Real Estate and the Stock Market: A Meta-Regression Analysis

Abstract

The real estate finance literature provides diverse and contradictory findings regarding the relationship between the real estate market and the stock market. Despite the importance of this relationship to the economy in general relatively little is known of what causes such differences. In this paper, through applying the technique of meta-regression analysis to the empirical studies in the area a significant step is made towards objectively integrating and synthesising the results and identifying systematic variations in the results of studies.

1. Introduction

Despite the importance of real estate assets to the general economy, surprisingly little is known of how such assets interact with other macroeconomic variables. There is much disagreement in literature regarding the nature of the relationship between real estate prices and the stock market. There is mixed evidence as to whether such a relationship actually exists, and where one is found on the size and direction of the relationship. The lack of an extended period of analysis and the omission of structural change periods in existing literature has led to confusion regarding the nature of any relationship.

The purpose of this paper is to overcome many of these limitations by employing meta-regression analysis to integrate and summarize in a statistically meaningful way disparate extant research results. By combining studies, a longer period of analysis is achieved that will incorporate the various cycles and shifts over time for which data was recorded and studied, leading to more accurate and meaningful results. Meta-regression analysis can improve the assessment of this important relationship by merging all of the existing estimates and investigating the sensitivity of the overall estimate to variations in the underlying studies. Furthermore, meta-regression analysis provides a method of quantitatively reviewing the empirical literature in a systematic and objective framework.

In this paper, two related but independent issues will be analyzed by meta-regression analysis: (1) To what extent has the literature confirmed that real estate returns and stock market returns are correlated, and (2) What is the effect of real estate returns on stock market returns?

2. Empirical research on the relationship between real estate returns and stock market returns

There is much disagreement in literature regarding the nature of the relationship between real estate prices and the stock market. As a starting point to many studies, the mostly commonly reported variable is the correlation between real estate returns and stock market returns. There is huge disparity in the size and direction of this variable – ranging from a negative correlation of 0.32 (Miles and McCue, 1984) to a positive correlation of 0.89 (Gyourko and Keim, 1992). Very high correlations are mostly reported for the US (Gyourko and Keim, 1992; Brown & Matysiak, 2000; Clayton and MacKinnon, 2001; Ghosh et al., 1996; Mei and Lee, 1994).

Standing out from these is Brown & Matysiak (2000) which reported a correlation of 0.86 for UK commercial real estate returns. Apart from being based in the UK, the majority of studies which found high correlations looked at REIT returns or property share returns. Nevertheless even some of those analyzing REIT returns in the US found negative to small positive correlations - Miles and McCue, 1984 (-0.32), Goldstein and Nelling, 1999 (-0.04) and Ghosh et al., 1996 (0.07). Differences in the time period of analysis may have a role to play in these results as both Miles and McCue (1984) and Goldstein and Nelling (1999) began their analysis in the early 1970s, much earlier than the vast majority of these studies. Small capitalization stock returns appear to have a higher correlation with real estate returns than large capitalization stocks. Mei and Lee (1994) are the only study looking at small capitalization stocks that reported a negative correlation (-0.04). Below a positive correlation of 0.25 there are very few studies that look at small capitalization stocks.

Similarly, significant disparity exists in the findings of studies which estimate the effect of real estate returns on stock market returns. Tse (2001), Qikarinen (2006), Okunev et al. (2000) and Apergis and McGuire (2007) find a significant inter-relationship between the two markets, while Quan and Titman (1997), Yunus (2008) and Beltratti and Morana (2010) find a relationship in some countries but not in others. However, there is still considerable disagreement between the studies relating to the size, direction and nature of the relationship.

Liow and Yang (2005) find the housing and stock markets to be cointegrated, Chen et al. (2009) finds cointegration in some time periods, while Qkunev and Wilson (1995) believe the markets are fractionally cointegrated. In some studies, the real estate market is found to have a strong granger causality effect on the stock market, with Okunev et al. (2000) reporting a stock market coefficient of 1.67. However, using a similar method the findings of Yunus (2008) suggest that the real estate market does not have any granger causality effect on the stock market.

While most of the literature is US based, some authors have examined the relationship in an international context, either by analyzing other countries individually or through panel data analysis. By examining a larger set of countries, panel data analysis attempts to increase the number of observations and hence the reliability of the results. Mixed findings stem from such methods of analysis. Quan and Titman (1997) find a stock coefficient of 0.53 when doing a panel data analysis of 7 Asian countries between 1979 and 1984. However, in a later paper by the same authors (1999) a panel data analysis of 6 European economies between 1983 and 1996 reveals a stock coefficient of -0.5. Cross sectional studies also produce mixed results. Quan and Titman (1997) utilize cross section data to allow for a longer holding period while still having sufficient data to examine the relationship between real estate and stock returns. Over a 7 year holding period, the stock coefficient found to be 0.53. However, in their later study (1999) of 14 different countries, cross sectional results for the same length of holding period ranged from 0.2 to 0.47 depending on the period of the study and whether rental rates or capital values were analyzed.

As with the literature of the correlation between real estate returns and stock market returns, analysis of the effect of the real estate market on the stock market generally found the largest positive effects in the US (Okunev et al., 2000; Liang et al., 1995; Okunev and Wilson, 1997; Clayton and MacKinnon, 2001). However, this is not always the case as an analysis of the US market by Glascock et al. (2000) revealed that the real estate market had a negative effect on the stock market of -2.06 between 1992 and 1996.

Studies examining the returns to REITs or property shares, as opposed to commercial property or housing assets, generally found a higher positive effect of these real estate assets on the stock market. Okunev et al. (2000) found a stock coefficient of 1.67 in a granger causality test of the effect of Equity REITs on the S&P500 between 1989 and 1998. Using a two index market model, Liang et al. (2005) revealed a stock coefficient of 1.08 in the relationship between Hybird REITs and NYSE/ASE market return index between 1973 and early 1989. However, on the other end of the scale, Glascock et al. (2000) based his strongly negative stock coefficient value on the relationship between Mortgage REITs and the S&P500.

3. Meta regression analysis: Approach

Stated simply, “meta-regression analysis is the regression analysis of regression analyses”, Stanley and Jarrell (1989:299). It provides a means of removing the subjectivity in literature surveys and objectifying the review process. Unlike a traditional literature review where the review chooses which studies to include, what weight to give to each to the results of each study and how to interpret the finding, with meta-regression analysis all relevant studies are included, the results are weighted objectively based on their expected accuracy or reliability and the process of analysis integrates and summarises the results to provide estimates of empirical magnitudes and to determine what factors cause variations in the results.

Meta-regression analysis is becoming increasingly popular in the social sciences, including economics and finance, as a means of examining and combining different research results on a given issue. It is particularly useful where alternative specification and assumptions lead to conflicting results. The advantages of using the technique of meta-regression analysis is best explained in the seminal work of Stanley and Jarrell (1989:300): “Meta-regression analysis not only recognises the specification problem but also attempts to estimate its effects by modeling variations in selected econometric specifications. Meta-regression analysis provides us with the means to analyze, estimate, and discount, when appropriate, the influence of alternative model specification and specification searches. In this way, we can more accurately estimate the empirical magnitudes of the underlying econometric phenomena and enhance our understanding of why they vary across the published literature.”

Meta-regression analysis developed from a popular technique, particularly in medical research, called meta-analysis. From each study, meta-analysis calculates the effect size, $w = (u_e – u_c)/\sigma_c$, where u_e is the mean of one group (generally the experimental group), u_c is the mean of the control group and σ_c is the standard deviation of the control group. The effect size w is used to compare the parameter estimates from various studies. This standardised statistic provides a means of consistently interpreting in a numerical fashion the results of highly individualised studies across all variables and measures involved, (Lispey and Wilson,2001). However, the applicability of this technique to finance and economics is limited because it is rare to encounter studies with experimental and control groups. Unlike effect size, in the context of a regression, there are units of measurement attached to a regression coefficient. Analogous to the effect size would be the reported *t*-statistic associated with the regression coefficient. A *t*-statistic does not have dimensionality and therefore is a standardised measure of the critical parameter of interest, (Stanley and Jarrell, 1989).

A further limitation of meta-analysis is that it fails to address the question of what are the key differences that cause variation among the studies results. Meta-regression analysis attempts to overcome these limitations by explaining the assumptions and specifications that systematically affect the results of studies.

A typical meta-regression model takes the form:

$$b_i = \beta + \sum_{k=1}^{K} \alpha_k X_{ik} + e_i \qquad i = 1,2,...L.$$

where b_i is the is the reported estimate of the statistic of β of the i^{th} study in the literature totalling L studies, β is the "true" value of the parameter of interest, X_{ik} is the meta-independent variable which measures the relevant characteristics of an empirical study, α_k the meta-regression coefficient that indicates the effect of particular study characteristics and e_k denotes the meta-regression disturbance term.

Stanley (2001) outlines five steps for conducting a meta-regression analysis, as follows:

1. Include all relevant studies from a standard database
2. Choose a summary statistic and reduce the evidence to a common metric
3. Choose moderator variables
4. Conduct a meta-regression analysis
5. Subject the meta-regression analysis to specification testing

Following these five steps the two meta-regression analyses of this paper serve the purpose of assessing:

Regression (1) To what extent has the literature confirmed that real estate returns and stock market returns are correlated, and

Regression (2) What is the effect of real estate returns on stock market returns?

3.1 All relevant studies

An extensive search for articles relating to the relationship between real estate returns and stock market returns was conducted in the EconLit, IDEAS, SSRN and JSTOR databases. Further studies were found from an internet search using the Irish Google search engine (www.google.ie) and the Google Scholar search engine (www.scholar.google.com). Studies that were cited in any of these articles were found, studies cited in the found cited articles were found, and this process continued until no new studies were cited. Although the literature search process was designed to be comprehensive, it cannot be guaranteed that all relevant studies were found. This may be due to the search process or to publication selection bias, where editors tend only to publish significant results. A number of studies that were found through the search process did not contain the necessary information and were disregarded.

Most studies contained more than one set of relevant results. As suggested by Stanley and Jarrell (1998) multiple observations from the same study were recorded as separate observations if they came from different time periods or had different models. Similarly, multiple observations from the same study, with the same time and model estimates but in different geographies, were recorded as separate observations. Estimates from similar studies reported in different articles by the same author using the same data were also recorded as separate observations.

The search process for relevant articles for the first meta-regression analysis resulted in 17 studies with 168 observations, for the second meta-regression analysis there were 9 studies with 128 observations. Table A1 and A2, in the Appendix, list the papers from which studies were drawn.

3.2 Parameter of interest

Ideally the parameter of interest for the first meta-regression analysis would be the value of the correlation between real estate returns and stock market returns as this variable is widely reported in studies of the relationship between real estate and the stock market. However, this variable has some undesirable properties due to its inherent standardisation that yields correlations ranging from -1 to +1 regardless of the numerical values of the underlying data to which it is applied. Therefore, correlations are generally transformed using Fisher's Z_r-transform, defined as

$$ESz_r = .5\log_e[(1+r)/(1-r)],$$

where r is the correlation coefficient and log_e is the natural logarithm. For ease of interpretation, the Z_r-transformed correlations are translated back into standard correlation form in the results, using the inverse of the Z_r-transformation.

The parameter of interest for the second meta-regression analysis was chosen as the coefficient of the stock market variable in the regression of stock market returns on real estate returns. While less widely reported than the correlation, this parameter of interest is both important and interpretable in the relationship between real estate returns and stock market returns.

3.3 Moderator (meta-independent variables)

This step in the meta-regression analysis process requires the choice of moderator, predictor or meta-independent variables. Such variables can be continuous or binary variables reflecting the presence or absence of study characteristics.

The binary variables used in the first meta-regression analysis reflect the frequency of the data, the region of the study, the property type and the stock type. The frequency of the data is analysed as it has been proposed in literature that relatively long measurement intervals are required to observe a relationship between the real estate market and the stock market, (Quan and Titman, 1999). The region of study is examined because it has been debated in literature whether this is a significant factor determining the relationship between real estate returns and stock market returns, (Quan and Titman, 1996; Yunus, 2008). Contrasting results in the empirical literature involving various property and stock types drives the inclusion of these as independent variables, (Miles and Cue, 1984; Gyourko and Keim, 1992; Eichholtz and Hartzell, 1996). Further to these variables, in the second meta-regression analysis binary variables are also included to reflect the methodology of the study as it is commonly recognised that differences in this factor can have a major impact on a study's findings. The continuous variables for both of the studies are, the year of the data, the year of publication of the article, the number of observations, the number of authors of the article and finally, for the second meta-regression analysis, also included is the p-value for the coefficient on the stock market variable. The year of the data is included as independent variables to capture changes over time in the observed relationship due to different periods of data used in the analysis, while year of publication is inserted to highlight systematic changes in the results of studies conducted during different time periods. The number of authors is analysed to investigate if this could influence the observed relationship, perhaps multi-author papers reporting more conservative results. The number of observations is a reliability measure which is used to weight the results in the first regression and as a moderator variable in the second regression. Similarly, the reported *p*-value is a reliability and accuracy measure that is used to weight the results of the second regression.

Refer to the Appendix for comprehensive definitions of the meta-independent variables, and for tables containing the parameters of interest and their respective meta-independent variable study characteristics.

Table 1 shows the correlations among the variables in the meta-regression 1. As can be expected the year of publication and the mid-point of the time period analysed are highly correlated. Also unsurprisingly, the property type and the frequency of the data are highly correlation. REITs, property shares and property mutual funds tended to have a higher frequency of data available than would other property assets, such as commercial property and housing assets. Similarly, there is a quite high correlation between property type and region due to the relatively high quantity of REITs located in the US. High correlation among the moderator variables generally reduces the significance of the individual variables coefficients in the meta-regression analysis, although together they may be jointly very significant the effect of one cannot be distinguished from the effect of the other. For this reason, it was decided to omit the year of publication and the frequency from the meta-regression 1.

Table 1: Meta-regression 1 - Correlation matrix

Variables	*Zr*-transformed correlation	Year of publication	Year of data	No. authors	No. observations	Region	Frequency	Property type	Stock type
Zr-transformed correlation	1.00	0.08	-0.08	-0.12	0.19	0.27	0.14	0.42	-0.37
Year of publication	0.08	1.00	0.62	-0.35	0.14	-0.14	-0.26	-0.26	0.20
Year of data	-0.08	0.62	1.00	0.17	-0.14	-0.31	-0.06	-0.02	0.04
No. authors	-0.12	-0.35	0.17	1.00	-0.22	0.13	0.34	0.37	-0.32
No. observations	0.19	0.14	-0.14	-0.22	1.00	0.31	0.34	0.37	-0.12
Region	0.27	-0.14	-0.31	0.13	0.31	1.00	0.35	0.42	-0.43
Frequency	0.14	-0.26	-0.06	0.34	0.34	0.35	1.00	0.60	-0.33
Property type	0.42	-0.26	-0.02	0.37	0.37	0.42	0.60	1.00	-0.43
Stock type	-0.37	0.20	0.04	-0.32	-0.12	-0.43	-0.33	-0.43	1.00

Table 2 shows the correlations among the variables in the meta-regression 2. The results are similar to those of the meta-regression 1, however more pronounced. The year of publication and the mid-point of the time period have a correlation coefficient of 0.68. In this case the property type and the frequency are perfectly positively correlated, and both have correlation of 0.93 with the region. To avoid multi-colinearity in the meta-regression 2 it was decided to omit frequency, region and year of publication.

Table 2: Meta-regression 2 - Correlation matrix

Variables	Stock coeffi-cient	P -value	Year of public-ation	Year of data	No. autho-rs	No. Obser-vations	Regi-on	Freq-uency	Proper-ty type	Stock type	Cointe-gration	Cross section /panel	Granger Causali-ty
Stock coefficient	1.00	-0.59	-0.29	-0.46	0.08	0.20	0.16	0.16	0.16	-0.12	-0.33	-0.09	0.19
P -value	-0.59	1.00	0.05	0.21	-0.01	-0.36	-0.12	-0.20	-0.20	0.16	0.13	-0.22	-0.01
Year of publication	-0.29	0.05	1.00	0.68	-0.56	0.16	-0.24	-0.08	-0.08	-0.04	0.01	0.30	0.60
Year of data	-0.46	0.21	0.68	1.00	-0.56	-0.17	-0.43	-0.35	-0.35	0.00	0.05	0.22	0.21
No. Authors	0.08	-0.01	-0.56	-0.56	1.00	0.03	0.65	0.57	0.57	0.09	0.11	-0.33	-0.09
No. Observations	0.20	-0.36	0.16	-0.17	0.03	1.00	0.23	0.29	0.29	-0.11	0.20	0.28	0.27
Region	0.16	-0.12	-0.24	-0.43	0.65	0.23	1.00	0.93	0.93	-0.31	0.45	-0.58	0.16
Frequency	0.16	-0.20	-0.08	-0.35	0.57	0.29	0.93	1.00	1.00	-0.31	0.45	-0.58	0.31
Property type	0.16	-0.20	-0.08	-0.35	0.57	0.29	0.93	1.00	1.00	-0.31	0.45	-0.58	0.31
Stock type	-0.12	0.16	-0.04	0.00	0.09	-0.11	-0.31	-0.31	-0.31	1.00	-0.44	0.18	0.05
Cointegration	-0.33	0.13	0.01	0.05	0.11	0.20	0.45	0.45	0.45	-0.44	1.00	-0.26	-0.07
Cross section/panel	-0.09	-0.22	0.30	0.22	-0.33	0.28	-0.58	-0.58	-0.58	0.18	-0.26	1.00	-0.18
Granger Causality	0.19	-0.01	0.60	0.21	-0.09	0.27	0.16	0.31	0.31	0.05	-0.07	-0.18	1.00

3.4 Estimation of the meta-regression model

The meta-regressions are estimated using the standard meta-regression model as discussed earlier, which takes the form:

$$b_i = \beta + \sum_{k=1}^{K} \alpha_k X_{ik} + e_i \qquad i = 1,2,...L.$$

In the meta-regression 1 and 2, the constant term, β, represents the average Z_r-transformed correlation and the average stock coefficient, respectively, calculated when all the moderator variables are zero. The X_{ik} variables are the moderator (or meta-independent) variables that measure characteristics of the study, such as the year of the data, the property or stock type, the methodology used.

3.5 Specification tests

This step involves checking that the assumptions underlying the estimation of the least squares model used in this study are satisfied.

Considering the correlation matrix of independent variables for both models, it is clear that the models' regressors are linearly independent. For meta-regression model 1, the normality of the residuals is assured from both a visual inspection of the histogram of residuals, see Figure A1 in the Appendix, and the Jarque-Bera test which is not statistically significant, thereby failing to rejecting the null hypothesis of normality. For the meta-regression model 2, this assumption is harder to meet as the Jarque-Bera test is statistically significant. However, the histogram of residuals suggests that they are distributed not too unlike a normal distribution; especially considering the panel nature of the data making this assumption less critical than it usually would be when using time series data, see Figure A2 is the Appendix.

In both models, White heteroskedasticity consistent covariance estimates are used to provide consistent parameter estimates in the presence of heteroskedasticity of an unknown form.

Ramsey's RESET test which provide a general test for misspecification of the errors, for example, omitted variables, incorrect functional form and correlation between the independent variables and the disturbance term, failed to detect specification error in either model.[1]

4. Meta regression analysis: Results

Table 3 displays the results from the estimation of the meta-regression analysis model 1. The model is estimated using least squares and is weighted on the log of the number of observations. This procedure allows estimates generated from larger sample sizes to have a proportionately larger effect on the estimated coefficients than those generated from smaller samples. The sample size is 168 and the dependent variable is Z_r-transformed correlation. The Z_r-transformed correlations are

[1] The Ramsey RESET Test had an F-Statistic *p*-value for meta-regression model 1 of 0.18, and for meta-regression model 2 of 0.66.

transformed back to standard correlational form for ease of interpretation in the results.[2] The model is significant at 1% and has a R^2 of 31%.

Table 3: Meta-regression 1 - Results

Variables	Coefficients	t-values	Probability
(Constant)	3.341	0.731	0.466
Year of data	-0.002	-0.652	0.515
No. authors	-0.071	-3.781	0.000*
Property type	0.136	4.784	0.000*
Stock type	-0.132	-3.705	0.000*
Region	-0.016	-0.487	0.627

* denotes significance at the 1% level.

Three of the meta-independent variables are highly significant – number of authors, property type and stock type. The greater the number of authors the lower is the reported correlation. As the number of authors increases by 1, the reported correlation decreases by 0.07, all else equal. While this is a difficult result to explain, it may indicate that multi-author studies are conservative in their estimations. The property type variable behaves as theoretically expected – REITs, property shares and property mutual funds are more highly correlated with the stock market than other types of property assets, such as commercial property and housing. This model suggests that with all else remaining constant, REITs, property stocks and property mutual funds will have a correlation with the stock market that is 0.14 higher than that of other assets. Again in keeping with theory, real estate assets display a higher correlation with small capitalisation stocks than large capitalisation stocks. For large capitalisation stocks, the correlation with real estate assets is lower by 0.13. Although the region is not a significant variable in this model, this may be due to its correlation with the property type, as discussed earlier. The year of the data is insignificant, suggesting that the correlation of real estate returns with stock market returns has not changed systematically over time. This indicates that despite the considerable stock market and property market booms and busts over the nearly 40 year period of the data, the average correlation between the two markets has remained constant.

Table 4 displays the results from the estimation of the meta-regression analysis model 2. The dependent variable is the coefficient on the stock market returns and the model is weighted by the

[2] This is performed using the formula $r = (e^{2ESzr} – 1)/ (e^{2ESzr} + 1)$. However, for a correlation matrix sufficiently distant from the limit values of 1 and -1, the Fisher's transformation is approximately equal to the original results.

inverse of the p-value for coefficient. The model is estimated by least squares and has 128 observations. The model is significant at 1% and has a relatively high R^2 of 66%.

Table 4: Meta-regression 2 - Results

Variables	Coefficients	t-values	Probability
(Constant)	43.836	4.131	0.000*
Year of data	-0.022	-4.174	0.000*
No. authors	-0.075	-0.864	0.389
No. observations	-0.001	-2.164	0.032**
Property type	0.682	3.060	0.003*
Stock type	0.086	2.365	0.020**
Cointegration	0.100	1.289	0.200
Cross section/panel	0.477	2.155	0.033**
Granger causality	-0.118	-0.502	0.616

*denotes significance at the 1% level

**denotes significance at the 5% level

The property type and stock type are still highly significant in this model, with a significance level of 1% and just over 1% respectively. The property type variable is economically very significant as it indicates that the stock market coefficient is higher by 0.69 when considering the relationship with REITs, property stocks or mutual funds rather than other real estate assets. The sign of the coefficient on the stock type variable is slightly counter-intuitive as it implies that the stock market coefficient is higher by 0.086 when analysing the relationship between large capitalisation stocks and real estate assets, than when studying small capitalisation stocks and real estate assets. However, the economic significance of this variable is considerably smaller than that of the property type.

The only one of the 3 methodologically important variables to be significant is that of cross section/panel, which suggests that stock market coefficient in the relationship with real estate assets is higher by 0.477 when using cross section or panel data analysis. This implies that the relationship between the stock market and real estate assets is stronger when considering a group of countries, rather than one country in isolation. This is intuitively appealing on two levels; firstly, the distortions and peculiarities of individual the markets in countries may weaken the observed relationship, however by studying a larger number of markets these effects become less pronounced and the overall relationship becomes clearer, secondly, by using panel data the number of observations in the study can be increased, which should make any existent relationship more evident.

Unlike the meta-regression model 1, the year of the data is statistically very significant in this model. The variable indicates that the effect of the real estate market on the stock market is decreasing over time. In particular, as the mid-point of the data range of a study increases by one year the stock market coefficient decreases by 0.022. While this is not a large value considered on its own, cumulatively over time this would indicate a large weakening of the effect of real estate assets on stocks. Again, unlike the meta-regression model 1, the number of authors of a study did not have a significant affect on the results.

Included as an explanatory variable in this model, the number of observations in each study was statistically significant at 5%. This variable indicates that the larger the number of observations the lower the observed effect of real estate assets on the stock market. As the number of observations in a study increases by one, the stock coefficient decreases by 0.001. Considering as a study of this kind can vary largely on the number of observations used, this variables suggests that it can have a large effect on the studies findings. Furthermore, if we assume that a studies' reliability increases with the number of observations, this indicates that the more reliable studies find real estate assets have a smaller effect on the stock market.

5. Conclusions

Over the past 30 years, several studies have empirically analysed the relationship between real estate returns and stock market returns. However, from studying bibliographic databases, this paper appears to be the first attempt to quantitative synthesis these studies by means of meta-regression analysis. Through this process limitations of the original studies, for example, shortage of data and model misspecification can be controlled for. Overcoming the restrictions, subjectivity, and dissonance of traditional literature reviews, meta-regression analysis allows the results of all relevant studies be objectively integrated and the sensitivity of these results to various factors analysed. In an economically and financially important area of study, where there is little consensus on the nature of the relationship, not least the factors influencing this relationship, this paper provides a significant step forward in the research.

In the first meta-regression analysis, 31% of the variation in the correlation between models was explained by variation in the independent regressors. The property type and stock type analysed significantly affected the findings of the study. As would be expected, REITs, property shares and property mutual funds were more closely correlated with the stock market than other types of property, such as commercial property and housing. Similarly, real estate returns were more highly correlated with small capitalisation stocks than large capitalisation stocks. The greater the numbers of authors to a paper, the more likely the results are to report a lower correlation. This may be a spurious result, or perhaps indicate that multi-author papers are more conservative in their results. Interestingly, the time period and region studied did not significantly influence the results.

The second meta-regression model managed to explain 66% of the variance in the stock coefficient by the variance in the moderator variables. Once again, both the property type and stock type were statistically significant. With a higher statistical and economic significance, and in line with theory, the property type coefficient indicated that REITs, property shares and property mutual funds had a greater effect on the stock market than other real estate assets. However, counter-intuitively, the stock type coefficient suggested that the real estate assets had a greater effect on large capitalisation stocks than small capitalisation stocks. Importantly for investors who may be trying to diversify assets, the findings indicate that the effect of the real estate on the stock market has systematically reduced over time. The number of observation is found to reduce the observed effect, perhaps flagging that the more reliable results find a smaller relationship. Where the study uses cross section or panel data, the reported effect of the real estate market on the stock market is greater. This suggests that on an aggregated level the effect of the real estate market on the stock market is greater than when individual markets are considered in isolation. Other methodologies used by studies did not appear to significantly affect the results. Unlike the previous analysis, the second meta-regression analysis did not find the number of authors to have a significant affect on the results.

Further analysis of the empirical literature in the area of real estate finance is required to provide some consensus, meaningfulness and significance to the disparate results of various studies. Such analysis requires a sufficient number of studies using the same metric of analysis for the dependent variable and is therefore somewhat restricted in the specific questions that may be analysed using this methodological tool. However, the question of whether real estate returns are normally distributed is an important issue that has been extensively studied in the real estate literature and would lend itself well to the process of meta-regression analysis.

Appendix

Table A1: Meta-regression analysis 1: List of papers

Author	Year
Gyourko and Keim	1992
Brown	1991
Brown & Matysiak	2000
Clayton and MacKinnon	2001
Eichholtz and Hartzell	1996
Ghosh et al.	1996
Goldstein and Nelling	1999
Hartzell et al.	1986
Laopodis	1999
Lizieri and Satchell	1997
Maurer et al.	2004
Mei and Lee	1994
Miles and McCue	1984
Oikarinen	2006
Quan and Titman	1999
Sing and Ling	2003
Wurtzebach et al.	1995

Table A2: Meta-regression analysis 2: List of papers

Author	Year
Clayton and MacKinnon	2001
Glascock et al.	2000
Li and Wang	1995
Liang et al.	1995
Okunev and Wilson	1997
Okunev et al.	2000
Quan and Titman	1997
Quan and Titman	1999
Yunus	2008

Meta-regression analysis 1: List of meta-independent variables for and definitions

- Year of publication
- Year of the data – The mid-point of the data range of the study
- Number of authors
- Number of observations
- Region – 1 if US; 0 otherwise
- Frequency – 1 if quarterly or monthly; 0 if longer than quarterly
- Property type – 1 if REIT, property share or property mutual fund; 0 otherwise
- Stock type – 1 if large capitalization stock; 0 otherwise

Meta-regression analysis 2: List of meta-independent variables for and definitions

- Year of publication
- Year of the data – The mid-point of the data range of the study
- Number of authors
- Number of observations
- Region – 1 if US; 0 otherwise
- Frequency – 1 if quarterly or monthly; 0 if longer than quarterly
- Property type – 1 if REIT, property share or property mutual fund; 0 otherwise
- Stock type – 1 if large capitalization stock; 0 otherwise
- Cointegration – 1 if cointegration analysis employed; 0 otherwise
- Cross section/panel – 1 if cross section or panel data analysis employed; 0 otherwise
- Granger causality – 1 if granger causality analysis employed; 0 otherwise

Figure A1: Meta-regression Analysis 1 – Histogram of standardized residuals

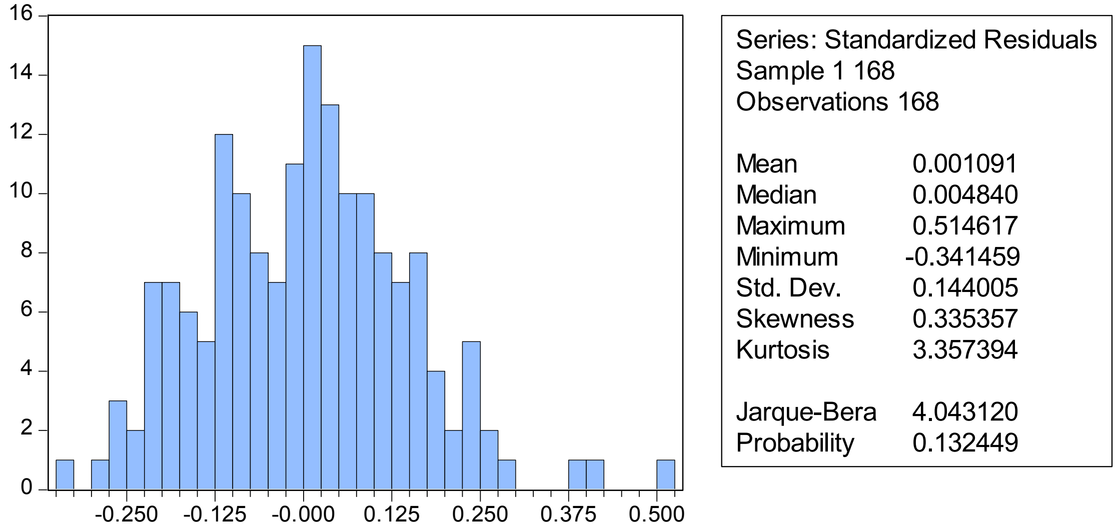
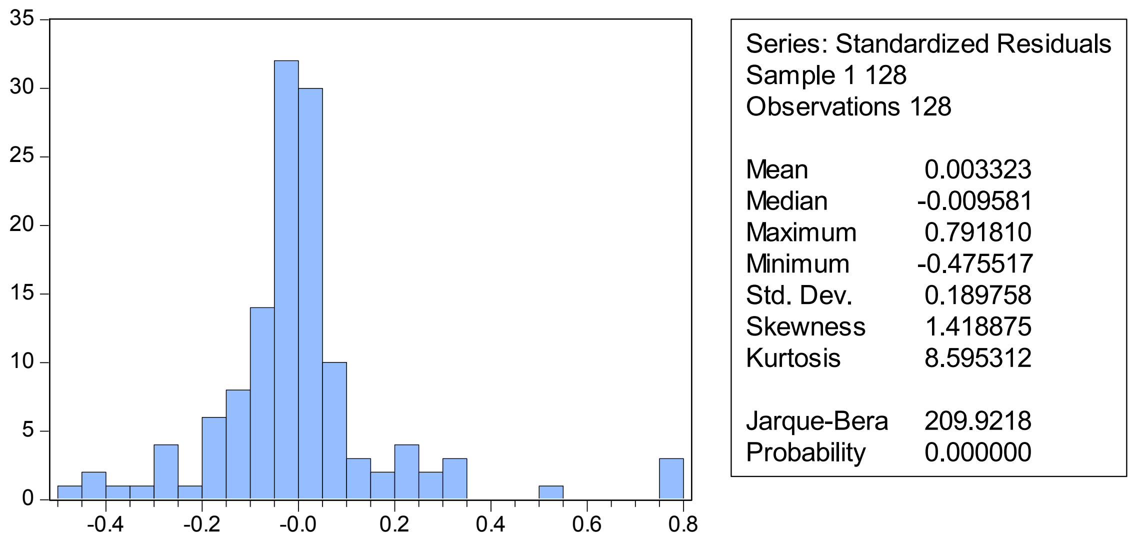


Figure A2: Meta-regression Analysis 2 – Histogram of standardized residuals



Bibliography

APERGIS, N. & LAMBRINIDIS, L. 2007. More Evidence on the Relationship between the Stock and Real Estate Market. *Working Paper Series* [Online]. [Accessed 14 September 2010].

BELTRATTI, A. & MORANA, C. 2010. International House Prices and Macroeconomic Fluctuations. *Journal of Banking and Finance,* 34**,** 533-545.

BOND, S. A. & PATEL, K. 2003. The Conditional Distribution of Real Estate Returns: Are Higher Moments Time Varying? *Journal of Real Estate Finance and Economics,* 26**,** 319-339.

BROWN, G. R. 1991. *Property investment and the capital markets*, E & FN Spon.

BROWN, G. R. & MATYSIAK, G. A. 2000. *Real estate investment : a capital market approach,* Harlow, Financial Times Prentice Hall.

CLAYTON, J. & MACKINNON, G. 2001. The Time Varying Nature of the Link between REIT, Real Estate and Financial Asset Returns. *Journal of Real Estate Portfolio Management,* 7**,** 43-54.

EICHHOLTZ, P. M. A. & HARTZELL, D. J. 1996. Property Shares, Appraisals and the Stock Market: An International Perspective. *Journal of Real Estate Finance and Economics,* 12**,** 163-178.

GHOSH, C., MILES, M. & SIRMANS, C. F. 1996. Are REITs Stocks? *Real Estate Finance,* 13**,** 46-53.

GLASCOCK, J. L., LU, C. & SO, R. W. 2000. Further Evidence on the Integration of REIT, Bond, and Stock Returns. *Journal of Real Estate Finance and Economics,* 20**,** 177-194.

GOLDSTEIN, M. A. & NELLING, E. F. 1999. REIT Return Behaviour in Advancing and Declining Stock Markets. *Real Estate Finance,* 15**,** 68-77.

GYOURKO, J. & KEIM, D. B. 1992. What Does the Stock Market Tell Us About Real Estate Returns? *Journal of the American Real Estate and Urban Economics Association,* 20**,** 457-485.

LAOPODIS, N. 2009. REITs, the Stock Market and Economic Activity. *Journal of Property Investment and Finance,* 27**,** 563-578.

LI, Y. & WANG, K. 1995. The Predictability of REIT Returns and Market Segmentation. *The Journal of Real Estate Research,* 10**,** 471-482.

LIANG, Y., MCINTOSH, W. & WEBB, J. R. 1995. Intemporal Changes in the Riskiness of REITs. *The Journal of Real Estate Research,* 10**,** 427-443.

LING, D. C. & NARANJO, A. 1999. The Integration of Commercial Real Estate Markets and Stock Markets. *Real Estate Economics,* 27**,** 483-515.

LIOW, K. H. & YANG, H. 2005. Long-Term Co-Memories and Short-Run Adjustment: Securitized Real Estate and Stock Markets. *The Journal of Real Estate Finance and Economics,* 31**,** 283-300.

LIPSEY, M. W. & WILSON, D. B. 2001. *Practical meta-analysis,* Thousand Oaks, Calif. ; London, Sage.

LIZIERI, C. & SATCHELL, S. 1997. Interactions Between Property and Equity Markets: An Investigation of the Linkages in the United Kingdom 1972-1992. *Journal of Real Estate Finance and Economics,* 15**,** 11-26.

MAURER, R., REINER, F. & SEBASTIAN, S. 2004. Characteristics of German Real Estate Return Distributions: Evidence from Germany and Comparison to the U.S. and U.K. *Journal of Real Estate Portfolio Management,* 10**,** 59-76.

MEI, J. & LEE, A. 1994. Is There a Real Estate Factor Premium? *Journal of Real Estate Finance and Economics,* 9**,** 113-126.

MILES, M. & MCCUE, T. 1984. Commercial Real Estate Returns. *AREUEA Journal,* 12**,** 355-377.

MYER, F. C. N. & WEBB, J. R. 1993. Return Properties of Equity REITs, Common Stocks, and Commercial Real Estate:A Comparison. *The Journal of Real Estate Research,* 8**,** 87-106.

OIKARINEN, E. 2006. Price Linkages Between Stock, Bond and Housing Markets - Evidence from Finnish Data. *Discussion Papers* [Online]. Available: https://econpapers.repec.org/paper/rifdpaper/1004.htm [Accessed 14th September 2010].

OKUNEV, J. & WILSON, P. 1995. Using Non-Linear Test to Examine Integration Between Real Estate and Equity Markets. *Working Paper* [Online]. Available: http://ideas.repec.org/p/uts/wpaper.html.

OKUNEV, J., WILSON, P. & ZURBRUEGG, R. 2000. The Causal Relationship Between Real Estate Stock Markets. *Journal of Real Estate Finance and Economics,* 21**,** 251-261.

OKUNEV, J. & WILSON, P. J. 1997. Using Nonlinear Tests to Examine Integration Between Real Estate and Stock Markets. *Real Estate Economics,* 25**,** 487-503.

QUAN, D. C. & TITMAN, S. 1996. Commercial Real Estate Prices and Stock Market Returns: An International Analysis. [Accessed 14th September 2010].

QUAN, D. C. & TITMAN, S. 1999. Do Real Estate Prices and Stock Prices Move Together? An International Analysis. *Real Estate Economics,* 27**,** 183-207.

RUI, C., GUANGRONG, T. & QIZHONG, D. 2009. Research on the Dynamics of Volatilities between Stock Market and Real Estate Market. Available: http://www.eres2009.com/papers/3CChen_Rui.phf [Accessed 14th September 2010].

SING, T. F. & LING, S. C. 2003. The Role of Singapore REITs in a Downside Risk Allocation Asset Allocation Framework. *Journal of Real Estate Portfolio Management,* 9**,** 219-235.

STANLEY, T. D. 2001. Wheat From Chaff: Meta-Analysis as Quantitative Literature Review. *Journal of Economic Perspectives,* 15**,** 131-150.

STANLEY, T. D. & JARRELL, S. B. 1989. Meta-Regression Analysis: A Quantitative Method of Literature Surveys. *Journal of Economic Surveys,* 19**,** 299-308.

STANLEY, T. D. & JARRELL, S. B. 1998. Gender Wage Discrimination Bias? A Meta-Regression Analysis. *Journal of Human Resources,* 33**,** 947-973.

TSE, R. Y. C. 2001. Impact of Property Prices on Stock Prices in Hong Kong. *Review of Pacific Basin Financcial Markets and Policies,* 4**,** 29-43.

WILSON, P., OKUNEV, J. & TA, G. 1996. Are Reall Estate and Security Markets Integrated? Some Australian Evidence. *Journal of Property Valuation and Investment,* 14**,** 7-24.

WILSON, P. J. & OKUNEV, J. 1996. Evidence of Segmentation in Domestic and International Property Markets. *Journal of Property Finance,* 7**,** 78-97.

WURTEZEBACH, C. H., HARTZELL, D. J. & GILIBERTO, S. M. 1995. Real Estate in the Portfolio: A New Look. *Perspectives.* Summer ed.: Heitman/JMB Advisory Corporation.

YUNUS, N. 2008. Dynamic Interaction among Securitized Property Market, Stock Market and Macroeconomic Fundamentals: International Evidence. University of Baltimore.