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Macro-Economic and Financial Determinants of Comovement across Global Real Estate Security Markets

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Abstract

This paper models the determinants of integration in the context of global real estate security markets. Using both local and U.S. Dollar denominated returns, we model conditional correlations across listed real estate sectors and also with the global stock market. The empirical results find that financial factors, such as the relationship with the respective equity market, volatility, the relative size of the real estate sector and trading turnover all play an important role in the degree of integration present. Furthermore, the results highlight the importance of macro-economic variables in the degree of integration present. All four of the macro-economic variables modeled provide at least one significant result across the specifications estimated. Factors such as financial and trade openness, monetary independence and the stability of a country's currency all contribute to the degree of integration reported.

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1: Introduction:

During the course of the last twenty years the global listed real estate security sector has increased in size dramatically. This growth has been aided by the growth in the U.S. Real Estate Investment Trust (REIT) market and the introduction of REIT vehicles in the majority of large international capital markets. These developments have contributed to the development of an accompanying literature that has considered the diversification benefits available and the interlinkages present across international real estate security markets. However, despite this, very few papers have explicitly considered the determinants and underlying factors that influence the integration observed across listed real estate sectors. An honorable exception in this respect is Liow (2012). Liow (2012) draws upon those papers in the mainstream finance literature that have empirically considered the key factors influencing of integration across global markets (e.g. Pretorious, 2002; Dellas & Hess, 2005; Beine & Candelon, 2011; Walti, 2011) and examines eight markets in the Asia-Pacific region. The paper however, solely considers the contribution of financial time-series factors, primarily the relative volatility of listed real estate and lagged correlations. Importantly, the analysis does not incorporate macro-economic factors.

It is on this issue that the current paper aims to contribute to the literature. We analyze and model the correlation dynamics across twelve real estate security markets in Asia-Pacific, Europe and North American for the period 1973 through 2010. Using annualized estimates of conditional correlations we consider both the degree of comovement across the twelve markets and between the listed real estate sectors and the global stock market. The conditional correlations are modeled in a panel framework. The use of lower frequency annual data allows not only financial but also a variety of macro-economic variables to be incorporated into the empirical specifications as explanatory variables. Real estate securities provide an interesting setting in which to consider the role of financial and macro-economic variables in the comovement and integration of asset

returns. Whilst the issue of economic and financial integration is obviously of enormous general interest, it is of particular relevance when considering listed real estate. The fact that real estate firms have a fundamental asset, quite directly connected to economic conditions, underpinning their operations may lead to macro-economic variables having a major impact upon the degree of integration and comovement reported across international markets. Furthermore, real estate securities are themselves a combination of a real asset, in terms of the underlying properties, and a financial asset, in the form of the shares. It is therefore imperative that macro-economic variables are directly considered in any analysis of comovement and integration.

These issues have interesting additional implications in the context of the broader literature. Heathcote & Perri (2004) note that whilst real economic integration has weakened in recent decades, financial integration has strengthened. Dehesh & Pugh (2000) argue that changes in the global economic system and in particular the process of deregulation, have contributed to an increase in capital flows. Furthermore, whilst during periods of domestic economic stability property cycles are largely endogenous and primarily driven by disequilibrium in the sector, in times of economic instability they are exogenous. Therefore, as global integration increases so does the risk of foreign shocks impacting upon real estate. It could also be argued that the deregulation that occurred in many markets in the financial services industry from the late 1970s onwards contributed to this exposure by aiding in the development and growth of global financial services firms.

The empirical analysis, conducted using underlying returns denominated in both U.S. Dollars and local currencies, highlights the importance of considering a broad range of factors. We find that financial variables such as volatility, the correlation with the respective domestic stock market, the relative size of the real estate sector and trading turnover all play an important role in the degree of integration present. However, the macro-economic variables tested are also found to be significant factors in terms of the degree of integration observed. All four of the macro-economic variables (trade openness, financial openness, monetary independence and currency stability) provide at least one

significant result across the specifications estimated. The remainder of the paper is structured as follows. Section 2 discusses some of the relevant literature regarding the comovement and integration of financial markets. Section 3 outlines both the data utilized and the methodological framework adopted in the estimation of the conditional correlations. Section 4 expands upon this to provide information pertaining to the panel model specified and tested in the analysis of the conditional correlations and the macro-economic and financial variables. Section 5 discusses the empirical results whilst the final section provides concluding comments.

2: Financial Integration Literature

Following on from the seminal work on international diversification in the sixties and seventies the examination of the comovement of global equity markets has a long history in the finance literature. Specifically relating to correlations between markets, the mainstream literature has frequently observed their time-varying nature, with a large number of papers noting that this relationship is related to the state of the market. Specifically that correlations tend to rise when returns are lower and specifically during bear markets and crises[1]. Furthermore, correlations have been found to be positively related to volatility (Longin & Solnik, 1995, 2001; Catao & Timmermann, 2009; Walti, 2011). The unfortunate consequence of this is that diversification benefits are reduced at exactly the moment when they would be required the most, i.e. during periods of increased uncertainty and poor performance. However, this effect may not be solely related to financial crises, indeed there may be more general issues concerning market maturity. Ross (1989) argues that information flows may be linked to volatility and that as markets mature and information flows improve, together with potential effects on integration, one of the results is increased volatility.

At a global level the connection between financial markets and both economic integration and financial liberalisation has been extensively documented. A large proportion of this literature has been specifically concerned with emerging markets and how their characteristics alter as they mature[2]. At a broader level it has been reported in a number of papers that correlations across markets tend to increase together with enhanced

economic integration (Erb et al., 1994; Longin & Solnik, 1995; Goetzmann et al., 2005)[3]. Flavin et al. (2002) illustrates that whilst the impact is not as distinct as when examining economic integration, geographic proximity can also contribute to enhanced financial integration in equity markets. A recent paper by Beine et al. (2010) highlights the linkages between financial and economic integration, finding that macroeconomic factors and liberalization of financial markets can impact upon comovement across the return distribution. Specifically they report findings that show that both financial liberalization and reduced foreign exchange rate volatility increase comovement in the left hand tail of the return distribution[4]. Bekaert & Harvey (1995) find that as a market becomes more integrated the relative importance of its domestic variance falls in favor of the covariance with the world market. Walti (2011) argues that lower foreign exchange rate volatility may also contribute to enhanced economic synchronization, this is certainly the case in the extreme scenario of currency unions (Rose & Engel, 2002). A number of papers have provided broader evidence in terms of the importance of monetary and economic variables such as interest rates, trade figures, foreign direct investment and interest rates (Bracker et al., 1999; Bekaert & Harvey, 2000, Bekaert et al., 2001; Wu, 2000; Pretorious, 2002)

Some recent papers to have considered the broader issue of integration and segmentation have noted that correlations are not necessarily a satisfactory measure of integration (e.g. Bekaert et al., 2009; Pukthuanthong & Roll, 2009; Eun & Lee, 2010; Bekaert et al., 2011). Connolly & Wang (2003) argue that integration between markets can be attributed to two factors, namely; common underlying economic fundamentals (e.g. Flannery & Protopapadakis, 2002) or contagion effects. Connolly & Wang (2003) find that although macroeconomic announcements do convey information, the degree of integration between the U.S., U.K. and Japan is dominated by contagion effects. This is the case even after controlling for the impact of economic information flows. Pretorious (2002) argues that in addition to economic fundamentals and contagion there is a third explanation behind co-movement, namely features of the market such as market capitalization, industrial structure, liquidity and volatility. This third category is of interest in the context of our study for a number of reasons. Firstly, by solely considering listed real estate we

are looking at a single industry and secondly, a number of the factors such as market size are incorporated into our analysis.

A number of recent papers have considered the underlying relationships underpinning stock market comovement (e.g. Pretorious, 2002; Dellas & Hess, 2005; Beine & Candelon, 2011; Walti, 2011). Most of these papers have used a similar methodological framework to the one that is adopted in the current paper, namely the use of a panel specification to model correlations across countries. Issues on which the papers differ on include data frequency, the methods used to estimate the correlations and the explanatory variables incorporated into the panel model. Walti (2011) considers bilateral correlations across fifteen mature stock markets for an extended period from 1975 through to 2006. A key focus of the Walti (2011) paper is concerned with monetary integration, and especially so within a European context. The results suggest that in terms of both reduced exchange rate volatility and converging inflation expectations, monetary integration contributes to enhanced financial integration. As would also be expected given the focus of the paper, trade integration is also found to contribute to increased stock market co-movement.

Whilst Walti (2011) considers developed mature markets, a number of papers have extended the analysis to consider the case of emerging markets. However, in most cases the importance of fundamental economic factors continues. Beine & Candelon (2011) considers 25 emerging markets, providing results that highlight the importance of trade and financial liberalization with respect to financial integration[5]. The authors argue that financial liberalization leads to a reduction in asymmetric information which is a major factor in increased stock market comovement, a view consistent with that presented by Ross (1989). The results with respect to trade integration specifically illustrate that trade liberalization leads to an increase in the correlation between the equity markets of trading partners. As Beine & Candelon (2011) control for trade intensity this finding is not due to the sheer volume of trade but rather a supplementary signaling channel[6]. Dellas & Hess (2005) consider both mature and emerging markets, considering quarterly data over the 1980-1999 period. As with other pieces of research, relationships are noted between stock

market synchronization and financial development, with significant coefficients found with respect to volatility and liquidity[7].

Over the last two decades a number of papers have considered the portfolio benefits to arise from investing internationally across international real estate security markets[8]. However, a smaller number of papers have considered the degree of integration and comovement present. The primary exceptions in this regard are a number of recent pieces of research to have considered both volatility and correlation dynamics between international securitized real estate. These papers have considered a number of issues in this respect with key findings including; evidence of spillover effects in both returns and volatility (Michayluk et al., 2006; Liow et al., 2011; Hoesli & Reka 2011; Yang et al., 2012; Zhou 2011), lower correlations between the real estate security markets considered than between the respective equity markets (Liow et al., 2009) and evidence that listed real estate markets are not segmented from stocks generally (Liow & Ibrahim 2010).

However, with the exception of Liow (2012), no studies have considered what factors influence the degree of comovement present. Examining eight real estate security markets in the Asia-Pacific region Liow (2012) consider a range of volatility measures, considering the relative volatility of listed real estate with the respective local, regional and global stock markets. In addition, he includes lagged correlations, again with the local, regional and global equity markets. Whilst the specification includes a variety of variables, the only ones that enter the final stepwise determined model are a mixture of the lagged correlations and the ratio of real estate volatility to one or more of the local, regional or global stock market. Whilst providing an important initial analysis the paper is constrained by its sole consideration of Asian markets and the non-examination of macro-economic and trade factors.

3: Data and Estimation of Conditional Correlations

The underlying data used in this study consists of weekly index data for twelve global markets, namely; Australia, Austria, Belgium, Canada, France, Germany, Hong Kong, Japan, Malaysia, Singapore, UK and USA. The overall sample extends from January 1973 to December 2010. In some cases the sample is constrained. However, given that the empirical framework adopted is a panel model this does not materially impact the analysis. The data was obtained from Thompson Reuters Datastream and comprises of their own estimated indices. The decision to use Datastream's own indices was purely so that a single data provider was used across both markets and in terms of real estate specific and general stock indices. The indices are value-weighted and are broadly comparable to alternatives estimated by other data providers. Given the nature of the markets under consideration it is important to note that the indices are not limited to Real Estate Investment Trusts, but also include both investment and development focused property companies. This is an advantage in the use of the Datastream indices as with the exception of the United States and Australia, REITs were introduced during the sample period. In addition, in some markets, such as the UK and Hong Kong, the corporate sector continues to be a large component of the overall listed real estate sector. Table 1 provides details of the summary and descriptive statistics for the data, including the starting point of the sample period analyzed.

This paper considers the issue of integration using a broad methodological framework. We firstly estimate the conditional correlations across a number of international real estate security markets. A variety of approaches, including simple unconditional rolling correlations, can be considered in the analysis of changing dynamics in the correlation structure between markets. The use of GARCH (Generalized Autoregressive Conditional Heteroscedasticity) based methods to estimate dynamic conditional correlations differentiates the paper from some of the previous work in the field. Walti (2011), for example, uses simple annual unconditional correlations estimated from weekly returns, whilst Beine & Candelon (2011) uses the realized moments framework of Andersen et al. (2003). However, as Case et al. (2012) notes, the choice of window used in either a rolling estimation or in an exponentially weighted moving average framework is

subjective, with no strong theoretical basis underpinning the choice. Furthermore, Forbes & Rigobon (2002) note that unconditional correlations can exhibit bias, an effect that can be particularly noted during periods of increased volatility, when an upward bias can be introduced into the correlation coefficients. This provides further rationale behind the use of GARCH based conditional correlations as they are not subject to this potential upward bias. This is of particular relevance given the increase in volatility in a number of the listed real estate sectors over the period under examination (e.g. Cotter & Stevenson, 2008; Jirasakuldech et al., 2009) and more generally the heightened volatility observed in equity markets around the 2007-9 financial crisis.

Whilst a number of alternative multivariate GARCH specifications are available that can be used to estimate conditional correlations, we adopt the Dynamic Conditional Correlation (DCC) model of Engle (2002)[9]. The DCC model initially estimates GARCH (1,1) specifications, employing the resulting standardized residuals to estimate the time varying correlation matrix. To do this, the residuals are transformed by their estimated standard deviations $\Xi_t = \varepsilon_t / \sqrt{h_t}$. The covariance matrix can be expressed as $H_t \equiv D_t R_t D_t$, where D_t is a diagonal matrix of univariate GARCH volatilities. $R_t = Q_t^{*-1} Q_t Q_t^{*-1}$ is the time varying correlation matrix, with Q_t as described by

$$Q_t = (1 - a - b)\overline{Q} + a(\Xi_{t-1}\Xi'_{t-1}) + bQ_{t-1} \tag{1}$$

$\overline{Q}$ is the unconditional covariance of standardized residuals resulting from the first stage estimation, and Q_t^* is a diagonal matrix composed of the square root of the diagonal elements of Q_t. As with the standard GARCH(1,1) model the coefficients of the DCC(1,1) model are estimated by the maximum likelihood procedure using the algorithm of BFGS. The log likelihood function, under the assumption of conditional multivariate normality can be displayed as follows:

$$L(\vartheta) = -\frac{1}{2}\left[TN\ln(2\pi) + \sum_{t=1}^{T}\left(\ln|H_t| + \Xi_t' H_t^{-1}\Xi_t\right)\right] \quad (2)$$

where Ξ_t is an N x 1 vector stochastic process, with $H_t = E_{t-1}(\Xi_t \Xi_t')$, being the N x N conditional variance covariance matrix.

The conditional correlations are estimated from weekly returns, themselves based upon Wednesday figures. The use of weekly returns has advantages over both daily and monthly data. Firstly, in comparison to monthly data it provides a greater core sample size. Secondly, daily data suffers, in a global context, from non-synchronous trading hours. For each real estate security market the conditional correlations are estimated with the remaining eleven countries. In addition, correlations are estimated for each listed real estate market with both its own local equity market as well as the global market. Finally, corresponding correlations are estimated for each country in terms of the domestic stock market and the global market. All of cross-border correlations are estimated using both local currency returns and those converted into U.S. Dollars. This also allows the analysis to be considered from the perspective of either a hedged or unhedged U.S. domiciled investor. In addition, the local currency results can be taken from the perspective of a perfectly hedged investor, irrespective of their domicile.

The conditional correlations form the base data used in the panel regressions, the specifications of which are detailed in the following section. However, two adjustments are made to the correlations prior to their modeling. Firstly, whilst the majority of papers to have modeled correlations have used the raw correlation data (e.g. Pretorious, 2002; Dellas & Hess, 2005; Liow, 2012) a problem with that approach is that correlation coefficients are constrained in having a value between -1 and +1. This leads to normality issues both in terms of the correlations and also in the error term in the panel specifications used in the paper. Figure 1 illustrates this quite clearly which displays a histogram of all of the conditional correlations estimated between the pairs of real estate security markets in local currency[10]. We therefore use the Fisher-Z transformation used in

papers such as Otto et al. (2001), Walti (2011) and Beine & Candelon (2011). In this case the conditional correlations are adjusted as follows:

$$w_{i,j,t} = \ln \frac{1+\rho_{i,j,t}}{1-\rho_{i,j,t}} \tag{3}$$

The second adjustment is that we do not model the underlying weekly data. Rather, we use annual estimates, more in keeping with the approach adopted in papers such as Beine & Candelon (2011) and Walti (2011). The advantage of using annual data in the panel specifications is that it allows the use of macro-economic data in the panel models. Those papers to have modeled either weekly or daily data (e.g. Liow, 2012) are limited to including financial series for which data is available at such a frequency. The use of annual data also has the advantage in that it eliminates the issue of lags and the choice of lag lengths in the estimation of the panel model.

Our adjustment to annual frequency does however differ from that used by papers such as Walti (2011) and Beine & Candelon (2011). As previously noted, Walti (2011), simply estimates an annual unconditional correlation figure. Given our use of a GARCH framework we have weekly observations. We therefore, take the average of the estimated weekly conditional correlations for each year. Our specification also differs in that rather than consider bilateral correlations in the panel model we take the average across the markets concerned. Therefore, for say the Australian REIT sector we take the average of the estimated conditional correlations across the other eleven listed real estate sectors. The rationale in this regard is primarily concerned with the macro-economic variables used, as discussed in Section 4.

4: Panel Model

4.1: Model Specification

The primary empirical tests involve the estimation of panel models with the conditional correlations, estimated as detailed in the preceding section, as the dependent variable. Two broad specifications are used. In the first case the dependent variable is based upon the annual average conditional correlation for each country with respect to other listed real estate markets. In the second specification the dependent variable is based upon the conditional correlations of each listed real estate market versus the global equity market.

The base line model is a panel specifications of the following form:

$$\rho_{\bar{x},t} = \alpha_t + \beta_1 \rho 1_{x,e,t} + \beta_2 \rho 2_{e,w,t} + \beta_3 vol_{x,t} + \beta_4 vol(ratio)_{x,t} + \beta_5 cap1_{x,t} + \beta_6 cap2_{x,t} + \beta_7 to_{x,t} + \beta_8 open_{x,t} + \beta_9 MI_{x,t} + \beta_{10} fx_{x,t} + \beta_{11} trade_{x,t} + \mu_{x,t} \quad (4)$$

Where $\rho_{\bar{x},t}$ is the average correlation for market *x* with the other listed markets in year *t*. The independent variables can be divided into two categories. The first group considers financial market data and are:

- The annual average correlation of the listed real estate market with its respective stock market $\left(\rho 1_{x,e,t}\right)$
- The annual average correlation of the domestic equity market with the world market $\left(\rho 2_{e,w,t}\right)$
- The volatility of the listed real estate sector $\left(vol_{x,t}\right)$
- The relative volatility of the listed real estate sector to the respective domestic equity market $\left(vol(ratio)_{x,t}\right)$
- The ratio of the market capitalization of listed real estate to the domestic equity market $\left(cap1_{x,t}\right)$
- The ratio of domestic stock market to the global market in terms of market capitalization $\left(cap2_{x,t}\right)$

- The turnover of listed real estate, as measured in monetary terms as a percentage of market capitalization. $\left(to_{x,t}\right)$

The second group of variables considers broader macro-economic factors, namely:

- Financial Openness $\left(open_{x,t}\right)$
- Monetary Independence $\left(MI_{x,t}\right)$
- Foreign Exchange Stability $\left(fx_{x,t}\right)$
- Trade Openness $\left(trade_{x,t}\right)$

The second specifications substitutes the correlation of listed real estate stocks with the world equity market as the dependent variable. The correlation of real estate securities with the domestic equity market is replaced as the first independent variable with the annual average correlation with other listed real estate markets, the dependent variable in the first specification. This model can therefore be represented as follows:

$$\begin{aligned}\rho_{x,w,t} = {} & \alpha_t + \beta_1 \rho 1_{\bar{x},t} + \beta_2 \rho 2_{e,w,t} + \beta_3 vol_{x,t} + \beta_4 vol(ratio)_{x,t} + \beta_5 cap1_{x,t} \\ & + \beta_6 cap2_{x,t} + \beta_7 to_{x,t} + \beta_8 open_{x,t} + \beta_9 MI_{x,t} + \beta_{10} fx_{x,t} + \beta_{11} trade_{x,t} + \mu_{x,t}\end{aligned} \tag{5}$$

As noted previously, both models are estimated in local currency and in U.S. Dollars. The panel regressions are modeled with fixed effects, thereby allowing for common international shocks. This is a similar approach to that adopted by Walti (2011). An advantage of this specification is that it is an effective means of controlling for shocks in the correlations during periods of financial crisis. Given the long-time series considered, the sample period contains a number of events that possibly could result in temporary shocks and increases in the coefficients observed, e.g. the oil crises of the mid-seventies, the 1987 crash, the 1997/8 Asian crisis and the 2007/8 financial crisis.

4.2: Financial Time Series Variables

The first group of variables consider time-series aspects of the underlying real estate security and stock data. We use the correlation of the listed real estate sector with its

respective domestic equity market. The rationale behind its examination is that markets more highly correlated with their domestic equity market are potentially more exposed to general equity market shocks at a global level. We may hypotheses therefore, that the higher the correlation with the domestic market the higher the degree of integration at a listed real estate level, as considered in specification 1 (Equation 4). The second correlation variable is the average annual correlation of the domestic equity market with the world market. The rationale here follows on from the preceding. If a stock market overall has a higher correlation with the global market we may hypothesize that the listed real estate market is also more integrated. Therefore, we again may expect under the scenario of integration, a significant positive coefficient in this regard.

With respect to risk we consider both the volatility of the listed real estate sector itself and its relatively volatility to the domestic stock market. Annualized volatility measures are estimated for both the real estate sector and the markets overall in a manner similar to the calculation of the annual correlation data. The ratio of the relative real estate security volatility to the overall stock market is then estimated based on the annual data. This is in part based upon the rationale that correlations often display a positive relationship with volatility (e.g. Longin & Solnik, 1995, 2001). The next two financial time-series measures are market capitalization ratios. The first is of the listed real estate sector relative to its respective equity market. The second is the relative size of the country's stock market to the global market. Both of these ratios are defined as follows. The average market capitalization of the respective markets/sectors is calculated for each year based upon the underlying weekly data. The ratios are based on the annual averages. The rationale behind considering size is that markets where real estate securities are relatively larger may display greater evidence of global integration due to increased domestic integration, a similar rationale to that used when looking at the correlations. Likewise, a larger domestic stock market in global terms may contribute to greater real estate specific integration.

The final financial variable used is the turnover of listed real estate in monetary terms expressed as a percentage of market capitalization. Bekaert et al. (2011) use turnover in

their analysis of segmentation, arguing that increased turnover can be taken as an indicator of financial development (Atje & Jovanovic, 1989)[11]. In a broad equity market context it would therefore be expected that increased development would lead to increased integration. Whether a similar finding is found in the case of an individual industry sector, as is the focus of our analysis, is a more debatable point.

4.3: Macroeconomic Variables

Our analysis considers four key macro-economic measures, namely; *Financial Openness*, *Monetary Independence*, *Foreign Exchange Stability* and *Trade Openness*. All four measures are general in nature and do not directly relate to bilateral relations between countries in our sample. This is in contrast to some previous work (e.g. Walti, 2011). This is also the reason as to why we consider an average correlation figure rather than model the bilateral correlations. The first three variables are obtained from Aizenman et al. (2010), using what they refer to as their 'Trilemma Indices'. The Trilemma refers to the hypothesis that a country cannot not achieve all three aims of: monetary independence, stability in the movements of their currency and financial openness (Obstfeld et al., 2005). Policies may aid in the achievement of one goal, but it will be to the detriment of others, and that it is only possible to achieve combinations of two of the three goals at the same time under a single policy regime. Therefore, given the importance of the interaction of the three Trilemma variables, it is important to consider all three in the empirical analysis. In contrast, for example, Walti (2011) only includes in his empirical analysis a measure of monetary independence relating to the Exchange Rate Mechanism and the European single currency (Euro).

The first of the Trilemma Index variables is *Financial Openness*. The measure used is based upon the index of capital account openness (KAOPEN) proposed by Chin & Ito (2006, 2008). The index is normalized from zero to one, a higher figure indicating a greater level of financial openness. The index incorporates information from the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions and is the first standardized principal component. As Walti (2011) notes, there is disagreement in the literature concerning the most appropriate measure of financial liberalization. The

KAOPEN Index is a *de jure* measure, as acknowledged by Chin & Ito (2006, 2008), in that it captures changes in policy. Papers such as Bekaert & Harvey (2003) argue that financial liberalization may have an impact on factors such as capital flows from the announcement date rather than the date of implementation. Aizenmann et al. (2010) however argue that *de facto* measures can be vulnerable to other macroeconomic and financial effects. In contrast their *de jure* measure is, they argue, a more robust consideration of policy intentions[12].

The Aizenman et al. (2010) measure of *Monetary Independence* is calculated as the reciprocal of the annual correlation between the monthly interest rate of the home country and the base country. The base country used in each case is that country with which the home market's monetary policy is most closely aligned. Aizenman et al. (2010) use, where available, the analysis of Shambaugh (2004) to define the respective home country and IMF data otherwise. The final Trilemma Index is that which measures *Exchange Rate Stability*. This is estimated as the annual standard deviation of the monthly exchange rate between the home and previously defined base country.

The final variable used is *Trade Openness*. The rationale behind its inclusion is due to the number of papers that have noted that trade integration plays a key role in the determinants of financial integration (e.g. Beine & Candelon, 2011). We define this as follows in a manner similar to Hutson & Stevenson (2010), using data obtained from the World Bank.

$$\text{trade openness} = \frac{\text{imports} + \text{exports}}{\text{GDP}} \tag{6}$$

5: Empirical Results

The empirical results are displayed in Tables 2 and 3. Table 2 reports the results from the first component of the analysis which is concerned with the degree of integration present across the listed real estate sectors. The panel specification, as displayed in Equation (4), uses the conditional correlations across the real estate sectors as the dependent variable.

The independent variables comprise of a mix of financial and macro-economic variables as previously discussed. The tests are run twice, once based on local currency data and once with the underlying series converted into U.S. dollars. The results support some of the previous literature and also the key hypotheses discussed in this paper.

The first two explanatory variables provide a key insight into the importance of the broader equity markets in terms of the integration across listed real estate markets. In both local and U.S. dollar terms the correlations of the listed real estate sector with its respective domestic stock market, and of domestic equities with the global market are both positive and significant at conventional levels. It should be noted that the correlations examined as explanatory variables do differ in form to those used in many previous studies. Some mainstream studies have not considered correlations, other than perhaps lagged correlations (e.g. Beine & Candelon, 2011). This is primarily because they are focusing upon overall integration at a country level. The interpretation of our findings does differ from previous work, and may be considered in the following manner. The significant correlation with domestic equities can, as with Liow (2012) be interpreted in that higher the degree of domestic integration, in terms of their domestic stock market, it makes it more likely that a real estate sector, is also integrated at a global level, even in the context of the world real estate security market. The rationale with respect to the stock market variable is therefore an extension of that. If a country's overall stock market has a higher correlation with the global market we may hypothesize that the real estate sector is also more integrated, even in the context of global real estate securities. Effectively, both of these measures highlight the importance of financial integration.

With regard to the volatility measures the relative volatility of listed real estate to domestic stocks is not significant in either currency specification. However, the stand-alone volatility measure of the respective real estate sectors in significant at conventional levels when the data is converted into U.S. dollar. This does support the literature that illustrates the positive relationship between correlations and volatility and highlights the fact that correlations and therefore integration often rises during periods of increased uncertainty (e.g. Longin & Solnik, 1995, 2001; Catao & Timmermann, 2009). Our data

does again however require specific interpretation. Given that we are considering an individual sector of the equity market in comparison to the overall market it does make intuitive sense that the results may be weaker in comparison to some of the existing empirical evidence. A possible reason as to why our real estate specific findings are generally weaker than those reported by Liow (2012) may be concerned with the fact that he modeled the underlying weekly data. It is therefore not that surprising that the evidence presented was stronger with respect to the influence of volatility in comparison to our analysis of annual data. This difference in data frequency may also explain the strong results reported by Dellas & Hess (2005). The lack of significance with respect to the relative volatility measure does indicate that what is of greater concern is overall risk.

The remaining financial series are in five out of six cases significant. The first two of the remaining measures consider the ratio of the market capitalization of the listed real estate sector relative to its respective equity market and secondly the country's stock market to the global equity market. The rationale behind considering size is based upon the hypothesis that in countries where the listed real estate is relatively larger, in terms of the domestic equity market, not only may this contribute to increased domestic integration, but it may make the listed real estate sector more exposed to global shocks and thus enhanced global integration. Likewise, a larger equity market in global terms may contribute to greater real estate specific integration due to increased integration for the country overall. The real estate-domestic ratio in local currency terms is not significant. This would imply that relative size by itself is not a sufficient factor in increased integration. The fact though that the aforementioned correlation with the domestic equity market is significant does illustrate the importance of this factor. What is of interest is that once external factors enter into the issue, through the conversation of the underlying returns into U.S. dollars, the results are significant at conventional levels. Stronger results are observed in the case of the broad equity market measure, as would be expected. In both currency scenarios the larger the domestic equity market is at a global level, then the greater the degree of real estate specific integration. This highlights the importance of the broader equity markets when considering integration and therefore diversification in a real estate specific context.

The final financial variable considered is turnover. The rationale behind its examination is mainly drawn from the literature on emerging markets. As previously cited, studies such as Bekaert et al. (2011) consider turnover in their analysis of segmentation, arguing that increased turnover can be taken as an indicator of financial development. As previously discussed in Section 2 whilst this argument does make sense in a broader equity market context it is more debatable point as to whether significant findings would be reported in a sector specific context especially, as in our case, turnover is defined at a sector level as the ratio of turnover versus market capitalization. However, in both specifications the coefficient is positive and significant. A further factor in this regard relates to the growth of the listed real estate sector globally over the course of the last decades. This may help to explain why it continues to provide significant results at a sector level. Whilst detailed considerations of turnover have been limited in a real estate specific context, those studies that have considered the issue (e.g. Cotter & Stevenson. 2008) have found it to be a significant determinant of volatility in a domestic U.S. REIT context.

The attention now turns to the four macro-economic variables considered in the analysis. The first three are the Trilemma indices measuring *Financial Openness*, *Monetary Independence* and *Foreign Exchange Stability*, whilst the final considers *Trade Openness*. Of immediate note is that financial openness is not significant in either specification. This is of interest given the previous literature to have noted the importance of financial liberalization on financial integration (e.g. Walti, 2011). There are a number of reasons as to why insignificant findings may be reported in our analysis. The first is concerned with the fact that we are considering an individual equity sector rather than the overall stock market, which may result in more sector specific factors dominating the impact of financial liberalization. In addition, the nature of real estate as an asset class may also specifically contribute in this regard. Given its illiquid characteristics, increased financial liberalization may take longer to impact upon the underlying real estate markets and therefore the firms operating in that market. Furthermore, it is well established that until relatively recently cross-border investment in real estate was limited in nature.

Therefore, even in markets that liberalized their investment markets relatively early, the impact in real estate may be subdued in comparison to the capital markets. On a related noted, it is often the case that property markets have different regulatory structures in place. Therefore, whilst financial liberalization may have taken place in the context of capital market assets, constraints on the real estate market may have still been in place. Finally, as noted in Section 4, there are disagreements in the literature as to whether *de jure* measures of liberalization, as used by ourselves and papers such as Aizenmann et al. (2010) is an appropriate way of considering the issue. Papers such as Bekaert & Harvey (2003), Lane & Milesi-Ferretti, (2001, 2007) and Walti (2011) rather use *de facto* measures.

The *Monetary Independence* coefficient is significant in the local currency scenario and is of a positive sign. The measure we use, obtained from Aizenman et al. (2010), is the reciprocal of the annual correlation between the monthly interest rate of the home country and the specified base country. The results are therefore counter to the findings in papers such as Walti (2011) who in the specific context of Europe found that monetary integration increased the bilateral correlations across stock markets. However, the focus of the Walti (2011) paper in concentrating at Europe does give it a very specific interpretation. As noted previously in the paper, some studies have noted a divergence between integration economically and financially. Studies such as Heathcote & Perri (2004) report that although financial integration has increased in recent decades, real economic integration has actually weakened during the same time. Our results may therefore be an indication that despite the importance of the underlying economic conditions to real estate, financial market effects dominate. This stance would to some degree be supported by the significant results noted with respect to the correlation of listed real estate and its domestic market and the domestic and global general stock markets.

It to obtain a fuller consideration of these issues we should also consider our results we respect to both the stability of the countries currency's and to trade openness. We note a significant positive coefficient with respect to foreign exchange stability when the U.S.

dollar denominated data is considered, however, in local terms it is insignificant as are either coefficient with respect to trade openness. In this case our significant result with respect to foreign exchange stability does support Walti (2011) who finds that reduced foreign exchange volatility contributes to increased integration. It also makes intuitive sense that this significance is with respect to the second specification when the data is converted into U.S. dollars. The final variable considered is *Trade Openness* due to the empirical evidence that has cited and noted the importance of trade integration in financial integration. However country to papers such as Walti (2011) and Beine & Candelon (2011) we do not find significant results. This is possibly due to the definition of trade openness that we use. Whilst many previous papers considered bilateral trade data, in terms of both liberalization and intensity, we, as in the analysis of monetary independence, use an 'aggregate' overall measure. It may also be that given the nature of real estate that trade is a less important factor in driving the returns of real estate securities.

Table 3 reports the corresponding panel model when the correlation of listed real estate with the global stock market is modeled as the dependent variable. This analysis therefore expands upon the preceding discussion in that we are considering integration in a broad equity market context, with the global stock market, and not just the specific real estate sector. Many of the results are similar to those reported previously with regard to real estate specific integration, effectively highlighting the importance of the role of the broader equity markets, both locally and globally, in the dynamics of the listed real estate sector. As would be expected, the more integrated the domestic stock market overall is with the global market the more integrated the listed real estate sector is with the global market. Likewise, it make sense that if the correlation of a real estate sector with other real estate markets is higher, then the integration present with the global market is also stronger. Both correlation variables are positive at a statistically significant level under both currency scenarios. As with the first specification, the volatility ratio variables do not enter the model as significant at conventional levels, however, the market capitalization ratios are, as before, in the main significant. However, it needs to be noted that whilst the size ratios are both positive and significant when local currency data is

considered, when U.S. dollar data is analyzed the one significant result, the domestic to world market, is significant but of a negative sign. This would suggest that the smaller the stock market of a country is relative to the global market then the more integrated that markets respective real estate sector is with the global market. This goes against does not make intuitive sense and goes against the results discussed thus far. It is however of interest that a similar result is also noted with respect to turnover. In both specifications turnover, whilst significant, is of a negative sign.

With respect to the macro-economic variables it of interest that Financial Openness and Trade Openness both report positive and significant findings, Financial Openness when the U.S. Dollar scenario is considered, whilst Trade Openness is significant in both cases. This is supportive of studies such as Pretorious (2002), Dellas & Hess (2005), Beine & Candelon (2011) and Walti (2011). It may be the case that by considering integration with the global stock market, country effects come into play more. In contrast, when the integration across the specific real estate sectors was considered, we do not find significant results. In contrast though, neither monetary independence nor foreign exchange stability is significant in either currency scenario, although reported significant results in the context of real estate integration.

6: Concluding Comments

Whilst a large literature has developed considering the international diversification benefits available across listed real estate security markets, very little research work has been undertaken in considering what factors may play a role in the degree of integration present. This study has considered those factors that may contribute to integration both across real estate security markets and between them and the global stock market. The results highlight the importance of both financial and economic variables in the degree of integration present. In particular, the empirical analysis highlights the importance of considering how the respective domestic equity market contributes. This is in terms of its relationship with both the local real estate sector and the global stock market. However, not only do financial variables contribute. Macroeconomic and trade variables play an important role. Of the four such variables modeled, financial openness, monetary

independence, foreign exchange rate stability and trade openness each is significant in at least one of the specifications modeled. It is of interest that these findings do appear to vary depending on whether inter-real estate integration is considered or whether the relationship with the overall global equity market. Whilst the current work has highlighted the importance of economic and financial variables, the fact that real estate firms own fundamental assets, directly linked to underlying economic conditions, poses an interesting question for subsequent work. This is namely whether the results reported may be attributed to increased economic or increased financial integration ?

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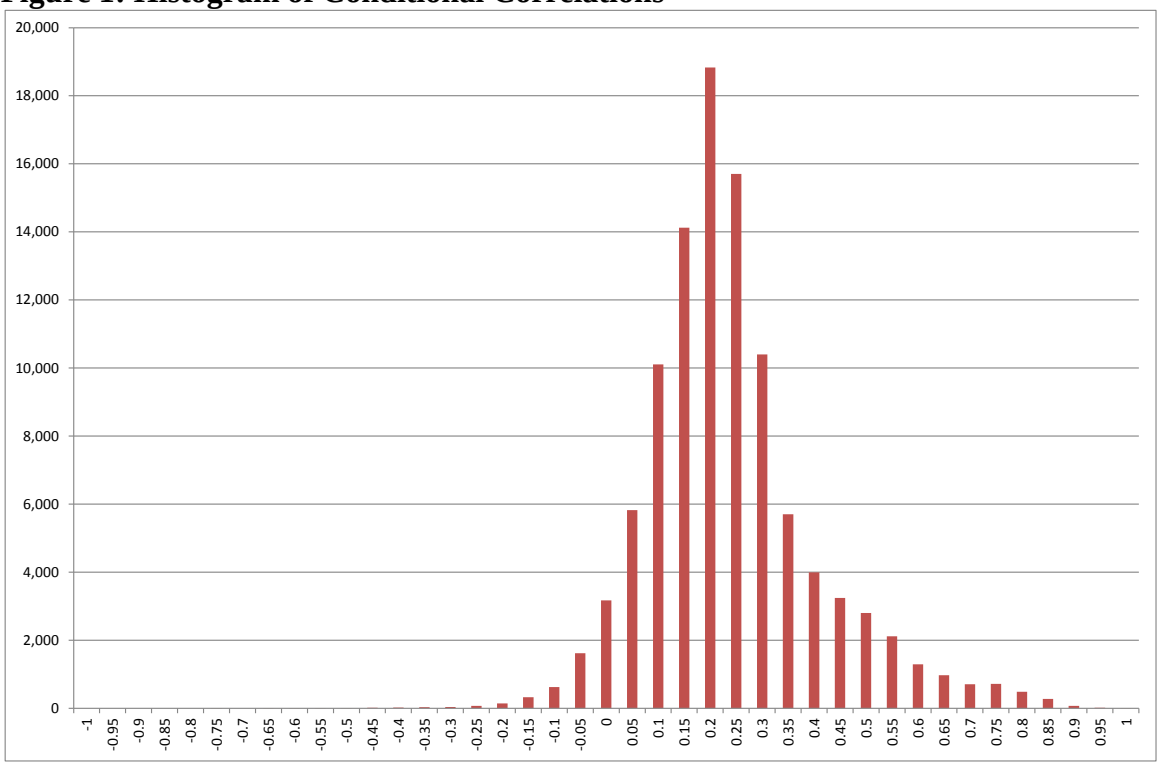
Tables & Figures

Table 1: Summary and Descriptive Statistics in Local Currency

	Sample	Mean	Median	Maximum	Minimum	Std. Dev	Skewess	Kurtosis
Panel A: Listed Real Estate								
Australia	03/01/73	0.1034%	0.1499%	17.5763%	-27.8995%	2.7415%	-0.9702	17.9533
Austria	16/10/91	0.0386%	0.0929%	29.2026%	-25.4279%	2.7220%	-0.1249	40.0393
Belgium	03/01/73	0.0737%	0.0000%	16.6569%	-16.2907%	2.4824%	-0.1093	8.6115
Canada	03/07/85	0.0807%	0.2856%	13.3682%	-26.5971%	2.7907%	-1.7529	16.3686
France	03/01/73	0.1040%	0.1467%	10.2395%	-13.0469%	2.1197%	-0.5735	7.5777
Germany	29/09/93	0.1322%	0.0000%	18.2055%	-29.5052%	3.8208%	-0.1066	9.1997
Hong Kong	03/01/73	0.1528%	0.2783%	29.8986%	-47.2555%	5.3954%	-0.6285	10.2129
Japan	03/01/73	0.0322%	-0.0646%	20.7957%	-28.2881%	3.6660%	0.0574	7.6991
Malaysia	08/01/86	0.1026%	0.0304%	41.8106%	-32.6566%	5.1142%	0.2759	12.0751
Singapore	03/01/73	0.0738%	-0.0620%	45.9115%	-51.2800%	4.6762%	-0.2654	18.3803
UK	03/01/73	0.0813%	0.1322%	26.5659%	-22.1202%	3.5170%	0.0110	10.1359
USA	03/01/73	0.1320%	0.2402%	25.5829%	-23.1359%	3.7581%	-0.2498	8.4924
Panel B: Equity Markets								
Australia	03/01/73	0.1316%	0.2026%	14.3631%	-35.0328%	2.6135%	-1.1739	20.8954
Austria	03/01/73	0.1035%	0.0835%	15.6060%	-19.5456%	2.4998%	-0.5201	11.6257
Belgium	03/01/73	0.1009%	0.1596%	15.7664%	-16.3574%	2.3734%	-0.5150	9.0568
Canada	03/01/73	0.1300%	0.2067%	10.3241%	-15.2568%	2.0982%	-0.6949	7.0865
France	03/01/73	0.1374%	0.2785%	14.5811%	-19.5069%	2.7638%	-0.6161	6.6807
Germany	03/01/73	0.0944%	0.2295%	12.8343%	-15.2654%	2.4214%	-0.8511	7.4862
Hong Kong	03/01/73	0.1700%	0.3687%	20.8633%	-36.7030%	4.1292%	-0.7343	8.8215
Japan	03/01/73	0.0469%	0.1483%	14.9209%	-20.1117%	2.5280%	-0.4501	7.3710
Malaysia	08/01/86	0.1674%	0.2762%	27.6192%	-32.3560%	3.4243%	-0.7243	16.8241
Singapore	03/01/73	0.0728%	0.0441%	22.8183%	-42.1794%	3.2707%	-1.1635	20.8371
UK	03/01/73	0.1410%	0.2708%	22.3165%	-17.4612%	2.5131%	-0.0397	10.3071
USA	03/01/73	0.1246%	0.2965%	9.9845%	-17.0590%	2.3151%	-0.6665	7.2456

Notes: Table 1 reports summary statistics for the twelve countries overall equity markets and real estate sectors. These statistics are based upon local currency denominated returns. The date shown provides the first date in the sample. For all countries the analysis ran from this date through to the end of 2010.

Figure 1: Histogram of Conditional Correlations



Notes: Figure 1 displays a histogram of the conditional correlations between the listed real estate sectors, estimated using the DCC model, in local currency terms.

Table 2: Listed Real Estate Integration

	Local Currency			US Dollars		
	Coefficient	**Standard Error**	**t-stat**	**Coefficient**	**Standard Error**	**t-stat**
Constant	-0.6845	0.1284	-5.3302***	-0.3018	0.1179	-2.5589**
Correlation with Domestic Equities	0.4223	0.0479	8.8129***	0.6841	0.0724	9.4509***
Correlation of Domestic and World Equities	0.3848	0.0429	8.9767***	0.1441	0.0578	2.4957**
Volatility of Listed Real Estate	0.0003	0.0014	0.2316	0.0020	0.0011	1.8481*
Relative Volatility of Listed Real Estate to Domestic Stocks	0.0075	0.0145	0.5170	0.0064	0.0169	0.3778
Listed Real Estate to Domestic Equity Market Capitalisation	0.7110	0.5058	1.4058	3.3847	0.3843	8.8081***
Domestic Equity to World Equity Market Capitalisation	1.1809	0.4550	2.5952**	1.3199	0.3999	3.3010***
Turnover of Listed Real Estate	0.0557	0.0323	1.7242*	0.1036	0.0323	3.2116***
Financial Openness	0.0445	0.0322	1.3834	-0.0077	0.0297	-0.2607
Monetary Independence	0.2365	0.0865	2.7338***	0.0280	0.0839	0.3343
FX Stability	0.1416	0.1447	0.9787	0.3194	0.1244	2.5685**
Trade Openness	-0.0002	0.0003	1.3834	0.0002	0.0002	-0.9472
Adjusted R-Squared	0.7480			0.8285		
F-Statistic	62.0746			106.8240***		

Notes: Table 2 reports the results from the panel model specified in Equation (4). The dependent variable is the average annual conditional correlation across the twelve real estate security markets. * indicates significance at a 10% level, ** at a 5% level and *** at a 1% level.

Table 3: Integration with World Stock Market

	Local Currency			US Dollars		
	Coefficient	**Standard Error**	**t-stat**	**Coefficient**	**Standard Error**	**t-stat**
Constant	-0.2136	0.0684	-3.1206***	-0.1453	0.0642	-2.2649**
Average Correlation with Listed Real Estate Markets	1.1706	0.0609	19.2369***	0.9660	0.0692	13.9532***
Correlation of Domestic and World Equities	0.1323	0.0273	4.8451***	0.2193	0.0248	8.8370***
Volatility of Listed Real Estate	0.0010	0.0007	1.3882	-0.00007	0.0006	-1.1723
Relative Volatility of Listed Real Estate to Domestic Stocks	0.0069	0.0077	0.9011	0.0002	0.0093	0.0171
Listed Real Estate to Domestic Equity Market Capitalisation	0.5197	0.2163	2.4024**	0.0205	0.2059	0.0996
Domestic Equity to World Equity Market Capitalisation	3.1911	0.2090	15.2652***	-0.8202	0.2294	-3.5750***
Turnover of Listed Real Estate	-0.0384	0.0172	-2.2254**	-0.0419	0.0176	-2.3864**
Financial Openness	-0.0064	0.0171	-0.3774	0.0393	0.0164	2.3959**
Monetary Independence	0.0041	0.0460	0.0900	-0.0645	0.0465	-1.3879
FX Stability	0.0511	0.0744	0.6870	0.1044	0.0674	1.5489
Trade Openness	0.0009	0.0001	6.5362***	0.0004	0.0001	3.1926***
Adjusted R-Squared	0.8418			0.7594		
F-Statistic	117.5618			70.1487		

Notes: Table 3 reports the results from the panel model specified in Equation (5). The dependent variable is the annual conditional correlation of the twelve real estate security markets with the global stock market. * indicates significance at a 10% level, ** at a 5% level and *** at a 1% level.

Endnotes:

[1] See, for example, King & Wadhwani, (1990), Lin et al. (1994), Erb et al. (1994), Longin & Solnik (1995, 2001), de Santis & Gerard (1997), Ang & Chen (2002), Baele (2005), Asness et al. (2011).

[2] Bekaert & Harvey (1995, 1997, 2000); Henry (2000a, 2000b); Kim & Singal (2000); Bae et al. (2004, 2006); Patro & Wald (2005); Bekaert et al., (2005); De La Torre et al. (2007).

[3] In a related area of the literature, research has illustrated the positive relationship between trade and correlations in the economic/business cycle (e.g. Frankel & Rose, 1998; Calderon et al., 2007; Otto et al., 2001; Bordo & Helbling, 2004).

[4] For a broader consideration of financial liberalization and its potential impact see papers such as Quinn & Inclan (1997).

[5] See also Pretorious (2002) who considers bilateral correlations across ten emerging markets during the 1995-2000 period. Significant coefficients were reported with respect to trade and industrial production growth differentials.

[6] See studies such as Chinn & Forbes (2004) for a broader consideration of trade intensity.

[7] Both Catao & Timmermann (2009) and Walti (2011) also note the importance of cultural linkages, such as common language and legal frameworks, in financial integration.

[8] e.g. Eichholtz (1996a, 1996b); Liu & Mei (1998); Stevenson (2000, 2001); Hoesli et al. (2004).

[9] Papers such as Chong et al. (2012) and Case et al. (2012) have similarly used the DCC approach in the estimation of conditional correlations in the specific context of REITs.

[10] Whilst not shown similar distributions are found when mainstream stocks are considered and when the conditional correlations are estimated in US Dollar terms.

[11] See Lee & Rui (2002) for a broader discussion concerning the relationship between returns and trading volume in an international context.

[12] Some papers have used de facto measures. Walti (2011), for example, uses a bilateral measure for each pairing. The measure is initially based on the sum of a country's total foreign assets and liabilities divided by its GDP, as suggested by Lane & Milesi-Ferretti, (2001, 2007). The bilateral measure is estimated as the log of the product of the ratios from the two countries. Papers such as Imbs (2006) take a broader consideration looking at factors such as creditor rights and corruption, whilst Lane & Milesi-Ferretti (2008) argue that cross-border capital flows and investment holdings are also influenced by factors such as geographic distance and common language.