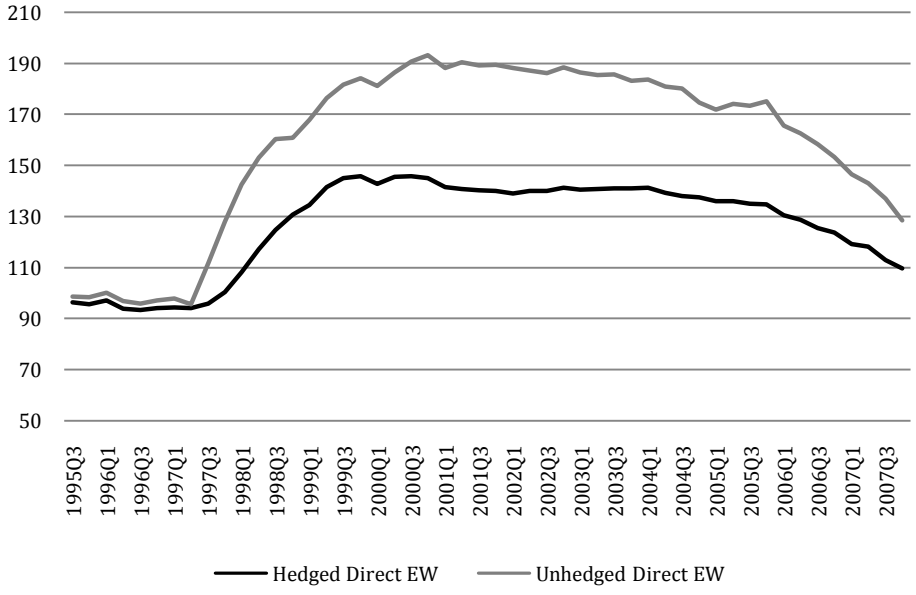


Figure 4.9 Index of cumulative log returns on the pure Australia factor for the direct and indirect property market, Q3 1995 – Q4 2007. This figure contains the unhedged and hedged sample with an equally weighted weighting scheme (EW)



Figures 4.10, 4.11, 4.12 and 4.13 show the log cumulative returns for the pure property type factors: Industrial, Residential, Retail and Office. Differences across property are important despite the fact that factors such as region, and size have been controlled for. The figures below gives an overview for the hedged samples with an equally weighted weighting scheme (EW) or a value weighting scheme (VW). The unhedged sample is omitted because the differences between the hedged and unhedged sample for the pure property factors are very small.

Again the differences across property types and the equally weighted and value weighted sample are substantial. In the Office and Industrial category the small observations outperform the large observations. While in the Retail and Residential market the large observations outperform the small observations.

The office category shows a clear positive trend during the sample period Q3 1995 till Q1 2001 for the equally weighted sample in the indirect property market. During the sample period the value weighted sample underperformed the equally-weighted sample in both markets. For the indirect market the difference in return between the equally- weighted and value-weighted sample is quite large around 25%. The retail market shows a negative trend for all subsamples from Q3 1995 till Q2 2001. After Q2 2001 the retail market shows a strong positive log cumulative return.

Figure 4.10 *Index* of cumulative log returns on the pure property type factor Office for the direct and indirect property market, Q3 1995 – Q4 2007. This figure contains the hedged sample with an equally weighted weighting scheme (EW)

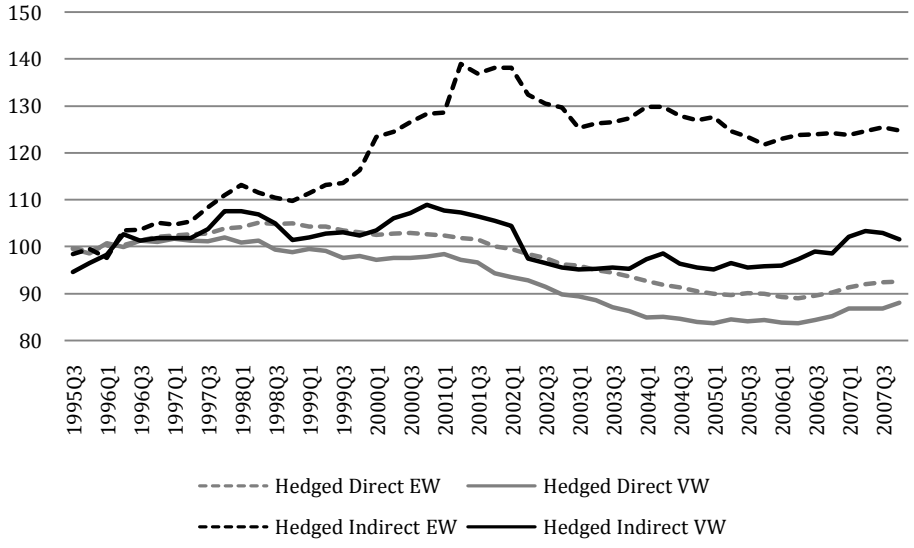


Figure 4.11 *Index* of cumulative log returns on the pure property type factor Retail for the direct and indirect property market, Q3 1995 – Q4 2007. This figure contains the hedged sample with an equally weighted weighting scheme (EW)

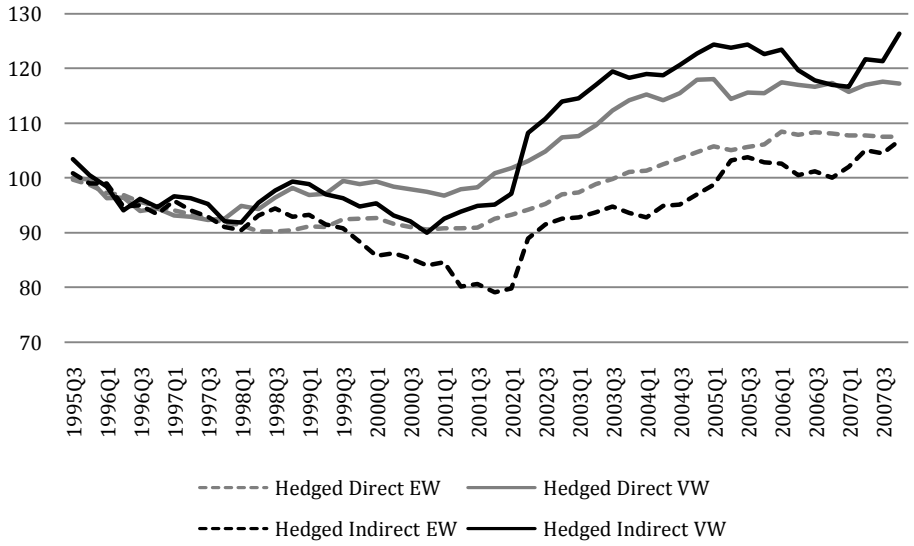


Figure 4.12 *Index* of cumulative log returns on the pure property type factor Residential for the direct and indirect property market, Q3 1995 – Q4 2007. This figure contains the hedged sample with an equally weighted weighting scheme (EW)

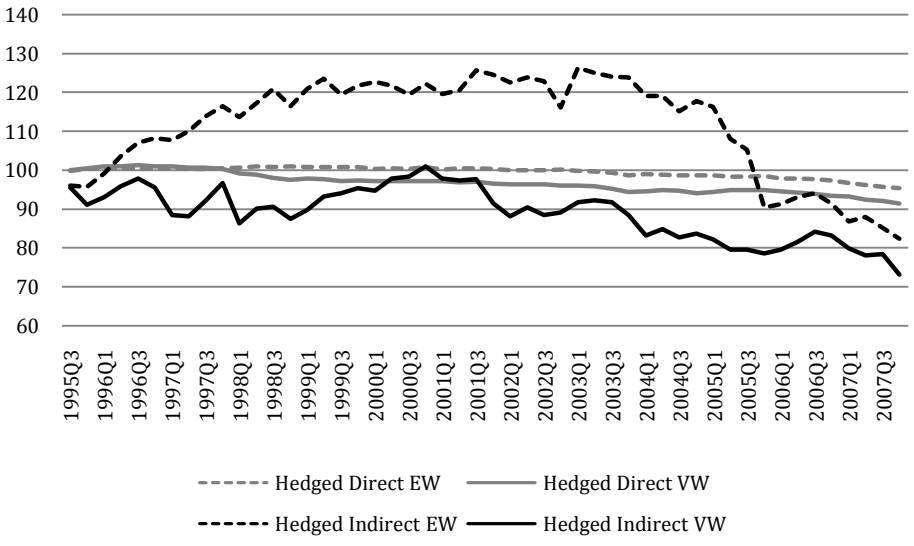
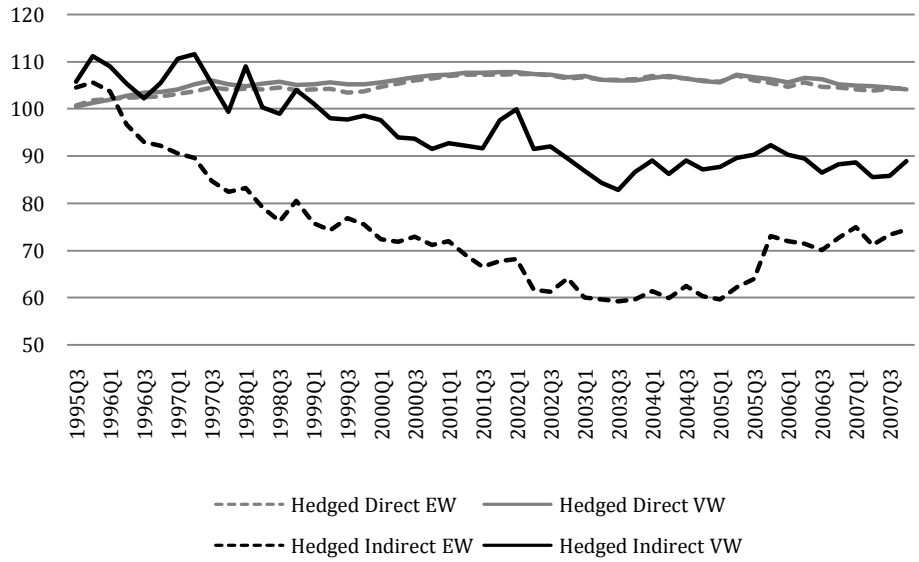


Figure 4.13 Index of cumulative log returns on the pure property type factor Industrial for the direct and indirect property market, Q3 1995 – Q4 2007. This figure contains the hedged sample with an equally weighted weighting scheme (EW)



In the table below we give an overview of the log cumulative returns for the different regions and property types. The cumulative log returns are calculated from the indices of cumulative pure returns. The table gives an overview for each region or sector in which market direct or indirect is the most appropriate platform to invest in for the sample period Q3-1995 till Q4-2007. As explained by the paper of Riddiough, Moriary and Yeatman (2005) liquidity is an important risk pricing factor. From this factor we should assume that the returns in the indirect market are lower than the returns in the direct market.

Table 4.5 Cumulative log returns for the pure region and pure property types.

	Direct EW		Indirect EW		Direct VW		Indirect VW	
Asia	**-26.98%**	*	-86.38%		**-6.69%**	*	-69.27%	
Europe	**7.44%**	*	-27.66%		**-1.80%**	*	-19.91%	
USA	0.68%		**27.52%**	*	2.73%		**21.43%**	*
Australia	13.74%		**82.14%**	*	-9.85%		**106.04%**	*
Industrial	**3.72%**	*	-28.81%		**3.59%**	*	-15.99%	
Office	-7.17%		**26.79%**		-11.55%		**7.37%**	*
Retail	**7.82%**	*	5.93%		17.21%		**22.08%**	*
Residential	**-4.45%**	*	-14.23%	*	**-8.47%**	*	-23.41%	

*This table indicates for each region or property type which investment is most appropriate (Direct or Indirect Market). The symbol * indicates for every region or property tye factor witch market is most appropriate market to invest in.

However, in table 4.5 we find that the results of the cumulated log return is in most cases very different in the direct market when compared to the indirect market. From this table several questions arise such as: Why is a given pure country factor so different in the direct market compared to the indirect market? Can we conclude from this that we should for example invest directly in retail but indirectly in the region Australia? How comes that a given pure country factor is so different in the direct market and in the indirect market?

Sorting out the possible explanations for the different results is important; as there are deeper economic questions related to which platform is the most efficient exposure to real estate. First, we may have missed some important risk factors. One important risk pricing factor is liquidity. Ownership of exchange traded real estate provides significantly greater liquidity than direct real estate ownership. Given that investors value liquidity, all else equal, indirect real estate pure factors should be lower than the pure factors in the direct market. Another important explanation for the difference is the effect of leverages in the indirect market. The effect of leverage increases the returns; and at the same time raises the volatility level in the indirect market. This makes a comparison between the two markets difficult. We were unable to make adjustment at REITs level, as there were no reliable leverage ratio's for our dataset. Another significant difference between the direct and indirect samples is that in the indirect market the total returns are reported after management and administration expenses, while in the direct market the returns are reported prior to investment fund managers fee expenses.

According to the market value weighted regression model the most appropriate platform to invest is for the regions of Asia and Europe the direct property market. For the property type industrial and residential, the direct market is the most attractive market to invest in. The different results of the market value weighted regression for the direct and indirect property market are clearly biased by the fact of differences in terms of property type holdings. For the direct market the property type's retail and office are the major property types. As these property types have different returns and risk characteristics than other property types, the results of the estimated direct pure factors are unfortunately biased. The returns of value weighted indices of the property type retail are larger than the other property types and will give a higher result bias. However, the value weighted return of the property type office is lower than the average value weighted returns of the other property type and so will bias the results of the value weighted pure factors downwards. Table 4.5 also show the cumulative log returns for the equally weighted regression model. The difference in property type holdings between the two markets do not bias the results for this model, because each observation is equally weighted. For the equally weighted regression results we can conclude that during the selected sample period investing directly in the region Asia and Europe is the most appropriate platform. For the property type Industrial, Retail and Office investing in the direct market is most efficient.

4.2 Homogeneity of region, sector and style factors

It is also very important to investigate the significance of each factor in the cross-sectional regression. Factors may have similar behaviors over time; while one is highly significant in each cross-sectional regression the other factor is less significant. We assume that the cross-sectional t-statistic is an indicator of the homogeneity of each factor.

In order to visualize how factor significance evolves over time, we represent the 12-month moving average of the t-statistics in figure 4.14, 4.15, 4.16 and 4.17. The top figure shows the results for the common factor for the direct and indirect market both based on the hedged equally weighted sample. Here we investigate that the common factor is in both markets highly significant. During the sample period the moving average t-statics of the direct market is much more significant than the t-statistic of the indirect market. However in both markets the t-statistics show the same trend during the selected period.

We report in figure 4.15 and 4.16 the moving average t-statistics for the region and sector factors for the direct and indirect property market. The figure shows the results for the hedged sample with an equally weighted weighting scheme and a value weighted weighting scheme. In the output we discover several important differences and similarities between both markets and the different factors. The significance of the region factor in the equally weighted sample for the direct market is increasing between the periods Q2 1997 till Q4 1998, while the opposite has occurred for the significance of the indirect region factor. During the period Q2 2000 and Q4 2002 the indirect region factor for the equally weighted sample is significant while the direct region factor was insignificant. At the end of the sample period the region factor for both markets is highly significant and the differences between the two markets are very small. If we take a look at the value weighted sample, the indirect factor is during the whole period more significant then the direct region factor.

The sector factors are for the indirect property market in most cases insignificant or less significant than the country factors. For the direct market in the equally weighted sample the sector factor becomes more significant than the region factor during the period Q4 2001 till Q4 2005. From this we can conclude that during this period for the direct market the sector factors are clearly more homogeneous then the region factors. However, for the entire sample period we can conclude that for both markets the region factors are more homogeneous than the sector factors.

The size factor has been significant for the value weighted direct sample from Q2 2000 and the average t-statistic was very high between the period Q3 2003 until Q4 2006. In figure 4.14 the indirect size factor is becoming significant for the value weighted sample in Q3 1997, but the size factor lost it homogeneity between Q2 2002 till Q4 2004. For the equally weighted sample the average t-statistic is for both markets less significant than for the value weighted sample.

Figure 4.14 Average absolute t-statistics of common factor over time (12 month moving average) for the Indirect and Direct property market. This figure contains the hedged sample with an equally weighted weighting scheme (EW).

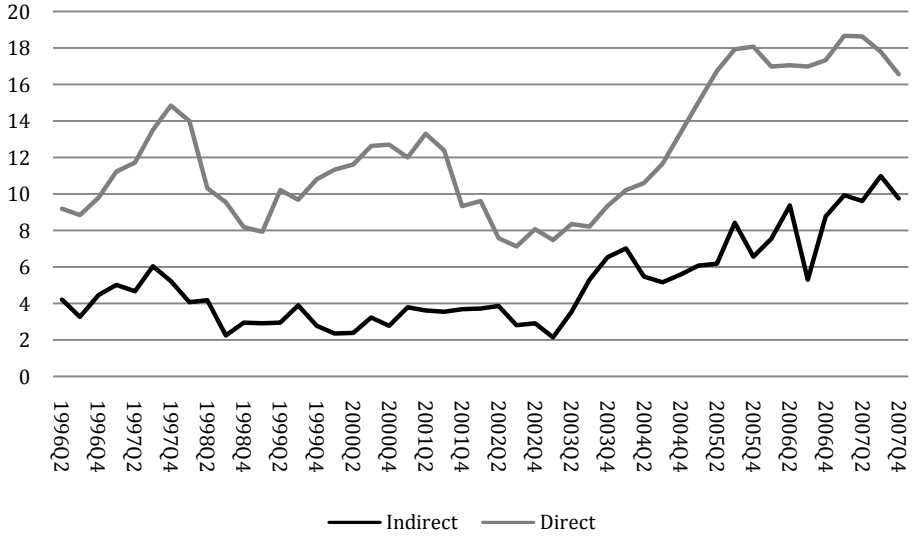


Figure 4.15 Average absolute t-statistics of countries and sectors over time (12 month moving average) for the Indirect and Direct property market. This figure contains the hedged sample with an equally weighted weighting scheme (EW).

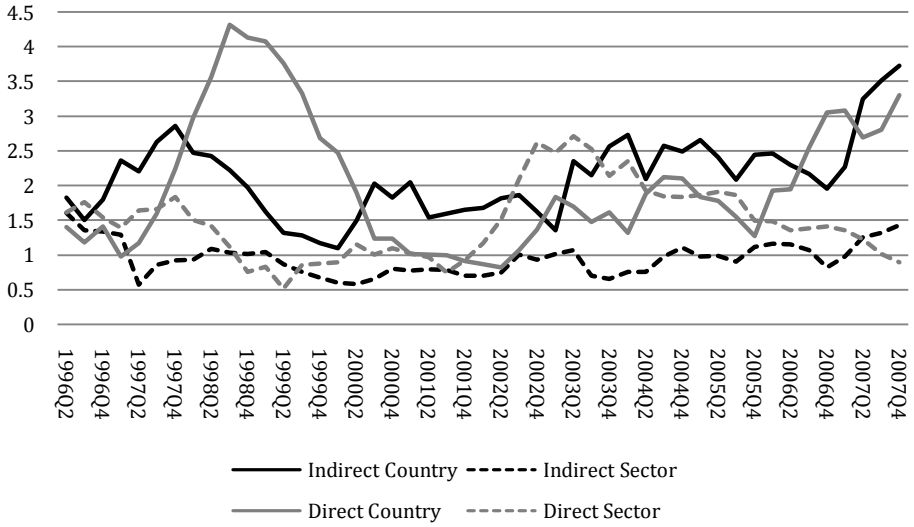


Figure 4.16 Average absolute t-statistics of countries, sectors over time (12 month moving average) for the Direct property market. This figure contains the hedged sample with an value weighted weighting scheme (VW).

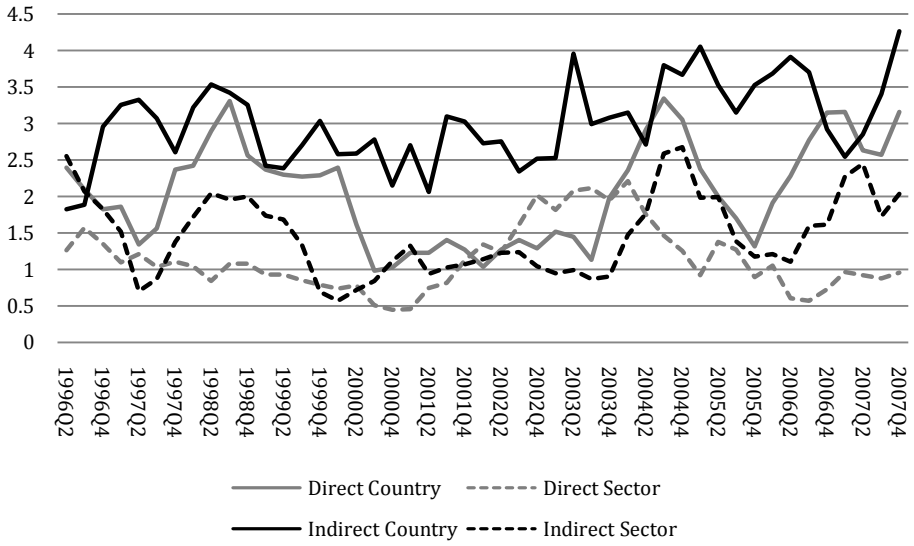
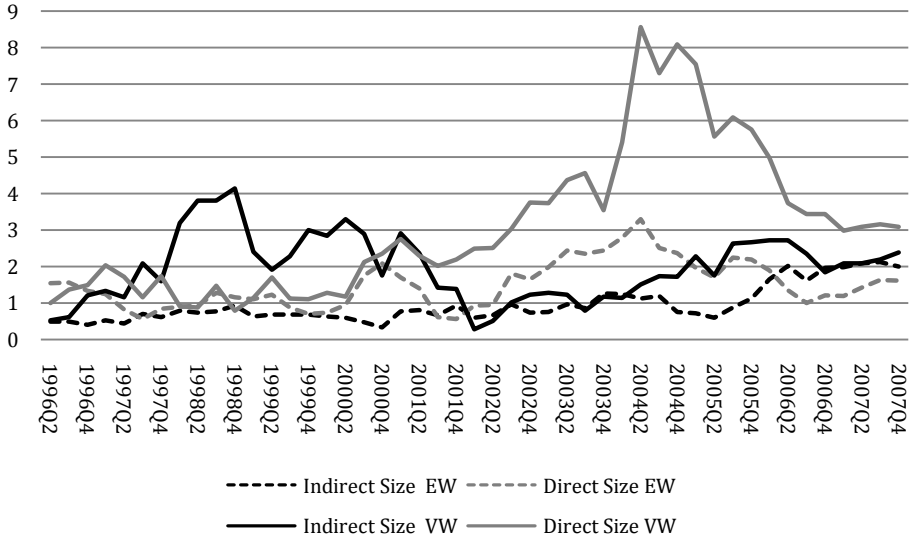


Figure 4.17 Average absolute t-statistics of the size factor over time (12 month moving average) for the Direct and Indirect property market. This figure contains the hedged sample with an value weighted weighting scheme (VW).



4.3 Price discovery in the Direct and Indirect property market

To investigate the relation between the indirect property returns and the direct returns we use an approach which is similar to the one used by Gyourko, Keim (1992) and Eichholtz and Hartzell (1996). By examining the speed of the process by which asset prices are formed and impound relevant information about asset values, leads and lags between direct and indirect markets can be identified and give insight into market and pricing issues. The cross-sectional estimated pure factor returns for the direct property market (F_t^D) are regressed on the lagged estimated pure factors for the indirect market real estate market (F_{t-1}^I). We also include an autoregressive term with a lag of one quarter to cope with the autocorrelation. This results in the following equation:

$$F_t^D = \alpha_0 + \alpha_1 F_{t-1}^D + \alpha_3 F_{t-1}^I + \mu_t \qquad (1)$$

In which (α_j) are coefficients and μ_t is a standard error term. The regression results are given in table 4.6 and 4.7. For all the countries, the autoregressive term is highly significant, while the relationship between the lagged indirect region factor is also highly significant for all regions except for the regions Asia. The adjusted (R^2) for this regression vary from 0.33 for the United States to 0.65 for the region Asia. The first order autoregressive term has the most impact on the direct pure factors. The (α_1) coefficient varies between 0.49 for United States and 0.65 for Asia. The constant term is zero for all the four region factors.

Table 4.6 Regression results : Direct and Indirect "pure' country factors. *

$$F_t^D = \alpha_0 + \alpha_1 F_{t-1}^D + \alpha_3 F_{t-1}^I + \mu_t \quad (1)$$
$$F_t^D = \alpha_0 + \alpha_1 F_{t-1}^D + \alpha_2 F_{t-4}^D + \alpha_3 F_{t-1}^I + \mu_t \quad (2)$$
$$F_t^D = \alpha_0 + \alpha_1 F_{t-1}^D + \alpha_2 F_{t-4}^D + \alpha_3 F_{t-1}^I + \alpha_4 F_{t-4}^I + \mu_t \quad (3)$$

	Model	α_0	α_1	α_2	α_3	α_4	R_adj^2
Europe	(1)	0.00	0.50		0.11		0.34
		(1.23)	**(4.07)*** **		**(2.80)** **		
	(2)	0.00	0.52	0.00	0.10		0.33
		(1.14)	**(3.93)*** **	**(0.04)**	**(2.69)** **		
	(3)	0.00	0.54	0.00	0.10	-0.02	0.32
		(0.94)	**(3.75)*** **	**(0.02)**	**(2.68)* **	**(-0.39)**	
United States	(1)	0.00	0.50		0.05		0.33
		(-0.94)	**(4.19)*** **		**(3.03)** **		
	(2)	0.00	0.49	0.12	0.05		0.35
		(-0.96)	**(3.95)*** **	**(0.93)**	**(2.91)** **		
	(3)	0.00	0.52	0.10	0.05	-0.01	0.34
		(-0.76)	**(3.73)*** **	**(0.78)**	**(2.87)** **	**(-0.44)**	
Asia	(1)	0.00	0.76		0.06		0.62
		(0.16)	**(8.24)*** **		**(1.81) ·**		
	(2)	0.00	0.73	0.10	0.05		0.65
		(0.28)	**(6.78)*** **	**(0.9)**	**(1.56)**		
	(3)	0.00	0.76	0.10	0.05	-0.02	0.64
		(0.08)	**(6.5)*** **	**(0.9)**	**(1.41)**	**(-0.15)**	
Australia	(1)	0.00	0.67		0.06		0.51
		(-0.059)	**(6.63)*** **		**(2.84) ** **		
	(2)	0.00	0.63	0.19	0.05		0.58
		(-0.25)	**(5.64)*** **	**(1.61)**	**(2.81) ** **		
	(3)	0.00	0.66	0.18	0.05	-0.02	0.57
		(-0.07)	**(5.39)*** **	**(1.50)**	**(1.55)**	**(-0.63)**	

*The t-values are denoted in the parentheses. All regressions are based on quarterly hedged logarithmic pure factors. The pure factor returns are estimated cross-sectionally by the following equation: $R_{i,t} = F_t + \sum_{k=1}^{N^C} D_i^{C_k} F_t^{C_k} + \sum_{k=1}^{N^S} D_i^{S_k} F_t^{S_k} + SZ_{i,t} F_t^{SZ} + \varepsilon_{i,t}$.

Since many properties are only appraised once a year, or are appraised four times a year an autoregressive term with a lag of four quarters would probably also have explanatory power to explain the direct pure factors. The autoregressive term is included in model (2):

$$F_t^D = \alpha_0 + \alpha_1 F_{t-1}^D + \alpha_2 F_{t-4}^D + \alpha_3 F_{t-1}^I + \mu_t \quad (2)$$

The four-quarter autoregressive term is not significant for any of the regions factors at all, and does not have any influence on the explanatory power of the model. These findings are confirmed if we also add another independent variable: an indirect property pure factor with a lag of four quarters ($\alpha_4 F_{t-4}^I$), as in the following model (3):

$$F_t^D = \alpha_0 + \alpha_1 F_{t-1}^D + \alpha_2 F_{t-4}^D + \alpha_3 F_{t-1}^I + \alpha_4 F_{t-4}^I + \mu_t$$

As can be seen in the table 4.6 the indirect property pure factor with a lag of four quarters is not significant for any of the regressions and influences the models R^2 negatively.

Table 4.7 Regression results : Direct and Indirect "pure' property type, common and size factors. *

$F_t^D = \alpha_0 + \alpha_1 F_{t-1}^D + \alpha_3 F_{t-1}^I + \mu_t$ *(1)*
$F_t^D = \alpha_0 + \alpha_1 F_{t-1}^D + \alpha_2 F_{t-4}^D + \alpha_3 F_{t-1}^I + \mu_t$ *(2)*
$F_t^D = \alpha_0 + \alpha_1 F_{t-1}^D + \alpha_2 F_{t-4}^D + \alpha_3 F_{t-1}^I + \alpha_4 F_{t-4}^I + \mu_t$ *(3)*

	Model	α_0	α_1	α_2	α_3	α_4	R_adj^2
Office	(1)	0.00	0.59		0.08		0.38
		(-1.62)	**(4.65)*** **		**(2.17)***		
	(2)	0.00	0.54	0.19	0.07		0.46
		(-1.09)	**(4.67)*** **	**(1.50)**	**(1.92)**		
	(3)	0.00	0.55	0.18	0.08	-0.03	0.46
		(-0.90)	**(4.72)*** **	**(1.41)**	**(2.02)**	**(-0.83)**	
Retial	(1)	0.00	0.46		0.08		0.26
		(0.58)	**(3.67)*** **		**(1.66)**		
	(2)	0.00	0.30	0.33	0.06		0.32
		(0.80)	**(2.29)***	**(2.59)***	**(1.43)**		
	(3)	0.00	0.29	0.32	0.06	0.02	0.31
		(0.82)	**(2.06)**	**(2.50)***	**(1.45)**	**(0.51)**	
Residential	(1)	0.00	0.15		0.01		0.00
		(-1.70)	**(1.04)**		**(1.02)**		
	(2)	0.00	0.05	0.24	0.01		0.05
		(-2.04)	**(0.33)**	**(1.41)**	**(0.98)**		
	(3)	0.00	0.03	0.24	0.01	0.02	0.08
		(-2.08)	**(0.23)**	**(1.41)**	**(0.77)**	**(1.61)**	
Industrial	(1)	0.00	0.01		-0.02		-0.03
		(0.37)	**(0.07)**		**(-0.84)**		
	(2)	0.00	-0.06	0.18	-0.02		0.00
		(-0.20)	**(-0.38)**	**(1.24)**	**(-1.00)**		
	(3)	0.00	-0.07	0.17	-0.02	-0.01	0.00
		(-0.26)	**(-0.48)**	**(1.11)**	**(-0.91)**	**(-0.61)**	
Common	(1)	0.04	0.03		-0.09		-0.04
		(1.95)	**(0.17)**		**(-0.15)**		
	(2)	0.04	0.03	0.21	-0.25		-0.03
		(1.62)	**(0.19)**	**(1.24)**	**(-0.38)**		
	(3)	0.05	0.00	0.20	0.57	-1.15	-0.02
		(1.97)	**(0.02)**	**(1.19)**	**(0.62)**	**(-1.25)**	
Size	(1)	0.00	0.36		0.08		0.18
		(-0.48)	**(2.72)** **		**(1.64)**		
	(2)	0.00	0.35	0.13	0.09		0.19
		(-0.20)	**(2.55)** **	**(0.95)**	**(1.74)**		
	(3)	0.00	0.35	0.13	0.09	-0.01	0.17
		(-0.19)	**(2.51)** **	**-0.96**	**(1.70)**	**(-0.15)**	

*The t-values are denoted in the parentheses. All regressions are based on quarterly hedged logarithmic pure factors. The pure factor returns are estimated cross-sectionally by the following equation: $R_{i,t} = F_t + \sum_{k=1}^{N^C} D_i^{C_k} F_t^{C_k} + \sum_{k=1}^{N^S} D_i^{S_k} F_t^{S_k} + SZ_{i,t} F_t^{SZ} + \varepsilon_{i,t}$

In table 4.7 we perform the same regressions analysis for the common, property type and size factor to investigate the relation between the direct and indirect property market. As can been seen in table 2.5 the intercept is for all regression zero. For the factors office, retail and size is the autoregressive term highly significant (α_1). The adjusted (R^2) for this regression vary from 0.18 for the size factor, 0.26 for the sector office and 0.38 for the sector retail. The relationship between lagged indirect and current direct property market is only significant for the property type factor office.

To investigate the relation between the direct and indirect property market we use simple regression models to get an insight into this relation. The results show a very significant relation between the country factors. The direct country factors appear to be determined to a large extend by their own history and by lagged indirect country factors. However, there appears to be no significant relation between direct and indirect property type, size and common factor. Only for the office sector there appears to be a weak relation between the lagged direct office factor.

5 Summary and Conclusion

This study examines the characteristics of the returns on the direct and indirect global property market for the period Q3 1995 till Q1 2008.We show empirical evidence of the importance of the common, region, sector and size factors for the construction of a global real estate portfolio. Our initial questions were clear: What factors determine the return on the direct and indirect property markets? Should a portfolio managers structure his portfolio along countries, sectors or size factors? What are the differences and similarities between the direct and indirect market? Is there a strong link between the direct and indirect property markets?

The overall results in the thesis indicate that for the direct market, regional effects have a stronger influence on the variation of an international portfolio than property types. In the indirect market the property types dominate the region factors during a large part of the sample. From this we can conclude that the indirect market is more internationally integrated than the direct market. This implies that for the direct market investing in multiple regions will lead to the largest risk reduction. For the indirect market, property type allocation is the most effective allocation strategy.

During the selected time period the country factors and property-type factors have an important influence on the return, but other factors are important, too. This is the case for the size factor. The pure size factor volatility is quite large indicating that the factor is an important risk factor. The volatility level of the size factor is even larger than the volatility level of the region and property type factors. For both markets the importance of this factor is such that a portfolio manager that would inadvertently over- or underexpose his or her portfolio to this size factor would take a significant amount of risk.

Overall we can conclude for both markets that pure factors are generally low or even negative correlated, as opposed to the correlations between the region and property type indices. The negative correlation coefficients between the pure factors would indicate that adding a region to an international portfolio will reduce the risk more than the outperformance. The size factor is in both markets highly correlated with the global factor. From the large correlation between the region and property type indices we can conclude that region and sector correlations are mainly influenced by the common and the size factor.

When the pattern and the significance of the pure factor returns are investigated, we find clear evidence of the statistical significance of the common, region and size factor. The sector factors are for the direct and indirect property market in most cases less significant or insignificant compared to the region factors. During the period Q4 2001 till Q4 2005 the property type factor for the direct market becomes more significant than the region factors. If we compare the homogeneity between the direct and indirect property market we can conclude that the significance level of the direct market is for all factors higher than for the indirect market.

The main question in the thesis questioned is if the platform of real estate asset matters. The result of the "pure" factors is in most cases very different in the direct market when compared to the indirect market. Sorting out the possible explanations for the different results is important; as there are deeper economic questions related to which platform is the most efficient exposure to real estate. Causes of this difference may include the leverage effect, missing risk factors like a liquidity factor. Another difference is that in the indirect market the total returns are reported after management fee expenses, while in the direct market the returns are reported prior to investment fund managers fee expenses. However, we can conclude that most differences are caused by the actual platform on which the assets are traded.

If we analyze the correlation between the direct and indirect returns. We conclude also that investment horizon plays an important role in the relation between the indirect and direct real estate market. For longer return periods the direct and indirect property returns are stronger correlated. While the correlations between listed real estate and the equity market declines. Thus, in terms of long term investment, listed real estate can be classified as the asset class "real estate". However, this strong relation does not mean a fully synchronous return development. There also exists a significant price discovery between the two markets. The results show a very significant relation between the lagged indirect region factors and the direct region factors.

First of all I am very thankful to Professor F. Hamelink for his interesting feedback and comments on my thesis. I learned a lot from you. I also would like to thank Mr. J. Meulenbelt (Head of Business Development Europe ING Real Estate Select) for providing me the opportunity to write this thesis. I also would like to thank Professor I. de Wit (Global Portfolio Manager at ING Real Estate) for his helpful feedback and comments. I also would like to thank Mr. J. Vreeker (Global Property Research) for providing me the necessary data on listed real estate. Finally, I would like to thank Mr. M. Theebe (Manager Capital Market Research, and Information), Mr. M. van der Spek (Head of Research Continental Europe ING Real Estate) and Mr. C. Hoorenman (Portfolio Manager at ING Real Estate) for always having time to answer all my varied questions.

Appendix 1A

Table 4.1. Summary statistics for the common, the pure region and the size factors.

Unhedged equal-weighted sample	(1)
Unhedged value- weighted sample	(2)
Hedged equal-weighted sample	(3)
Hedged value- weighted sample	(4)
Hedged log value-weighted sample	(5)

Region Factor					Propery type Factor				
Factor	Dataset	Pure Factor (%)	*t*	Std. Dev (%)	Factor	Dataset	Pure Factor (%)	*t*	Std. Dev (%)
Common	(1)	11.33%	**6.36**	2.14%	Office	(1)	-0.35%	**1.25**	1.14%
	(2)	11.49%	**4.10**	2.55%		(2)	-0.86%	**1.17**	1.21%
	(3)	9.44%	**1.51**	5.09%		(3)	-0.54%	**1.98**	1.19%
	(4)	12.52%	**4.47**	2.32%		(4)	-0.86%	**1.26**	1.27%
	(5)	12.68%	**2.8**	2.22%		(5)	-0.56%	**1.3**	1.18%
Europe	(1)	1.80%	**4.24**	3.57%	Retail	(1)	0.72%	**1.41**	1.43%
	(2)	0.76%	**4.3**	**3.61%**		(2)	1.72%	**1.61**	1.67%
	(3)	0.42%	**1.97**	1.72%		(3)	0.72%	**2.56**	1.42%
	(4)	-0.30%	**2.2**	2.13%		(4)	1.49%	**1.63**	1.66%
	(5)	0.40%	**1.71**	1.73%		(5)	0.76%	**1.4**	1.40%
U.S.A	(1)	0.34%	**3.69**	2.06%	Residential	(1)	-0.53%	**1.22**	0.67%
	(2)	0.84%	**2.94**	2.12%		(2)	-0.23%	**1.41**	0.82%
	(3)	0.12%	**2.55**	1.14%		(3)	-0.52%	**1.55**	0.66%
	(4)	0.32%	**1.8**	1.48%		(4)	-0.87%	**0.65**	0.81%
	(5)	0.11%	**1.76**	1.15%		(5)	-0.52%	**1.2**	0.65%
Asia	(1)	-3.58%	**2.01**	5.68%	Industrial	(1)	0.05%	**1.1**	1.31%
	(2)	-1.51%	**2.95**	5.53%		(2)	-0.11%	**0.76**	1.56%
	(3)	-2.08%	**1.98**	3.76%		(3)	0.23%	**1.79**	1.31%
	(4)	0.06%	**2.69**	4.68%		(4)	0.08%	**0.79**	1.59%
	(5)	-1.90%	**1.56**	3.85%		(5)	0.22%	**1.1**	1.31%
Australia	(1)	0.03%	**1.98**	4.73%	Size	(1)	-0.35%	**0.85**	4.10%
	(2)	-1.50%	**2.01**	4.90%		(2)	-1.40%	**2.21**	3.96%
	(3)	0.97%	**2.17**	3.21%		(3)	3.51%	**1.68**	5.40%
	(4)	-1.00%	**2.23**	4.27%		(4)	-0.46%	**2.48**	3.85%
	(5)	0.79%	**1.68**	3.31%		(5)	0.85%	**0.86**	2.72%

*The table contains the annualized mean return , standard deviation and median t-statistic for, the pure property-type factors, and the pure size factor. These are time-series moments on pure factor returns for the direct property market, which are estimated cross-sectionally.by the following model : $R_{i,t} = F_t + \sum_{k=1}^{N^C} D_i^{C_k} F_t^{C_k} + \sum_{k=1}^{N^S} D_i^{S_k} F_t^{S_k} + SZ_{i,t} F_t^{SZ} + \varepsilon_{i,t}$. The period ranges from Q3 1995 to Q4 2007.

Appendix 1B

Figure 4.3 B Index of cumulative log returns on the pure Asia factor for the direct and indirect property market, Q3 1995 – Q4 2007. This figure contains the unhedged sample with an equally weighted weighting scheme (EW) or value weighting scheme (VW).

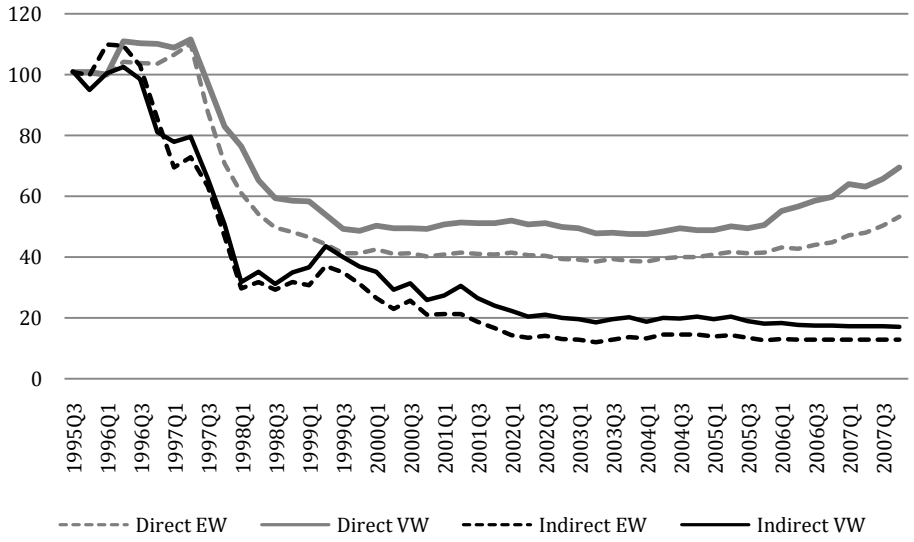


Figure 4.4 B *Index* of cumulative log returns on the pure USA factor for the direct and indirect property market, Q3 1995 – Q4 2007. This figure contains the unhedged sample with an equally weighted weighting scheme (EW) or value weighting scheme (VW).

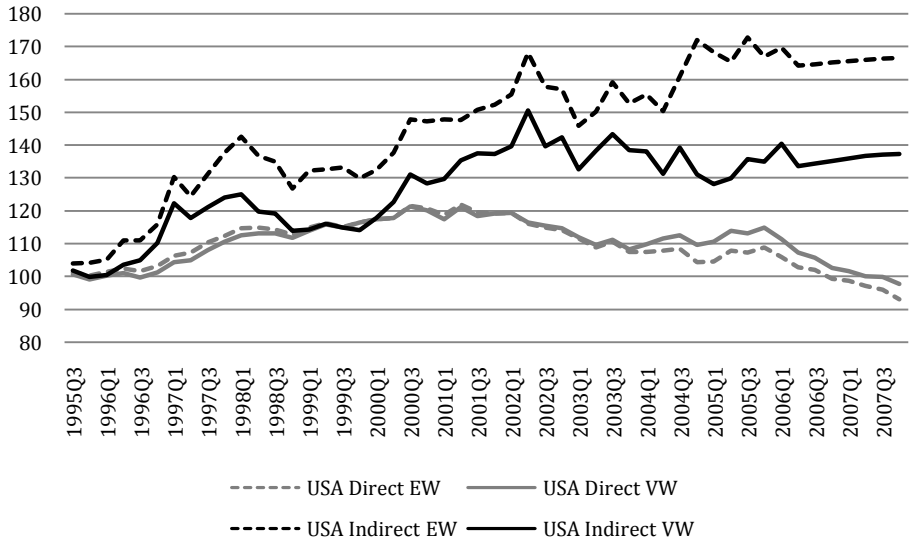


Figure 4.5 B Index of cumulative log returns on the pure Europe factor for the direct and indirect property market, Q3 1995 – Q4 2007. This figure contains the unhedged sample with an equally weighted weighting scheme (EW) or value weighting scheme (VW).

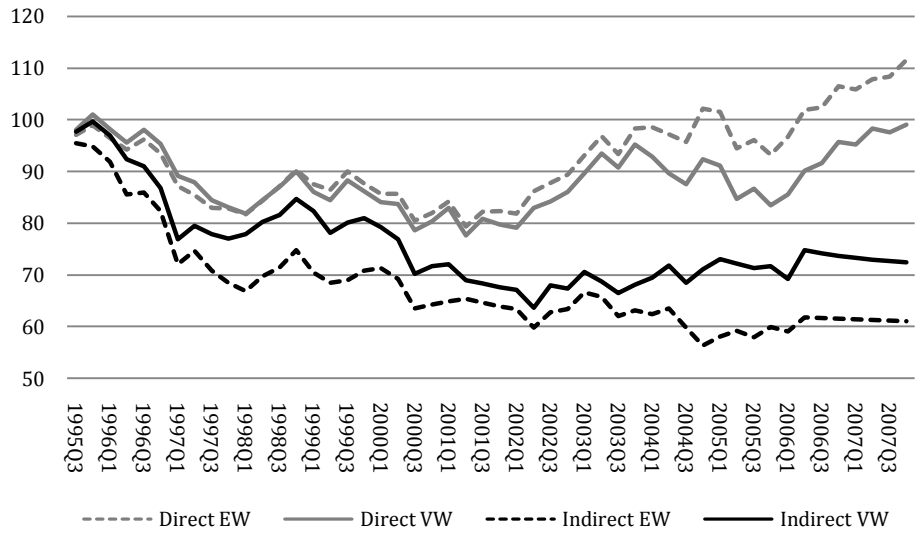
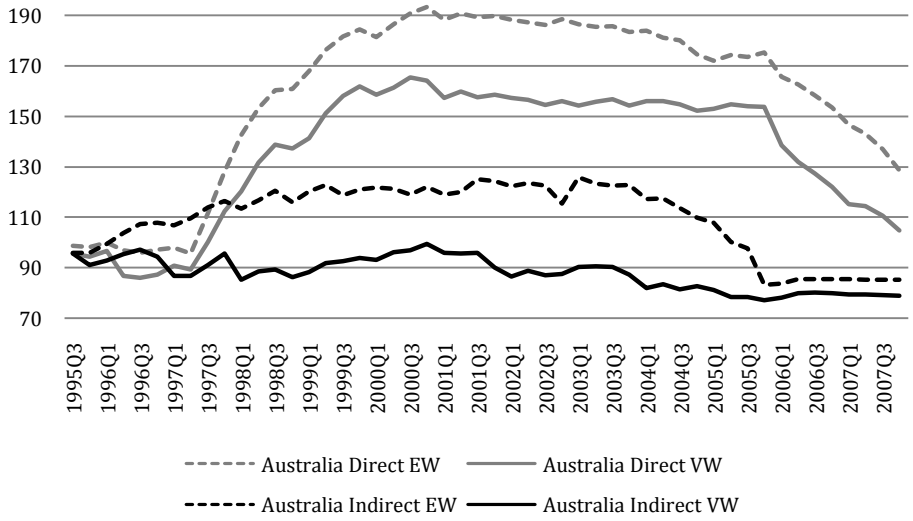


Figure 4.6 B Index of cumulative log returns on the pure Australia factor for the direct and indirect property market, Q3 1995 – Q4 2007. This figure contains the unhedged sample with an equally weighted weighting scheme (EW) or value weighting scheme (VW).



Appendix 1C Notations

The factor returns are estimated through cross-sectional regressions of real estate returns on their exposure to four factors categories. In this thesis we use the following notations.

- N_t denotes the total number of index constituents at time t, $t = 1 \dots \dots . T$
- $MC_{i,t}$ denotes the market capitalization of constituents i at time t. TMC_t is the total market capitalization at time t.
- $\omega_{i,t}$ is the weight of constituent i at time t. $\omega_{i,t}$ will depend according to the different weighting schemes applied in the cross-sectional regression. $\left(MC_{i,t}/TMC_t\right)$ if a value weighted weighting scheme is used , while $1/N_t$ if an equal-weighted scheme is applied. For the log value-weighted regression schemes the weight of stock i at time t is defined in the following way $ln\left(MC_{i,t}/TMC_t\right)$.
- N^C and N^S are the number of regions and property types.
- Real estate exposure to each factor at time *t:*
  - $D_i^{C_k}$ dummy variable, set to one if constituents i belongs to region k , $k = 1 \dots \dots N_C$
  - $D_i^{S_k}$ dummy variable, set to one if constituents i belongs to property type k , $k = 1 \dots \dots N_S$
  - $SZ_{i,t}$ is the size exposure for constituents i

- For each time period *t*, the cross-sectional regression provides an estimation of the following parameters*:*
  - the common or global factor return, denoted F_t,
  - the returns on the region factor, denoted $F_t^{C_k}$ $k = 1 \dots \dots N_C$
  - the returns on the property type factor, denoted $F_t^{S_k}$ $k = 1 \dots \dots N_S$
  - the size factor return, denoted F_t^{SZ}

The model, is specified as followed at time t,:

$$R_{i,t} = F_t + \sum_{k=1}^{N^C} D_i^{C_k} F_t^{C_k} + \sum_{k=1}^{N^S} D_i^{S_k} F_t^{S_k} + SZ_{i,t} F_t^{SZ} + \varepsilon_{i,t} \qquad (1)$$

The index return is at time t defined as the weighted average of the constituent returns.

$$\sum_{i=1}^{N^t} \omega_{i,t}\, R_{i,t}$$

Which, trough the full model equation *(1)*, is equal to:

$$= \; F_t + \sum_{k=1}^{N_C}\left(\sum_{i=1}^{N_t} \omega_{i,t}\, D_i^{Ck}\right) F_t^{Ck} + \sum_{k=1}^{Ns}\left(\sum_{i=1}^{Nt} \omega_{i,t}\, D_i^{Sk}\right) F_t^{Sk} \; + \sum_{i=1}^{N_t} \omega_{i,t} SZ_{i,t} F_t^{SZ} + \varepsilon_{i,t}$$

In order to estimate the above model and ensure that the world portfolio has zero exposure to each factor, we need to impose some additional restrictions on the parameters.

$$\sum_{t=1}^{N^C}\left(\sum_{i=1}^{N_t} \omega_{i,t}\, D_t^{C_k}\right) F_t^{C_k} = 0 \qquad (2)$$

$$\sum_{t=1}^{N^S}\left(\sum_{i=1}^{N_t} \omega_{i,t}\, D_t^{S_k}\right) F_t^{S_k} = 0 \qquad (3)$$

$$\sum_{t=1}^{N_t} \omega_{i,t} SZ_{i,t} F_t^{SZ} = 0 \qquad (4)$$

The following step consists in simplifying these constrains *(2, 3, 4)* and substituting them into the equation *(1)*. The constraints (2 and 3), $\sum_{i=1}^{NC} \omega_{i,t}\, D_i^{Ck}$ simply represent the relative weight of region K in the universe at time t and $\sum_{i=1}^{NS} \omega_{i,t}\, D_i^{Sk}$, the relative weight of property type K. Setting the relative weight of region and property type factors to:

$W_{Ck,t} \equiv \sum_{i=1}^{N_t} \omega_{i,t}\, D_i^{Ck}$ and $W_{Sk,t} \equiv \sum_{i=1}^{N_t} \omega_{i,t}\, D_i^{Sk}$

both constraints reduce to,

$\sum_{k=1}^{Nc} W_{Ck,t}\, F_t^{Ck} = 0$ and $\sum_{k=1}^{Ns} W_{Sk,t}\, F_t^{Sk} = 0$ *(5)*

Isolating the first factor return of each category $(k = 1)$ in the previous equation and substituting them into expressions $\sum_{k=1}^{Nc} D_i^{Ck}\, F_t^{Ck}$ and $\sum_{k=1}^{Ns} D_i^{Sk}\, F_t^{Sk}$, lead to:

$$\sum_{k=2}^{Nc}\left(D_i^{Ck}-\frac{W_{Ck,t}}{W_{C1,t}}D_i^{C1}\right)F_t^{Ck}$$

and

$$\sum_{k=2}^{Ns}\left(D_i^{Ck}-\frac{W_{Sk,t}}{W_{S1,t}}D_i^{s1}\right)F_t^{Sk}$$

(6)

To implement constraint *(4)*, the size exposure $SZ_{i,t}$, has to be defined through the constituents weight, $\omega_{i,t}$, according to the following method:

$$SZ_{i,t}=\frac{\frac{MC_{i,t}}{TMC_t}-u_t}{a_t}$$

(7)

The size exposure $SZ_{i,t}$ has to be defined through the stock weights $\omega_{i,t}$, according to the standardization rule in equation (3). Where $u_t=\sum_{i=1}^{Nt}\omega_{i,t}\frac{MC_{i,t}}{TMC_t}$ and a_t is chosen such that $max_i\left(SZ_{i,t}\right)$ = 1. In other words, u_t is the weighted average of the weights of the observations at time *t*, and a_t is a scaling factor ensuring an economic interpretation of the magnitude of the size factor. This method results in a model that has a zero exposure to the size factor and the largest constituent has an exposure of 1.

Implementing the introduced constraints *(5*, *6* and *7)* into equation *(1)* allows us to work on an unconstrained model:

$$R_{i,t}=F_t+\sum_{k=2}^{N^C}\left(D_i^{Ck}-\frac{W_{Ck,t}}{W_{C1,t}}D_i^{C1}\right)F_t^{Ck}+\sum_{k=2}^{N^S}\left(D_i^{Sk}-\frac{W_{Sk,t}}{W_{S1,t}}D_i^{S1}\right)F_t^{Sk}+$$

$$SZ_{i,t}F_t^{SZ}+\varepsilon_{i,t}$$

(8)

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