REAL ESTATE AND THE STOCK MARKET: A META-REGRESSION ANALYSIS

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ABSTRACT

The real estate finance literature provides diverse and contradictory findings regarding the distribution of real estate returns and the linkage between these returns and stock market returns. 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

The distributional properties of the returns of common stocks have been the subject of numerous empirical studies. Analysis of kurtosis in the equity market dates back as far as Mandelbrot (1963) and Fama (1965). For real estate assets, there exists a substantial body of research investigating the first two moments of returns (mean and variance), however analyses of the third and fourth moments (skewness and kurtosis) is very limited. The overwhelming majority of studies that do investigate these four properties find real estate returns to be non-normally distributed. There is little, if any, concrete analysis of what are the factors affecting the degree of non-normality, or in the case where returns are found to be normally distributed (Lizeri and Ward,1997; Seiler et al., 1999; Brown and Matysiak, 2000), what are the features of such studies.

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. Seiler et al. (1999) argues that studies of REIT performance should use as long a time period as possible as real estate has probably experienced the greatest number of booms and busts of any investment asset and as such this has lead to conflicting results in studies. 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, three related but independent issues will be analyzed by meta-regression analysis: (1) The degree of normality in real estate returns distributions, (2) To what extent has the literature confirmed that real estate returns and stock market returns are correlated, and (3) What is the effect of stock market returns on real estate returns?

2. EMPIRICAL RESEARCH ON THE DISTRIBUTION OF REAL ESTATE RETURNS AND THE RELATIONSHIP BETWEEN REAL ESTATE RETURNS AND STOCK MARKET RETURNS

The assumption of normality of the return distribution for direct (private) real estate returns and returns of real estate securities has been rejected in many studies (Myer and Webb, 1994, Byrne and Lee, 1997; Liow and Chan, 2005, Liu et al., 1992). There is considerable disagreement as to the direction of skewness of returns. Lizieri and Satchell (1997) and Brown and Matysiak (2000) have found returns to be positively skewed, Myer and Webb (1991), Knight et al. (2005) and Okunev (2000) found that they were negatively skewed, while within the one study Maurer et al.

(2004) and Pagliari and Webb (1995) found some return series to be positively skewed and others to be negatively skewed. The vast majority of studies concluded that real estate returns displayed excess kurtosis, (Myer and Webb, 1994; Byrne and Lee, 1997; Liow and Chan, 2005; Young et al., 2006).

Hutson and Stevenson (2008) examined the asymmetry in daily REIT returns and found skewness to be inversely related to the index's relative performance. In contrast, Bond and Patel (2003) found little evidence of time variation in the skewness parameters of REIT returns. Brounen et al. (2008) find property shares to be non-normally distributed, with kurtosis decreasing in all markets over time. Furthermore, kurtosis is found to be greatest among property stocks which have a high volume traded, are geographically specialised and have a small market capitalisation.

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 US, 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 Aperergis 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_i 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 three meta-regression analyses of this paper serve the purpose of assessing:

Regression (1) The degree of normality in real estate returns distributions,

Regression (2) To what extent has the literature confirmed that real estate returns and stock market returns are correlated, and

Regression (3) What is the effect of stock market returns on real estate 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 19 studies with 182 observations, for the second meta-regression analysis there were 17 studies with 168 observations and for the third meta-regression analysis there were 9 studies with 128 observations. Table A1, A2 and A3 in the Appendix, list the papers from which studies were drawn.

3.2 Parameter of Interest

In the meta-regression analysis accessing the normality of real estate returns, the parameter of interest was chosen as the Jarque-Bera (JB) statistic. It is a goodness-of-fit measure of departure from normality, based on the sample skewness and kurtosis. While the test suffers from limitations (eg. over rejection of null hypothesis of normality in small samples), it was chosen as it was the most widely reported test of normality of the return distribution and could be calculated from the sample skewness and kurtosis parameters when it wasn't directly reported. Papers which reported findings for excess returns, log returns, differentiated returns, etc were excluded from the meta-regression analysis.

Ideally the parameter of interest for the second 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

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

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 third 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 methodology employed, the region of the study and the property type. The frequency of the data is analysed because it has been argued in real estate literature that for some real estate assets, particularly commercial property, quarterly returns may be autocorrelated or that the valuations are out-of-date as they are not conducted quarterly on each property and therefore a longer time period should be used, (Seiler et al., 1999). However, using longer frequency data accentuates the problems associated with small sample sizes, particularly for real estate, where in most case the time period of the data is relatively short. Also, Liow and Chan (2005) forward normality is less likely to hold for more frequently observed real estate return data. A binary variable to reflect the methodology used in the study was inserted to capture any differences in the results due to using non-conventional methodology. Most papers simply calculated the JB statistic on the returns, but in some cases an autoregressive model was used to remove autocorrelation in the series. The region of the studies data was examined to investigate if this affected the degree of normality in the returns series. The property type under consideration has been suggested to impact on the distribution of returns. Bond and Patal (2003) argue that securitized real estate are more accurately reflects real estate returns than commercial real estate because it avoids the need to de-smooth the appraisal based indices used in the latter and hence the uncertainty surrounding the method chosen to correct the data. Securitized real estate also provides a longer period of data, which can capture more of the cycles in the data.

The second and third meta-regression analysis use binary variables to 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 used for all three meta-regression analysis 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 third 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 and second regression and as a moderator variable in the third regression. Similarly, the reported *p*-value is a reliability and accuracy measure that is used to weight the results of the third 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 first meta-regression. As can be expected the year of publication and the mid-point of the time period analysed are highly correlated. The high negative correlation between the region and the year of the data is due to the earlier data availability and research for the US compared to other regions. 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 from the regression.

Table 1: Meta-Regression 1 - Correlation Matrix

Variables	JB TEST	No. Authors	Frequency	Methodology	No. Observations	Property Type	Region	Year of data	Year of publication
JB TEST	1.00	0.03	0.06	0.06	0.63	0.32	-0.01	0.36	0.34
No. Authors	0.03	1.00	-0.29	0.09	-0.03	0.28	-0.02	0.07	0.16
Frequency	0.06	-0.29	1.00	-0.12	0.15	0.13	0.06	-0.02	-0.14
Methodology	0.06	0.09	-0.12	1.00	0.05	0.17	-0.19	0.17	0.16
No. Observations	0.63	-0.03	0.15	0.05	1.00	0.32	0.17	0.43	0.31
Property Type	0.32	0.28	0.13	0.17	0.32	1.00	-0.03	0.25	0.18
Region	-0.01	-0.02	0.06	-0.19	0.17	-0.03	1.00	-0.55	-0.55
Year of data	0.36	0.07	-0.02	0.17	0.43	0.25	-0.55	1.00	0.93
Year of publication	0.34	0.16	-0.14	0.16	0.31	0.18	-0.55	0.93	1.00

Table 2 shows the correlations among the variables in the meta-regression 2. Similar to the previous regression, the year of publication and the mid-point of the time period analysed are highly correlated. The property type and frequency of the data are highly correlated. REITs, property shares and property mutual funds tended to have a higher frequency 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. To avoid multi-colinearity, it was decided to omit the year of publication and the frequency from the meta-regression 2.

Table 2: Meta-regression 2 - 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 3 shows the correlations among the variables in the meta-regression 3. The results are similar to those of the meta-regression 2, 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 3: Meta-regression 3 - Correlation matrix

Variables	Stock coefficient	P -value	Year of publication	Year of data	No. authors	No. Observations	Region	Frequency	Property type	Stock type	Cointegration	Cross section /panel	Granger Causality
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 from the three models, it is clear that the models' regressors are linearly independent.

For the first meta-regression, the level of the JB statistic was initially used as the dependent variable. However, due to poor diagnostic properties of this model (eg. non-normalitiy, instability), the log of the JB statistic was used instead. The normality of the residuals for this model is indicated by the statistically insignificant JB statistic (0.09) and the histogram of residuals, see figure A1 in the Appendix. For meta-regression model 2, the normality of the residuals is assured from both a visual inspection of the histogram of residuals, see Figure A2 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 3, 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 unlike a normal distribution; see Figure A3 in the Appendix.

In all three 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

The result of meta-regression analysis 1 are displayed in Table 3. 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 182 and the model is significant at 1%, with a R^2 of 46%.

Table 3: Meta-Regression 1 - Results

Variables	Coefficients	t-values	Probability
(Constant)	-304.730	-6.577	0.000*
Year of data	0.153	6.588	0.000*
No. authors	0.054	0.141	0.888
Property type	1.285	3.920	0.000*
Frequency	1.911	4.134	0.000*
Methodology	0.625	0.919	0.360
Region	0.484	1.578	0.116

* denotes significance at the 1% level

The output of this model indicates that four of the independent variables, including the constant, have a statistically significant effect on the degree of normality in the returns of real estate assets. The later the time period of the data the more likely the returns are to be non-normally distributed. For each year increase in the mid-point of the data used by a particular study, the observed log of the JB statistic tends to increase by 0.15, all else equal. REITs, securitized real estate and real

[1] The Ramsey RESET Test had an F-Statistic *p*-value for meta-regression model 1 of 0.43, for model 2 of 0.18, and for model 3 of 0.66.

estate mutual funds are more likely to have a greater degree of non-normality in their returns than commercial property or housing. On average, with all else equal, the log of the JB statistic is higher by 1.28 when considering the former rather than the later. Related to this is the observation that the returns are more non-normal when using higher frequency data. Returns with a frequency of quarterly or shorter, tended to have a log of JB statistic that is higher by 1.91 than if considering annual or semi-annual data, all else equal. The region is does not appear to have a significant effect on the normality of the returns. As the region variable is quite highly correlated with the time period and the methodology, these were excluded variables were excluded from the model to see whether the region would then have a significant impact on the JB statistic. The output of this model still indicated that the region of the study did not affect the degree of normality in the real estate returns. The methodology used in the studies and the number of authors also did not appear to impact on the observed normality of the returns.

Table 4 displays the results from the estimation of the meta-regression analysis model 2. Similar to model 1, this model is estimated using least squares and is weighted on the log of the number of observations. The sample size is 168 and the dependent variable is Z_r-transformed correlation. The Z_r-transformed correlations are 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 4: Meta-Regression 2 - 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.

[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.

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 5 displays the results from the estimation of the meta-regression analysis model 3. The dependent variable is the coefficient on the stock market returns and the model is weighted by the 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 5: Meta-Regression 3 - 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 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. While it is generally believed that real estate assets are closer to small capitalisation stocks than large capitalisation stocks, it appears that real estate has a greater effect on large capitalisation stocks than small capitalisation stocks. However, the economic significance of this variable is considerably smaller than that of the property type.

The only methodology based independent variables which was significant was the cross section/panel variable, 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 2, the year of the data is statistically very significant in this model. The variable indicates that the effect of the stock market on real estate asset returns 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 2, 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 the stock market on real estate assets. 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 the stock market has a smaller effect on real estate assets.

5. CONCLUSIONS

Over the past 40 years, researchers have been analysing the distribution of real estate returns and 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 research on the causes of non-normality in real estate returns and little consensus on the nature of the relationship between real estate and stock market returns, not least the factors influencing this relationship, this paper provides a significant step forward in the research.

The first meta-regression analysis model explained 46% of the variation in the JB statistic. It was found that real estate returns have a higher degree of non-normality the later the time period of the study, indicating that returns are getting less normal over time. Higher frequency data also caused the returns to display less normality. Related to this was the finding that REITs, securitized real estate and real estate mutual funds had a lower degree of normality than other real estate assets, such as commercial real estate or housing.

In the second 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 third 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. The stock type coefficient suggested that 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 stock market on real estate 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 stock market on real estate is greater. This suggests that on an aggregated level the effect of the stock market on real estate 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.

Considering the results of the three meta-regression analysis, it appears that the property type has an important effect on the properties displayed by the real estate asset. Related to this is the frequency and region, both of which can be quite highly correlated with the property type. However, these do not display the same level of influence on the results. The stock type is also very significant in the nature of the relationship observed between the stock market and real estate assets. The time period of the data was an important factor in two of the three meta-regressions. The impact of the methodology used by researchers on the results has yet to be confirmed as it was not important in the first meta-regression, it did not apply to the second model and only one of the three methodologies tested for in the third meta-regression was significant. The number of authors to a paper does not play a notable part in two of the three meta-regressions and therefore it is questionable whether differences in the number of authors influence the results of research.

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.

APPENDIX

Table A1: Meta-Regression Analysis 1: List of Papers

Author	Year
Myer and Webb	1994
Byrne and Lee	1997
Liow and Chan	2005
Hutson and Stevenson	2008
Brounen et al.	2008
Myer and Webb	1993
Lizieri	2007
Pagliari and Webb	1995
Maurer et al.	2004
Myer and Webb	1991
Coleman and Mansour	2005
Chiang et al.	2008
Cotter and Stevenson	2008
Lizieri and Satchell	1997
Cotter and Stevenson	2006
Brown	1991
Brown and Matysiak	2000
Miles and McCue	1984
Okunev et al.	2000

Table A2: Meta-Regression Analysis 2: 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 A3: Meta-regression analysis 3: 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 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 more frequent; 0 if less frequent than quarterly
- Methodology – 1 if conventional, basic model; 0 if otherwise, eg. auto-regressive model
- Property type – 1 if REIT, property share or property mutual fund; 0 otherwise

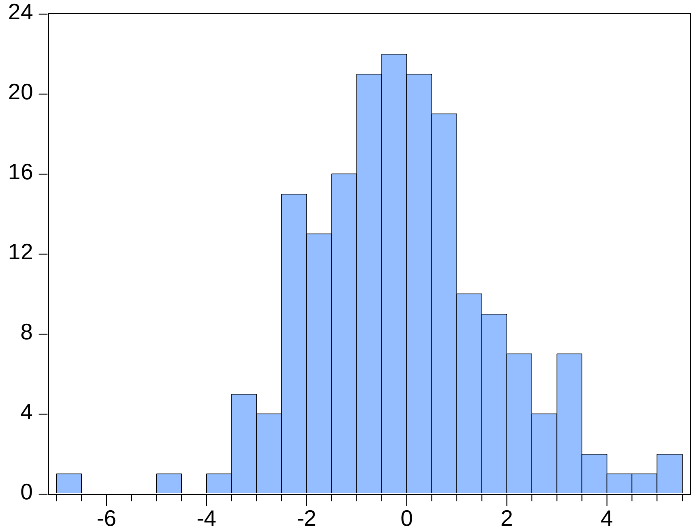
Meta-Regression Analysis 2: List of Meta-Independent Variables and Definitions

- 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 less frequent 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 3: List of Meta-Independent Variables and Definitions

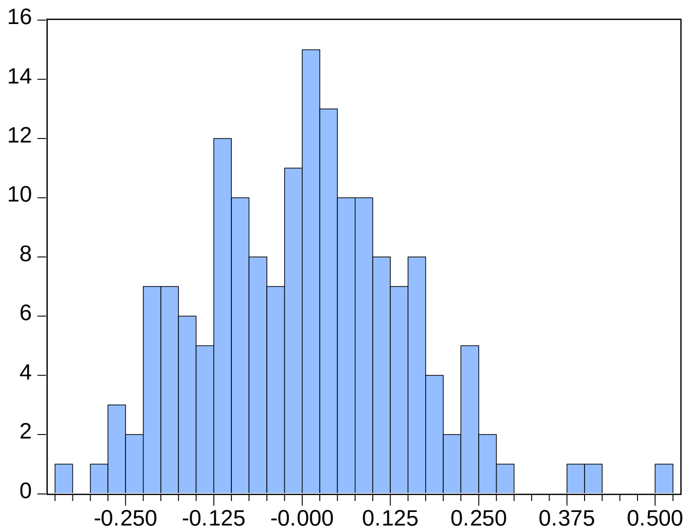
- Year of publication
- Year of the data – The mid-point of the data range of the study
- Number of authors
- Number of observations
- Region – 1 if US; 0 otherwise
- Frequency – 1 if quarterly or monthly; 0 if less frequent than quarterly
- Property type – 1 if REIT, property share or property mutual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



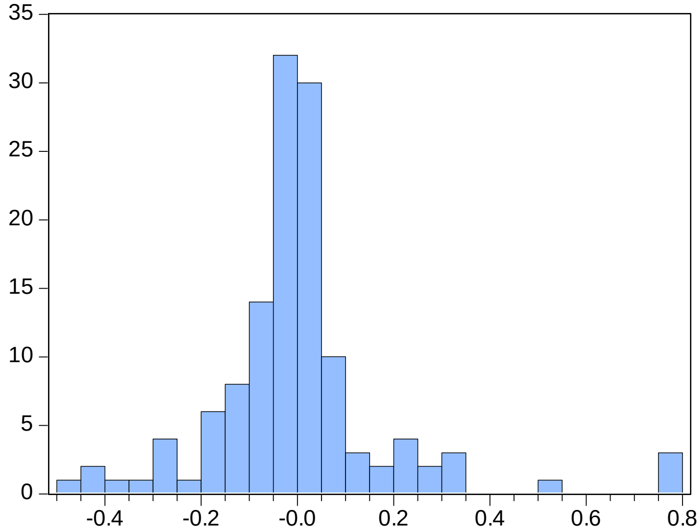
Series: Standardized Residuals	
Sample 1 182	
Observations 182	
Mean	-0.095133
Median	-0.131686
Maximum	5.315204
Minimum	-6.870164
Std. Dev.	1.887224
Skewness	0.174246
Kurtosis	3.707848
Jarque-Bera	4.720596
Probability	0.094392

Figure A2: Meta-Regression Analysis 2 – Histogram of Standardized Residuals



Series: Standardized Residuals	
Sample 1 168	
Observations 168	
Mean	0.001091
Median	0.004840
Maximum	0.514617
Minimum	-0.341459
Std. Dev.	0.144005
Skewness	0.335357
Kurtosis	3.357394
Jarque-Bera	4.043120
Probability	0.132449

Figure A3: Meta-Regression Analysis 3 – Histogram of Standardized Residuals



Series: Standardized Residuals
Sample 1 128
Observations 128

Mean	0.003323
Median	-0.009581
Maximum	0.791810
Minimum	-0.475517
Std. Dev.	0.189758
Skewness	1.418875
Kurtosis	8.595312
Jarque-Bera	209.9218
Probability	0.000000

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