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# The Impact of Futures Trading on the Linkages between Listed Real Estate and Direct Real Estate: International Evidence

December
2019

## EXECUTIVE SUMMARY

Given the increasing popularity of listed real estate futures in Europe and internationally, a specific study of the impact of European and international real estate futures is a compelling topic for research. Specifically, the listed real estate futures markets in the United States (US), Australia, Europe and Japan have a combined trading volume of €17 billion in 2018 with a growth rate of 112%, 53%, 18% and 68% respectively, compared to the previous year. Therefore, a study of listed real estate futures allows us to have a greater understanding how this innovative trading vehicle affects the listed property market. It also enables more informed and practical policy and investment decision-making regarding the role of real estate futures in the property market.

This report examines the impact of futures trading on the volatility linkages between listed real estate and direct real estate. The total returns of real estate stocks in Australia, Japan, the United States, the FTSE EPRA Nareit Developed Europe index and the FTSE EPRA Nareit Eurozone index over January 1990 to March 2019 were assessed with a number of empirical tests (i.e. GARCH, Spline-GARCH and Panel Analysis).

**There are three main findings:**

1) **The inception of listed real estate futures, in general, does improve the market efficiency of listed real estate market.**

It appears that the launch of listed real estate futures, in general, has improved the quality of information flowing to the listed real estate markets. The only exception is the Japanese listed real estate futures market. Specifically, the results suggest that futures markets, in general, improve liquidity and market depth; thereby the volatility of listed real estate can be reduced. As such, the inception of listed real estate futures, in general, does improve the market efficiency of listed real estate market.

2) **The launch of listed real estate futures leads to an enhanced volatility linkage between listed real estate and macroeconomic risk.**

A stronger volatility linkage between listed real estate and market fundamentals has been observed after the introduction of listed real estate futures markets. This can be attributed to the fact that listed real estate futures markets reduce market noise in the underlying listed real estate market by allowing investors to hedge and speculate in the futures markets instead of spot markets, reducing therefore their reliance on spot (listed real estate) market. Consequently, this allows the listed real estate sector to better reflect market fundamentals.

3) **The onset of listed real estate futures leads to a stronger volatility linkage between listed and direct real estate.**

We also documented an enhanced low-frequency volatility linkage between listed and direct real estate after the introduction of listed real estate futures markets. This suggests that listed real estate could behave more like direct property since listed real estate futures contracts being established. Given the listed real estate futures market allows the listed real estate sector to reflect market fundamentals more

effectively, it is reasonable to find that a stronger volatility linkage between listed and direct real estate. This also supports the finding of a recent EPRA study in which the risk profiles of privately and publicly traded real estate that are based on similar direct assets are alike (Hoesli and Oikarinen, 2014).

## Implications

1) Policy makers should encourage the development of listed real estate futures.
2) Listed real estate futures facilitate real estate investors' hedging strategy.
3) Real estate investors, particularly REIT investors can gain direct property exposure effectively via listed real estate as the onset of futures markets did reduce the volatility of listed real estate.

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## Introduction

To provide an alternative means of gaining exposure to the listed real estate sector and enhance the liquidity of listed real estate, a futures contract specifically written on listed real estate, an innovative trading vehicle, was established. This relatively new trading vehicle is known as listed real estate futures. The world's first listed real estate index futures market was launched in 2002 with the establishment of Australian-REITs index futures by the Australian Securities Exchange. After that, similar products were launched in a few of developed listed property markets (i.e. US listed real estate futures in 2007, FTSE EPRA Nareit Developed Europe futures and FTSE EPRA Nareit Eurozone futures indices in October 2007 and J-REIT futures in 2008). Importantly, the European listed real estate index futures sector has received increasing attention from institutional investors since its inception. After the initial establishment period in 2007-2008, the trading volume of the Europe index futures contracts has grown significantly from €81.7 million to €2.51 billion in 2018 (Thomson Reuter, 2019).

Internationally, there are several more successful listed real estate futures markets. For instance, the trading volume of the US and Australian listed real estate futures markets were €10.28 billion and €3.3 billion, respectively in 2018 (Thomson Reuter, 2019). The trading volume of both markets are 4.1 times and 1.3 times larger than the European market. In 2018, J-REIT futures also recorded a significant trading volume with €831.2 million, reflecting an increase of 68% compared with previous year. This clearly reflects the importance of listed real estate futures as an important risk management and investment tool for institutional investors. The impact of listed real estate futures trading on the listed real estate market therefore attracted a considerable degree of attention in recent years from investors, policy makers and academics. Table 1 shows a summary of each futures market, including the underlying indices.

**Table 1: Summary of Listed Real Estate Futures Markets**

| Futures | Inception Year | Turnover in 2018 (in € million) | Underlying Index |
|---|---|---|---|
| FTSE EPRA Nareit Developed Europe Index Futures | Oct 2007 | 2,511 | FTSE EPRA Nareit Developed Europe Index |
| FTSE EPRA Nareit Eurozone Index Futures | Oct 2007 | 8 | FTSE EPRA Nareit Eurozone Index |
| Dow Jones U.S. Real Estate Index Futures | Feb 2007 | 10,281 | Dow Jones U.S. Real Estate Index |
| Tokyo Stock Exchange REIT Index Futures | June 2008 | 831 | Tokyo Stock Exchange REIT Index |
| S&P/ASX 200 A-REIT Index Futures | Sep 2002 | 3,333 | S&P/ASX 200 A-REIT Index |

Sources: ASX (2019), FTSE (2019), TSE(2019), CBT (2019)

In comparison to the relatively large number of papers to have considered the mainstream stock futures markets, listed real estate index futures is fairly under-researched due to its short history. A number of studies have previously examined the hedging effectiveness of listed real estate futures. The results

have indicated that listed real estate futures are an effective risk management tool for investors in protecting the value of their listed real estate portfolios (Lee and Lee, 2012; Lee et al., 2014; Zhou, 2016). Further, Lee et al. (2014) find that the introduction of a futures market has improved the speed and quality of information flowing to the European listed real estate market. More specifically, they find evidence to suggest that the European listed real estate futures market has improved market depth of listed real estate market and has an underlying stabilising influence. The price discovery mechanism between listed real estate index futures and spot markets has also been examined by Shi and Xu (2013) and Zhou (2017). The studies suggest that the listed real estate market leads its futures market. Interestingly, Clements et al. (2017) also find that lumber futures contracts contain information for Timber REITs in the US. Recently, Lee et al. (2016) expand upon these findings and observe that the role of A-REITs futures market in the price formation process is related investor structure. Importantly, they find that the REIT futures market is attractive to speculators in response to a surge in demand for risk-sharing offered by hedgers. In other words, index futures can be used as a speculative asset (Zhou, 2016), thereby a futures market can facilitate investors' hedging and speculation strategies in that offer opportunities for investors, reducing their reliance on spot (i.e. listed real estate) market (Mckenzie, 2001). As such, the volatility of listed real estate is mitigated when the background level of futures activity is high. The finding is in line with the finding of the broader stock and futures markets (Bohl, et al., 2011). Given listed real estate has been argued to embed stock market noise that is not related to market fundamentals (Hoesli and Oikarinen, 2012), the mitigated volatility of real estate securities could make the listed real estate sector to reflect market fundamentals more effectively; thereby listed real estate could behave more like direct property.

A large number of studies have examined the interlinkages among listed real estate, direct property and general stocks. The results have frequently observed that the interlinkage is time-varying and dependent on the time period examined. Early studies such as Li and Wang (1995), Liu et al. (1990) and Mei and Lee (1994) report a strong correlation between REITs and the general stock market. Ling and Naranjo (1999) find that REITs are integrated with stocks, but segmented from direct property. Glascock et al. (2000) also find that US REITs behave more like general stocks instead of direct real estate since 1992. However, Clayton and Mackinnon (2003) show contrasting evidence in which equity REITs become increasingly sensitive to the performance of underlying real estate. Comparable evidence is found by Li et al. (2009), Oikarinen et al. (2011) and Ling and Naranjo (2015). Lee et al. (2008) attribute the results to the involvement of sophisticated investors in the REITs market since 1993. Oikarinen, Hoesli and Serrano (2011) investigated the dynamic relations between REITs and direct real estate, focusing on a long term cointegration. The results find that the two total return indices are cointegrated in the long term and there is a 'real estate factor' affecting their performance. Hence direct real estate returns can be predicted by analysing REIT returns.

As such, REITs, particularly large cap REITs behave more like direct real estate since 1993. Hoesli and Oikarinen (2012), using the US, UK and Australia data, find that REITs are much more closely related to direct real estate than to the general stock market, reinforcing their previous findings of the close relationship between REITs and direct real estate returns. Similar results are also documented by Serrano and Hoesli (2010) and Yunus et al. (2012) based on international data. However, Hoesli and Oikarinen (2012) were not able to find a similar result in Australia with sector level data. They also argue that the importance of sector level analysis on the return dynamic. The authors acknowledge that the outcome may vary across countries. Hoesli, Oikarinen and Serrano (2015) examined again whether REIT (public real estate) returns lead direct real estate returns, using REITs and TBI (private) sector data in the US, and bolstered their previous findings, suggesting a clear existence of lead-lag relationship between REITs and direct real estate but also concede that sector level data is very important for

analysing return dynamics across different asset classes. Another study done by Hoesli and Oikarinen (2016) have similar outcomes with two more UK sectors (retail and office) were added to the analysis. The aforementioned studies have however, focused on interlinkages among listed real estate, direct real estate and stocks in the return series' involved. Few studies have been undertaken on volatility interlinkages among these assets despite the fact that the volatility series of an asset does contain critical information. As discussed by Cotter and Stevenson (2006), the relationship in volatility has been more intuitive. The volatility interlinkages among listed real estate and general stocks have received very little attention in the literature, three notable exceptions being Cotter and Stevenson (2006), Yang et al. (2012) and Hoesli and Reka (2013).

To sum up, it seems clear that there is a strong long-term relationship between REITs and direct real estate that is meaningfully stronger than the short-term linkage between REITs and stock market. However, to the best of our knowledge, no study examines the linkage between real estate stocks and direct real estate from a volatility perspective. In addition, little attention has been placed to consider the impact of listed real estate futures on the interlinkages between real estate securities and direct property. Specifically, virtually, to the best of our knowledge, no study examines whether futures trading did reduce market noise of real estate stocks, enhancing therefore the linkages between real estate stocks and market fundamentals, as well as direct real estate.

## Research Questions and Contributions

The purpose of this study is to investigate the impact of listed real estate futures on the interlinkages between listed real estate and direct real estate with an international dataset including the US, Australia, Japan and Europe. Specifically, this study examines the following questions:

(1) Does the inception of listed real estate futures improve the market efficiency of listed real estate sector?
(2) Does a stronger association between listed real estate and market fundamentals being observed after the introduction of listed real estate futures?
(3) Does the launch of futures markets lead to a stronger volatility linkage between listed and direct real estate?

By answering these questions, this study offers contributions to the following areas. First, we extend the limited studies on the interlinkages among real estate securities, direct property and general stocks with considering the impact of listed real estate futures for the first time. To the best of our knowledge, the study is the first study that explores explicitly the impact of listed real estate futures on the interlinkages among listed real estate, direct property and general stocks. As highlighted by Lee et al. (2016) and Zhu (2016), index futures could be used as a speculative asset that will be appealing for speculators and hedgers. As such, the launch of an index futures offers a new trading platform for investors to gain or reduce their exposure in the listed real estate market. Consequently, it could reduce market noise of listed real estate, and allow listed real estate to better reflect market fundamentals, thereby it behaves more like direct real estate. However, no study has been placed on this area before.

Second, this study is the first to explicitly examine the long-term volatility linkages between listed real estate and direct property. This offers some empirical evidence from the long-term volatility perspective to the ongoing debate of whether securitised real estate behaves more like common stocks

or direct property. Thirdly, this is one of the first pieces of research to examine whether property futures offer an alternative means for speculative investments. The findings will assist policy makers to make an informed policy regarding the importance of real estate futures in enhancing the market efficiency of listed real estate sectors.

## Methodological Framework

This research project will involve 2 stages. **Stage 1** consists of the analysis of listed property futures, whilst **Stage 2** examines the impact of futures trading on the linkages of direct property and listed real estate.

### Stage 1

A standard way of answering the question whether the introduction of a futures market does improve the information flow of a real estate market is to consider volatility modelling. Following Lee et al. (2014), the **Bessembinder and Seguin (1992) model** was utilised. Specifically, an Autoregressive Integrated Moving Average (ARIMA) model is employed to decompose trading volume and open interest in the futures contracts into expected and unexpected components. Following Gulen and Mayhew (2000) and Lee et al. (2014), a negative link between expected volume and open interest and volatility are expected, indicating that futures markets improve liquidity and market depth; thereby the volatility of listed real estate can be reduced. It should be noted that expected volume and expected open interest are of interest variables that should be discussed in line with the effectiveness of futures trading in enhancing the market efficiency of the listed real estate markets.

Thereafter, a GARCH model was used to examine whether expected volume and open interest of real estate futures do reduce the volatility of listed real estate. If futures trading offers an alternative means of exposure to listed real estate for speculative activities, a higher reduction of volatility of listed real estate is expected as futures markets have been argued more attractive to speculators (Lee et al., 2016; Zhou, 2016). This is expected to offer an enhanced understanding of the impacts of real estate futures on real estate securities.

### Stage 2

The **second component** of the empirical analysis considers whether listed real estate behaves more like direct property after the introduction to real estate futures in a high-frequency setting, particularly Cotter and Stevenson (2006) indicate that the results with high-frequency data in volatility modelling have been more intuitive. To assess this, **a spline-GARCH model is employed to extract low-frequency volatility** that is plausibly caused by macroeconomic variables. The Spline-GARCH model developed by Engle and Rangle (2008). Engle and Rangel (2008) argue that the low-frequency volatility component describes permanent and/or slow-moving patterns of volatility (e.g. macroeconomic risk) more accurately. Engle and Rangel's (2008) Spline-GARCH model can be represented as follows:

$$r_t - E_{t-1}r_t = \sqrt{h_t}\varepsilon_t = \sqrt{\tau_t}\, g_t \varepsilon_t \text{, where } \varepsilon_t | \phi_{t-1} \sim N(0,1) \quad (1)$$

$$g_t = (1-\alpha-\beta) + \alpha\left(\frac{(r_{t-1} - E_{t-2}r_{t-1})^2}{\tau_{t-1}}\right) + \beta g_{t-1} \quad (2)$$

$$\tau_t = c\exp\left(\omega_0 t + \sum_{i=1}^{k}\omega_i((t - t_{i-1}) +)^2\right) \quad (3)$$

where $\varepsilon_t$ denotes the innovation term at time $t$, $E_{t-1}(r_t)$ represents the expectation in which it is conditional on an information set ($\phi_t$), $g_t$ characterises the high-frequency conditional volatility, $\alpha$ represents the ARCH term, $\beta$ reveals the GARCH term, $\tau_t$ is the variable of interest, which is the low-frequency component of the conditional volatility. As discussed by Engle and Rangel (2008), $\tau_t$ can be estimated as a direct function of macroeconomic risk.

Following Liow and Yang (2005) and Lee et al. (2018), several macroeconomic risk proxies (i.e. interest rate volatility, inflation volatility, GDP volatility, money supply volatility and foreign exchange volatility). **These risk proxies are estimated with the absolute values of the residuals of an autoregressive (AR (1))**. As the macroeconomic variables are only sampled at a quarterly frequency, direct modelling with high-frequency (daily) data is not feasible. Therefore, for each securitised real estate market, we convert the daily low-frequency volatility series into an annual low-frequency volatility time series with following Engle and Rangle (2008) and Lee et al. (2014). The empirical setting, which models the low-frequency volatility as a function of macroeconomic and direct property volatility.

$$Lowvol_{i,t} = c_0 + \gamma_1 IRVol_{i,t} + \gamma_2 GDPVol_{i,t} + \gamma_3 MSVol_{i,t} + +\gamma_4 FXVol_{i,t} + \mu_{i,t} \quad (4)$$

As discussed earlier, the linkages between listed real estate and macroeconomic risk proxies, including direct real estate are analysed into two periods (i.e. pre and post futures). If the market efficiency of listed real estate sector has been improved, we conjecture that there should be a strong link between listed real estate and direct real estate in the post futures period, whilst no comparable evidence in the pre futures period.

Given the EPRA index futures is the Pan-Eurozone futures contracts, we also included individual European markets in the panel analysis in response to the unavailability data representing the underlying futures market. In short, we include 8 markets in our empirical setting (namely Australia, Japan, the US, and 5 developed European markets including the UK, France, Germany, the Netherlands and Sweden). Two main reasons motivate this choice of individual European markets. First, these are the largest listed real estate markets in Europe and the world (See Table 2). Second, these European markets are consistent with the components of MSCI/IPD Pan-Europe Index; thereby the corresponding direct property indices are available.

**Table 2: Country Breakdown of FTSE/EPRA/NAREIT Developed Europe Index**

| Country | No. of Companies | Net Market Cap (€m) | Weight % |
|---|---|---|---|
| Germany | 13 | 57,819 | 27.62 |
| UK | 41 | 55,725 | 26.62 |
| Netherlands | 5 | 21,773 | 10.40 |
| Sweden | 15 | 20,059 | 9.58 |
| France | 6 | 18,359 | 8.77 |
| Switzerland | 5 | 12,199 | 5.83 |
| Belgium | 11 | 9,765 | 4.67 |
| Spain | 3 | 6,557 | 3.13 |
| Ireland | 3 | 2,286 | 1.09 |
| Austria | 1 | 1,905 | 0.91 |
| Finland | 2 | 1,322 | 0.63 |
| Norway | 1 | 1,271 | 0.61 |
| Italy | 1 | 262 | 0.13 |
| Total | 107 | 209,301 | 100.00 |

Source: FTSE Russell as at 31 December 2018

## Data

This study utilises the daily series outlined below to measure the performance of international listed real estate markets. The principal data sets to be used will be the FTSE EPRA Nareit listed real estate total return indices over January 1990 - March 2019; to be made available by EPRA. Firstly, this study examines the FTSE EPRA Nareit Developed Europe index. The closing prices, volume and open interest of the corresponding index futures that is the FTSE EPRA Nareit Developed Europe index futures are collected from Thomson Reuters Eikon. The performance of direct real estate in Europe is gauged with the MSIC IPD Pan-Europe Index. The data is obtained from MSIC/IPD. A variety of macroeconomic variables are also considered in the analysis. These variables include GDP, interest rate, M2 money supply and exchange rates. All datasets are obtained from Thomson Reuters Eikon. Corresponding international datasets for Australia, Japan and the US are also downloaded from EPRA, MSIC/IPD (i.e. Property Council /IPD Australia All Property Index, IPD Japan Monthly Property Index, US NCREIF Property Index).

Given the direct property indices are valuation-based indices, valuation-smoothing in the direct property series should be corrected. **To account for valuation-smoothing** in this direct property series, de-smoothing of the direct property series was done using **the standard Geltner (1993) procedure** with a one-year lag structure.

**Table 3: Variables used in the analyses**

| MARKETS | LISTED REAL ESTATE | DIRECT PROPERTY | FUTURES |
|---|---|---|---|
| AUSTRALIA | S&P/ASX 200 A-REIT - TOT RETURN IND* | MSIC/IPD AUSTRALIA TOTAL RETURN INDEX*** | ASX-S&P/ASX 200 A-REIT FUTURES* |
| US (REAL ESTATE) | DJGL UNITED STATES REAL ESTATE $ - TOT RETURN IND* | MSIC/IPD US TOTAL RETURN INDEX*** | CBT-DJ REAL ESTATE INDEX FUTURES* |
| JAPAN | TSE REIT INDEX - TOT RETURN IND* | MSIC/IPD JAPAN TOTAL RETURN INDEX** | TSE-REIT INDEX FUTURES* |
| EUROPE | FTSE EPRA Nareit DEV EUROPE - TOT RETURN IND* | MSIC/IPD PAN-EUROPE TOTAL RETURN INDEX***** | MATIF- FTSE EPRA Nareit EUROPE FUTURES* |
| EUROZONE | FTSE EPRA Nareit EZONE E - TOT RETURN IND* | MSIC/IPD EURO-ZONE TOTAL RETURN INDEX***** | MATIF- FTSE EPRA Nareit EUR ZONE FUTURES* |
| UK | FTSE EPRA Nareit UK - TOT RETURN IND* | MSIC/IPD UK TOTAL RETURN INDEX** | N/A |
| FRANCE | FTSE EPRA Nareit FRANCE - TOT RETURN IND* | MSIC/IPD FRANCE TOTAL RETURN INDEX**** | N/A |
| GERMANY | FTSE EPRA Nareit GERMANY - TOT RETURN IND* | MSIC/IPD GERMANY TOTAL RETURN INDEX***** | N/A |
| NETHERLANDS | FTSE EPRA Nareit NETHERLANDS - TOT RETURN IND* | MSIC/IPD NETHERLANDS TOTAL RETURN INDEX***** | N/A |
| SWEDEN | FTSE EPRA Nareit SWEDEVN - TOT RETURN IND* | MSIC/IPD SWEDEN TOTAL RETURN INDEX***** | N/A |

Note: * Daily / **Monthly / *** Quarterly / **** Semi-annually / ***** Annually, Quarterly interest rate, GDP, Money Supply, and Exchange rate for each country are also collected.

# Results

## Stage 1: Listed Real Estate Futures Trading Activity and the Efficiency of Listed Real Estate

The first section reports the results from a standard GARCH model. It examines how the onset of listed real estate futures has improved the flow of information in real estate equities. Specifically, it examines the relationship between the volatility of the underlying index (i.e. listed real estate) and the level of futures-trading activity, as proxied by both expected trading volume and open interest.

### Australia

The results of Australian-REIT futures are reported in Table 4. Firstly, we examine the variables of interest of this study (i.e. expected volume and expected open interest). As hypothesised that the coefficient of expected volume of A-REIT futures is negative and statistically significant at 1%, indicating that higher expected futures trading provides extra price expectation information; thereby a reduction in the volatility of listed real estate prices is found. Comparable results are found by Bessembinder and Seguin (1992) and Watanabe (2001) in the broader stock futures markets and Lee et al. (2014) in the listed real estate futures market. Further, a negative and strong link between expected open interest and the volatility of listed real estate (spot market) is documented, reflecting that the A-REIT futures market improves liquidity provision and depth in the underlying spot market, and thus have an underlying stabilising effect. As discussed by Bessembinder and Seguin (1992), market depth can be proxied by the expected open interest component in which it measures the amount of capital or the number of traders dedicated to a futures market at the beginning of a trading session. Thus, the documented strong negative link suggests an improvement of market depth. The findings are in line with the assertion of Gulen and Mayhew (2000) in that futures markets should have an underlying stabilising effect.

On the other hand, a positive and statistically significant relation between unexpected volume and the volatility of listed real estate is documented. This is intuitively appealing as exogenous volatility events cause higher trading volume. According to Bessembinder and Seguin (1992), the unexpected component, unlike the expected component that reflects the predictable level of futures trading, can be interpreted as information shocks. Importantly, information shocks are expected to move prices and generate trading in both markets (spot and futures) (Lee et al., 2014). As such, a positive coefficient is expected. Given the unexpected component capture trading activity stimulated by unexpected price changes, it is reasonable to document a positive relationship, after the futures have been launched, between the unexpected level of futures trading and the volatility of the underlying index (Gulen and Mayhew, 2000).

Similarly, a positive and statistically significant coefficient of unexpected open interest is also evident. The positive link between unexpected open interest and the volatility of listed real estate can also be explained in a similar fashion as the unexpected component of open interest is viewed as information shocks. Importantly, information shocks would move prices; thereby a higher volatility is expected. With respect to the magnitudes of the coefficients, we found like Bessembinder and Seguin (1992) and Gulen and Mayhew (2000) for general stock futures, are relatively small, reflecting that the economic significance of futures trading is weak, despite it being a significant variable.

Overall, the results suggest that the A-REIT futures market improves liquidity and market depth; thereby the volatility of listed real estate prices can be reduced. This not only implies futures trading have implications in terms of information flows of listed real estate, but it may also have an underlying stabilising role.

| **Table 4:** Volatility and expected & unexpected futures trading activity: Australia | |
|---|---|
| Panel A: Mean Equation | |
| Constant | 0.000 (0.726) |
| Lag Return (-1) | 0.032 (1.101) |
| Lag Return (-2) | -0.042 (-1.543) |
| Panel B: Variance Equation | |
| Constant ($\alpha_0$) | 0.000 (10.333)*** |
| ARCH ($\alpha_1$) | 0.150 (8.272)*** |
| GARCH ($\alpha_2$) | 0.600 (28.971)*** |
| Expected Volume | $-5.31 \times 10^{-8}$ (-1677.327)*** |
| Unexpected Volume | $1.70 \times 10^{-8}$ (6.354)*** |
| Expected Open Interest | $-1.34 \times 10^{-9}$ (-7.241)*** |
| Unexpected Open Interest | $1.34 \times 10^{-9}$ (2.143)** |
| Monday | $-3.68 \times 10^{-6}$ (-0.174) |
| Tuesday | $-9.04 \times 10^{-6}$ (-0.541) |
| Wednesday | $-9.22 \times 10^{-6}$ (-0.397) |
| Thursday | $-8.06 \times 10^{-6}$ (-0.419) |

Notes: This table reports estimated coefficients from a GARCH model with expected and unexpected futures-trading activity. Figures in parentheses in Panels A and B are the Bollerslev-Wooldridge robust standard errors. *, **, *** denotes significance at the 10%, 5% and 1% level respectively.

## Europe

Table 5 presents the results of the FTSE EPRA Nareit Developed Europe Index futures. The results are fairly consistent with the Australian futures market. The coefficient of expected volume is negative and statistically significant at 1%. This asserts higher futures trading volume does enhance the rate of information flow and reduce the volatility of the underlying market (i.e. the FTSE EPRA Nareit Developed Europe index). Further, a inverse link between expected open interest and the volatility of listed real estate (spot market) is also observed. The coefficient of expected open interest is negative and statistically significant at 1%, reflecting that the onset of listed real estate futures markets does improve the market depth. In other words, an underlying stabilising role of futures trading is evident, and futures trading did reduce the volatility of listed real estate sector in Europe.

Positive relations between the volatility of listed real estate and unexpected volume and unexpected open interest are also evident, although the unexpected open interest is not statistically significant. Results here indicate that information shocks are expected to move prices and generate trading in both markets (spot and futures). Interestingly, the results also suggest that the Pan European nature of the FTSE EPRA Nareit futures index, that is not centred on domestic indices (e.g. Australia), offers

comparable results to the domestic indices (e.g. Australia and the US). The insignificant coefficient with respect to unexpected open interest suggests that the unexpected component of open interest has little impact on spot price volatility in the European market. Comparable results are also documented by Bessembinder and Seguin (1992) and Lee et al. (2014). Again, the findings of this study with a larger dataset are consistent with the preliminary results of Lee et al. (2014), confirming the role of futures trading in enhancing the market efficiency of listed real estate sector in Europe.

Overall, the results suggest that the FTSE EPRA Nareit Developed Europe index futures does reduce the volatility of listed real estate prices and enhance the market depth of listed real estate in Europe with respect to the negative and significant coefficients of expected volume and expected open interest.

| **Table 5.** Volatility and expected & unexpected future trading activity: Developed Europe | |
|---|---|
| Panel A: Mean Equation | |
| Constant | 0.000 (0.983) |
| Lag Return (-1) | 0.081 (2.151)** |
| Lag Return (-2) | -0.059 (-1.670)* |
| Panel B: Variance Equation | |
| Constant ($\alpha_0$) | $6.86\times10^{-5}$ (4.227)*** |
| ARCH ($\alpha_1$) | 0.150 (4.628)*** |
| GARCH ($\alpha_2$) | 0.600 (8.278)*** |
| Expected Volume | $-9.62\times10^{-9}$ (-4.291)*** |
| Unexpected Volume | $7.76\times10^{-9}$ (2.333)** |
| Expected Open Interest | $-2.78\times10^{-9}$ (-3.196)*** |
| Unexpected Open Interest | $1.11\times10^{-9}$ (0.358) |
| Monday | $-1.03\times10^{-5}$ (-0.753) |
| Tuesday | $-1.01\times10^{-5}$ (-0.669) |
| Wednesday | $-7.45\times10^{-6}$ (-0.512) |
| Thursday | $-2.27\times10^{-6}$ (-0.129) |

Notes: This table reports estimated coefficients from a GARCH model with expected and unexpected futures-trading activity. Figures in parentheses in Panels A and B are the Bollerslev-Wooldridge robust standard errors. *, **, *** denotes significance at the 10%, 5% and 1% level respectively.

## Eurozone

The results of the FTSE EPRA Nareit Eurozone index futures are reported in Table 6. The coefficient of expected volume is negative and statistically significant at 1%, suggesting that futures trading does enhance the rate of information flow and reduce the volatility of the underlying market (i.e. the FTSE EPRA Nareit Eurozone index). Further, the expected component of open interest and the volatility of listed real estate (spot market) is negatively and statistically significant associated. The results are in line with the finding of Lee et al. (2014). In other words, these results very closely correspond to those reported in our earlier sections (e.g. Australia and the FTSE EPRA Nareit Developed Europe index); suggesting that the futures trading does have some stabilising influence.

Turning our attention to the unexpected components of volume and open interest. Both components are not statistically significant, indicating that the unexpected components of open interest and volume play a minor role on spot price volatility. Importantly, the insignificance of both variables can be attributed to the low trading volume and open interest for the index. The reduced volume and open interest also imply reduced market depth and information flows in comparison to the other listed real estate futures markets (e.g. Australia and the Europe wide index) (Lee et al., 2014). The results are consistent with the finding of Gulen and Mayhew (2000) in which variations across countries are found from international stock index futures trading. This also highlights the importance of international evidence.

Overall, a reduction of the volatility of listed real estate prices have been observed in line with the expected components of trading volume and open interest of the FTSE EPRA Nareit Eurozone index futures. This suggests that trading of the futures does improve the information flow and reduce the volatility of listed real estate. However, no evidence is found to suggest that the unexpected components of the Eurozone futures trading have an impact on spot prices.

| **Table 6:** Volatility and expected & unexpected futures trading activity: EuroZone | |
|---|---|
| Panel A: Mean Equation | |
| Constant | $5.76\times10^{-5}$ (0.147) |
| Lag Return | 0.073 (2.855)*** |
| Panel B: Variance Equation | |
| Constant | 0.000 (5.821) *** |
| ARCH | 0.133 (6.511)*** |
| GARCH (1) | 0.533 (3.675) *** |
| GARCH (2) | 0.044 (0.390) |
| Expected Volume | $-1.39\times10^{-7}$ (-3.628) *** |
| Unexpected Volume | $6.67\times10^{-8}$ (1.098) |
| Expected Open Interest | $-1.43\times10^{-8}$ (-111.227) *** |
| Unexpected Open Interest | $-1.64\times10^{-9}$ (0.750) |
| Monday | $-8.85\times10^{-5}$ (-1.938) * |
| Tuesday | -0.000 (-4.235) *** |
| Wednesday | $-7.84\times10^{-5}$ (-2.332) ** |
| Thursday | -0.000 (-4.100)*** |

Notes: This table reports estimated coefficients from a GARCH model with expected and unexpected futures-trading activity. Figures in parentheses in Panels A and B are the Bollerslev-Wooldridge robust standard errors. *, **, *** denotes significance at the 10%, 5% and 1% level respectively.

## Japan

The results of the Japanese REITs futures are reported in Table 7. The expected volume is negatively related to the Japanese listed real estate market, suggesting that listed real estate futures trading does reduce the volatility of listed real estate market in Japan, but it does not do so to a statistically significant extent. This means that the expected volume has little impact on spot price volatility. In addition, no evidence is available to support that the unexpected components of open interest and

volume have a profound implication on the underlying spot market with respect to the insignificant coefficients. This can be attributed to the low trading volume of this futures index. It should be noted that the Japanese REIT futures market is relatively small compared with other country-specified indices (e.g. A-REITs and US-REITs). For instance, the total trading volume of J-REIT futures in 2018 was around €800million compared with A-REIT futures (around €3.3 billion) and the US market (around €10 billion). Further, the trading volume of J-REIT futures is negligible compared to the Japanese listed real estate market size of almost €200 billion. Therefore, it is not surprising to find that J-REIT futures play a marginal role. However, the coefficient of expected open interest is negative and statistically significant at 1%, indicating that the establishment of futures trading does improve liquidity provision and depth in the underlying spot market.

Overall, unlike other futures markets, the results suggest that little evidence is available to support the notion of J-REIT futures does reduce the volatility of listed real estate prices in Japan. The low trading volume could be a plausible explanation for it, although the increasing popularity of listed real estate futures in Japan has been evidence in recent years.

| **Table 7.** Volatility and expected & unexpected future trading activity: Japan | |
|---|---|
| Panel A: Mean Equation | |
| Constant ($\alpha_0$) | 0.000 (1.106) |
| Lag Return ($\alpha_1$) | 0.005 (0.116) |
| Lag Return ($\alpha_2$) | 0.005 (0.132) |
| Lag Return ($\alpha_3$) | 0.005 (0.132) |
| Panel B: Variance Equation | |
| Constant ($\alpha_0$) | $5.00\times10^{-5}$ (4.386)*** |
| ARCH ($\alpha_1$) | 0.133 (3.811)*** |
| GARCH ($\alpha_2$) | 0.533 (2.510)*** |
| GARCH ($\alpha_3$) | 0.044 (0.283) |
| Expected Volume | $-8.52\times10^{-9}$ (-0.836) |
| Unexpected Volume | $1.36\times10^{-9}$ (0.020) |
| Expected Open Interest | $-8.10\times10^{-9}$ (-118.905)*** |
| Unexpected Open Interest | $1.31\times10^{-9}$ (0.0192) |
| Monday | $-2.63\times10^{-5}$ (-1.861)* |
| Tuesday | $-2.28\times10^{-5}$ (-1.848)* |
| Wednesday | $-1.76\times10^{-5}$ (-1.131) |
| Thursday | $-3.01\times10^{-5}$ (-1.943)* |

Notes: This table reports estimated coefficients from a GARCH model with expected and unexpected futures-trading activity. Figures in parentheses in Panels A and B are the Bollerslev-Wooldridge robust standard errors. *, **, *** denotes significance at the 10%, 5% and 1% level respectively.

## US

The results of US listed real estate futures are reported in Table 8. The coefficient of expected volume of US listed real estate futures is negative and statistically significant at 5%. This confirms that the US listed real estate futures market does enhance the information flows and reduce the spot volatility. Additionally, a strong negative link between expected open interest and the volatility of listed real estate (spot market) is also evident from Table 8 (statistically significant at 1% level), reflecting that the US listed real estate futures market improves market depth and the market efficiency of listed real estate market. As such an underlying stabilising effect is found. The results are consistent with the finding of Bessembinder and Seguin (1992) from the general stock and the preliminary finding of Lee et al. (2014) from the European listed real estate futures market.

A weak relation between the volatility of listed real estate and the unexpected components is also documented with respect to the coefficients for both components are statistically insignificant. This suggests that the unexpected components of open interest and volume have little impact on spot price volatility in the European market. The results are consistent the finding of Bessembinder and Seguin (1992) and Lee et al. (2014). Although US listed real estate futures index is the most active futures market, it did not receive considerable degree of attention from US real estate investors during its initial establishment period (2007-2013). A surge in trading volume was also found since 2014; thereby it is not very surprising to find little unexpected futures trading for the US market (see Figure 4).

Overall, the results suggest that US listed real estate futures does reduce the volatility of US listed real estate prices and enhance the market depth of US listed real estate with respect to the significant and negative coefficients of expected futures trading level, as proxied by open interest and volume.

| **Table 8.** Volatility and expected & unexpected futures trading activity: US | |
|---|---|
| Panel A: Mean Equation | |
| Constant $(\alpha_0)$ | 0.000 (0.987) |
| Lag Return $(\alpha_1)$ | 0.028 (0.482) |
| Lag Return $(\alpha_2)$ | -0.048 (-0.933) |
| Lag Return $(\alpha_3)$ | 0.004 (0.075) |
| Panel B: Variance Equation | |
| Constant $(\alpha_0)$ | 0.000 (5.754)*** |
| ARCH (1) | 0.133 (1.966)** |
| ARCH (2) | 0.044 (0.822) |
| GARCH (1) | 0.533 (5.784)*** |
| Expected Volume | $-4.53\times10^{-9}$ (-2.508)** |
| Unexpected Volume | $8.27\times10^{-10}$ (0.398) |
| Expected Open Interest | $-8.13\times10^{-10}$ (-17.949)*** |
| Unexpected Open Interest | $-1.05\times10^{-9}$ (-0.376) |
| Monday | $-1.20\times10^{-6}$ (-0.046) |
| Tuesday | $-1.01\times10^{-5}$ (-0.047) |
| Wednesday | $-9.13\times10^{-7}$ (-0.045) |

| | |
|---|---|
| Thursday | $-1.13\times10^{-6}$ (-0.047) |

Notes: This table reports estimated coefficients from a GARCH(1,1) model with expected and unexpected futures-trading activity. Figures in parentheses in Panels A and B are the Bollerslev-Wooldridge robust standard errors. *, **, *** denotes significance at the 10%, 5% and 1% level respectively.

## Summary

In general, the launch of listed real estate futures, but not all, does improve the flow of information in the listed real estate sector. Further, listed real estate futures markets, in general, do improve market depth as listed real estate is negatively associated with the expected futures trading volume and open interest, confirming the stabilising role of futures trading. This suggests that futures markets can improve liquidity provision and depth in an underlying spot market.

However, the results also highlight the variations by countries in which the Japanese listed real estate futures markets do not lead to a significant improvement of information flow and have a strong stabilising effect. This could be attributed to low-trading volume for this market. As discussed in the previous sections, the trading volume for this futures market is negligible compared with other real estate futures markets (i.e. the US, Australia and the wider Europe index futures markets).

Further, with respect to the magnitudes of the coefficients, we found like Bessembinder and Seguin (1992) and Gulen and Mayhew (2000), are relatively small, reflecting that listed real estate futures, in general, do have a significant impact on the volatility of listed real estate, but their economic values are relatively low.

**Table 9: Key findings**

| | Expected Volume | Expected Open Interest |
|---|---|---|
| Australia | ✓ | ✓ |
| The FTSE EPRA Nareit REIT Developed Europe Futures Index | ✓ | ✓ |
| The FTSE EPRA Nareit Eurozone Futures Index | ✓ | ✓ |
| Japan | ✗ | ✓ |
| United States | ✓ | ✓ |

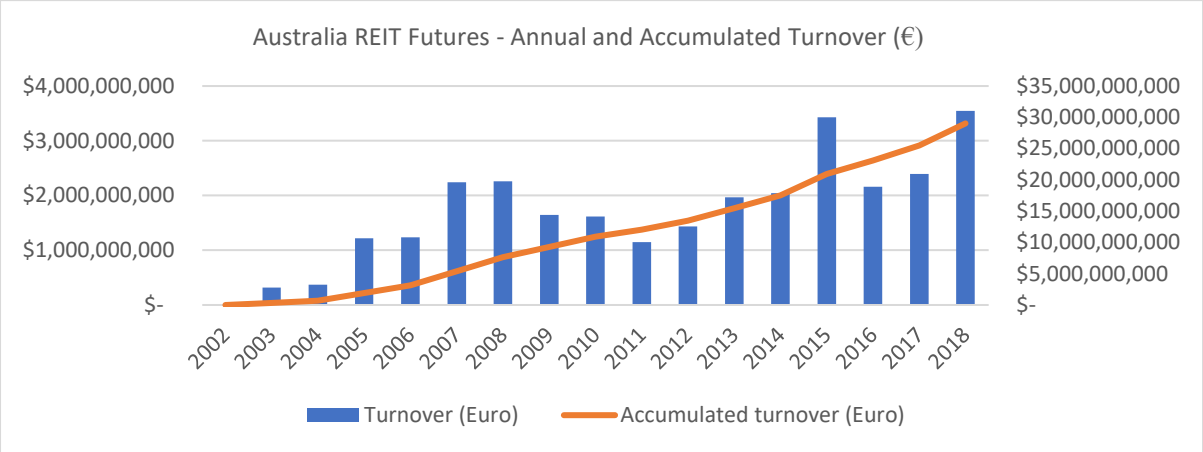
Notes: ✓ indicates an enhancement of listed real estate market efficiency ✗ indicates no enhancement of listed real estate market efficiency

### The Significance of Listed Real Estate Futures

The inconsistent results from the abovementioned section raises a question of whether futures activity might only have an impact in a market if it reached a level with sustained growth. Therefore, this section assesses the significance of listed real estate futures markets.

Figure 1 shows the trading volume of A-REIT futures. As can be seen, the market has grown steadily since 2005. Specifically, it recorded an annual trading volume of €1 billion in 2005. Thereafter, a rapid growth was evident in 2007 due to the surge of demand for risk sharing during the extremely volatile period in response to the GFC. Although the transaction reduced from 2009-2011, the transaction volume maintained at the threshold of €1 billion. Nevertheless, the increasing popularity of A-REIT futures has been observed since 2012, and its total transaction reached to $3.3 billion in 2018. This trading volume is significant with respect to the total listed real estate market size in Australia was only around €77 billion (EPRA, 2019). As such, after its initial establishment period (2002-2004), A-REIT futures had emerged as an important investment vehicle for Australian property investors as it has been well established and actively traded since 2005.

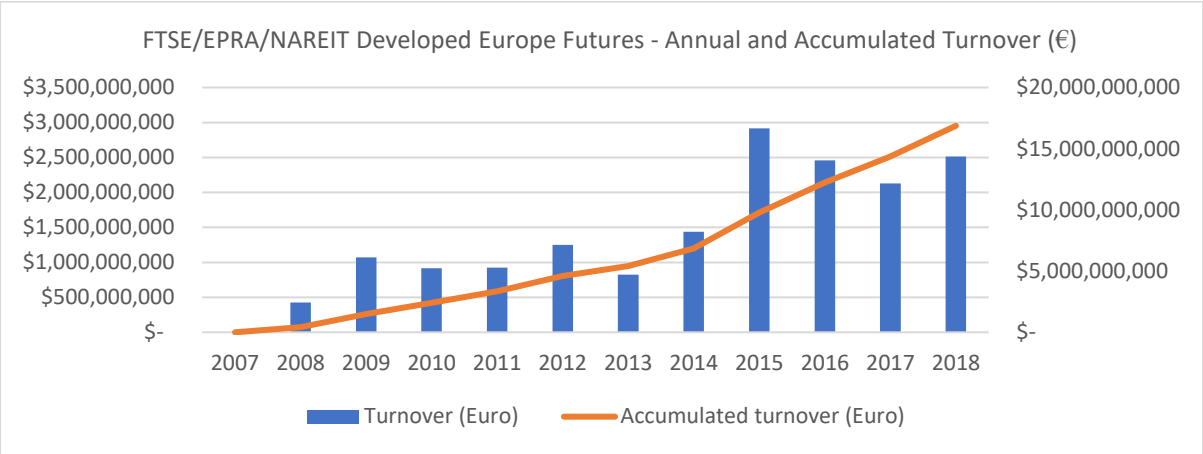
**Figure 1: The A-REIT Futures Trading**




Source: Authors' compilation (2019)

The growth of the wider Europe futures market is presented in Figure 2. Interestingly, the market reached a billion-transaction volume in two years after the futures inception, whilst no sustained growth of this market was found the following 4 years. The active transactions in 2009 and 2010 can be attributed to the onset of GFC. Nevertheless, the market did receive an increasing attention since 2014 with an annual total transaction, on average, of around €2.2 billion. In other words, the wider Europe futures market only received considerable degree of attention from property investors and emerged as an important investment vehicle since 2014.

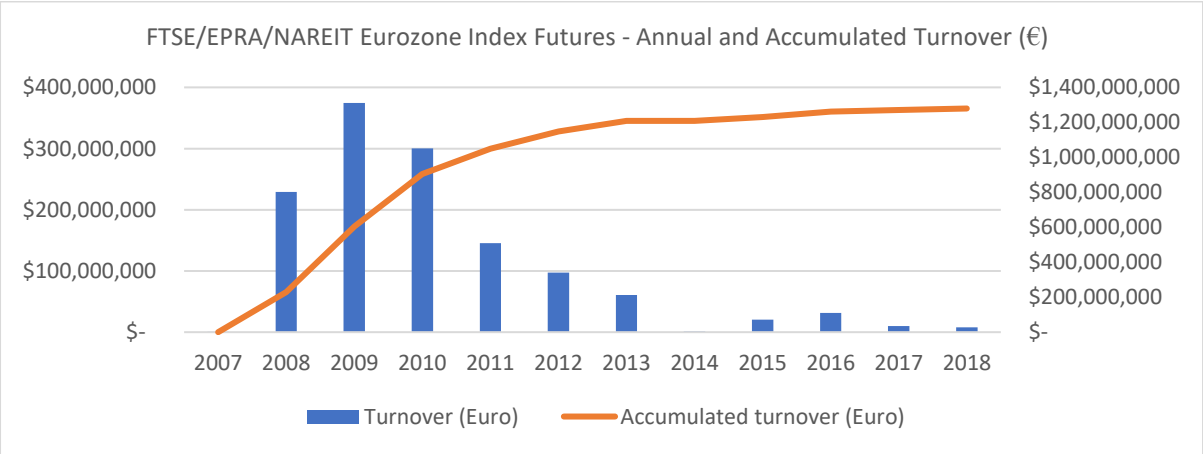
Figure 2: The FTSE/EPRA/NAREIT Developed Europe Index Futures Trading




Source: Authors' compilation (2019)

Figure 3 presents the growth of the Eurozone index futures market. Despite the futures market was active in the first 3 years since its inception, the trading volume dropped dramatically from 2011. Importantly, the market was very inactive since 2014. This raises the question of the role of the Eurozone index futures market in affecting the underlying market. This also explains the preceding insignificant results of the unexpected components of open interest and volume in explaining the volatility of listed real estate that are reported in Table 6. It should be noted that the Eurozone index is largely centred on a small number of large real estate markets, the biggest being France. However, the wider Europe index covers these markets and the UK. This also raises the possibility of latent demand for a U.K. specific contract. In short, the Eurozone index futures did not emerge as an established property investment vehicle compared to the wider Europe index futures.

Figure 3: The FTSE/EPRA/NAREIT Eurozone Index Futures Trading

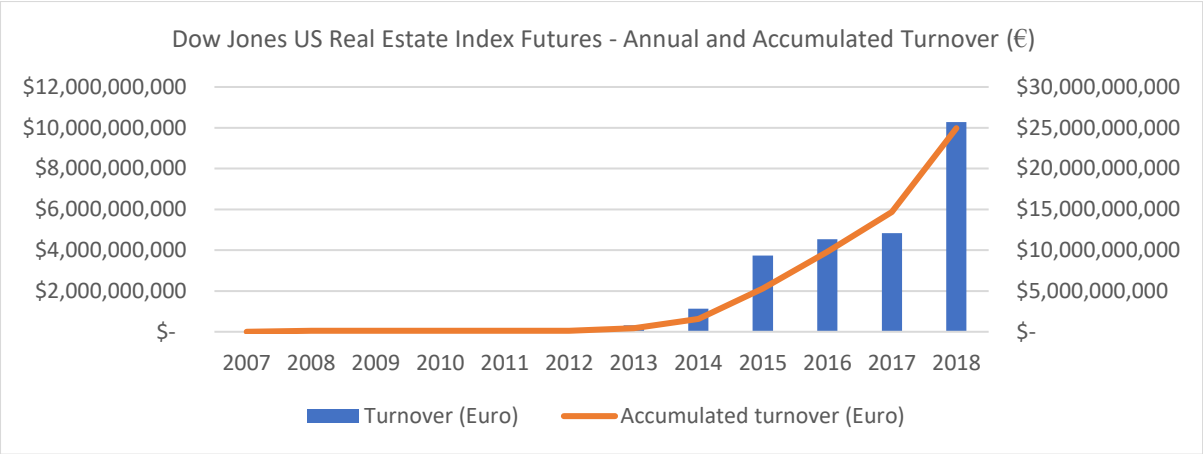



Source: Authors' compilation (2019)

The US listed real estate futures market was firstly introduced in 2007. In contrast to the European and Australian listed real estate futures markets, the US listed real estate futures did not receive considerable degree of attention from property investors during the GFC period (see Figure 4). The

market remained inactive during its initial establishment period (2007-2013). However, a surge in trading volume was evident in 2014. Thereafter, the market has become the largest and most active real estate futures market with an annual trading volume with at least €4 billion since 2016. In 2018, it also reached to the level of €10 billion. This clearly highlights the statue of the US listed real estate futures market; thereby the market clearly emerged as an active futures market since 2014.

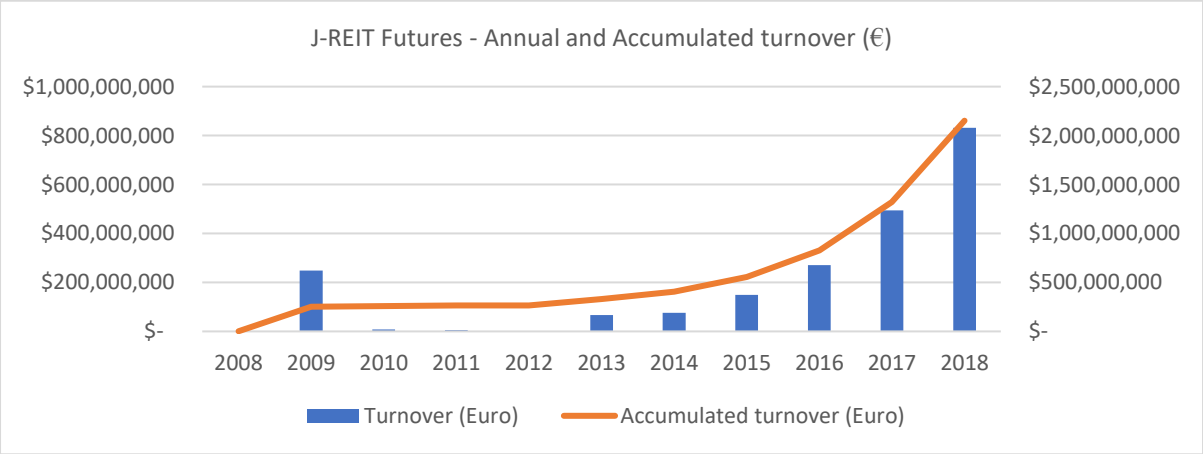
### Figure 4: The Dow Jones US Real Estate Index Futures Trading




Source: Authors' compilation (2019)

The trading volume of J-REIT futures market over 2008-2018 is reported in Figure 5. The figure shows that the futures contract did not receive significant attention from Japanese property investors during its initial established period. The only exception was in 2009 which was coincident with the onset of GFC. However, the market has received an increasing attention from property investors since 2015 in that a rapid growth rate of 450% was evident over 2015-2018. This sees J-REIT futures has received an increasing attention from Japanese property investors despite the futures trading level is still relatively low compared with other markets such as the US listed real estate futures market.

### Figure 5: The TSE REIT Index Futures Trading




Source: Authors' compilation (2019)

Overall, this section shows that the listed real estate futures markets, in general, require some initial establishment periods to allow the markets to grow to a well-established level, and being actively traded. The well-established period for each futures market is summarised as below, and are of important for the Stage 2 analysis:

- Australian REIT futures: 2005
- The FTSE/EPRA NAREIT Developed Europe Index futures: 2014
- The FTSE/EPRA NAREIT Eurozone Index futures: nil
- The US listed real estate futures: 2014
- J-REIT futures: 2015

## Stage 2: The Impact of Listed Real Estate Futures on the Volatility Linkages between Listed Real Estate and Direct Property

The previous section has demonstrated that listed real estate futures markets do improve market depth and lead to a reduction of listed real estate volatility. The mitigated volatility of real estate securities could make the listed real estate sector to reflect market fundamentals more effectively; thereby listed real estate could behave more like direct property. In other words, a stronger association between listed real estate and direct property should be documented in the post-futures period with an actively traded futures market.

To gauge whether the introduction of listed real estate futures does enhance the linkages between listed real estate and direct property, a sub-period analysis was conducted. Following Lee at al. (2018), the low-frequency volatility of listed real estate was firstly extracted from a spline-GARCH. Thereafter, the low-frequency volatility linkages between listed real estate and macroeconomic risk was analysed in a panel analysis. The results are presented in Table 11[1].

A comparison of the results before and after futures trading shows interesting findings. It can be seen from Table 11 that the coefficient of direct property volatility is not statistically significant and negative prior to the establishment of futures. This suggests that there is a weak relationship between the low-frequency volatility of listed real estate and direct property volatility prior to the futures contracts being launched and actively traded. However, a positive and statistically significant relationship is documented during the post-futures period. This suggests that a stronger volatility between real estate securities and direct property is observed after the contracts being introduced and actively traded. The results are intuitively appealing. The results can be attributed to the fact that listed real estate futures offers a new trading platform for investors to gain or reduce their exposure in the listed real estate market. Specifically, index futures could be used as a speculative asset that will be appealing for speculators and hedgers (Zhu, 2016). As such, it reduces market noise of listed real estate (as documented in Stage 1) and allows the listed real estate market to better reflect market fundamentals and behaves more like direct property. However, it should be noted that the coefficient of direct property is relatively low compared with other macroeconomic risk proxies (e.g. GDPVol and MSVol), highlighting that the economic significance of direct property volatility in explaining the low-frequency volatility of listed real estate is relatively weak, despite it is a statistically significant variable. This also suggested that other macroeconomic variables have a stronger economic impact on the low-frequency

[1] One could make the case that the futures trading only have an impact on a listed real estate market if the futures markets being well established and actively traded. Hence, we examined the sub-period analysis by comparing the results before and after the maturity of futures trading. Nevertheless, a comparison of the results before and after the launch of futures was also conducted without considering the maturity of a futures market. Our results are robust and no significant different is found.

volatility of real estate stocks compared with direct property, although these variables are statistically significant during the post-futures trading period.

This is further supported by the results of macroeconomic risk. Interestingly, strong volatility linkages are documented between listed real estate and interest rate (IRVol), GDP (GDPVol), Money Supply (MSVol) and Exchange rate (FXVol) in the post futures period. Nevertheless, no similar evidence is found for the pre-futures period. Results here confirm that listed real estate markets have stronger links with macroeconomic risk since the launch of listed real estate futures. This further reflects that property futures offer an alternative means for speculative and hedging activities; thereby a stronger association between listed real estate and market fundamentals being observed after the introduction of listed real estate futures. This also supports the notion of Engle and Rangel (2008) that the low-frequency volatility is strongly linked with slowly varying deterministic conditions in the economy.

In addition, the sign of GDPVol warrants further discussion, although it is statistically significant. Unlike other macroeconomic risk proxies, the sign of GDPVol is negative, reflecting that the heightened GDP risk would reduce the low-frequency volatility of real estate stocks. This could be attributed to the study period in this study. Many real estate futures (i.e. US, Japan and Europe) were launched during the onset of global financial crisis. The GFC has had an adverse impact on listed real estate markets and the global economies (Lee et al., 2016). As such, a number of stimulus packages had been launched in response to the worsening economic climate (e.g. quantitative easing; loose monetary policies; significant reduction of interest rates etc) (Lee et al., 2015). Despite these policies, stagnate economy growths had been documented in these markets (e.g. Australia, the US, Japan, Europe) since the GFC. Therefore, it is possible to find a negative link between listed real estate volatility and GDPVol. Further, the negative association between FXVOL and listed real estate volatility could be attributed to the GFC and the study period.

**Table 11: Comparison between before and after the futures trading being actively traded**

| | Pre-Futures | Post-Futures |
|---|---|---|
| All Markets | | |
| Constant | 0.010 (1.478) | 0.011(157.646)*** |
| GDPVol | 0.039(0.248) | -0.086(-32.011)*** |
| IRVol | 0.008(2.578)** | 0.001(32.553)*** |
| MSVol | -0.012(-1.536) | 0.009(12.654)*** |
| FXVol | 0.002(0.048) | -0.001(-16.501)*** |
| DPVol | 0.017(1.625) | 0.004(10.015)*** |

Notes: This table reports estimated coefficients from a fixed-effect regression. For IR volatility series, the model is estimated by an unbalanced panel analysis where the dependent variable is the low-frequency volatility obtained from a Spline-GARCH model. For other volatility series, the models are estimated in the same setup. Volatility series for IR, GDP, MS, FX and DP are obtained from the (absolute value of) residuals of AR(1) models. T-values are presented in parentheses. The White cross-section robust standard errors are utilized. *, **, *** denotes significance at the 10%, 5% and 1% level respectively.

The key finding can be summarised in Table 12. Specifically, a strong link between the low-frequency volatility of real estate stocks and direct property volatility is evident for the post-futures period, whilst no comparable evidence is found for the pre-futures period.

**Table 12: Key finding**

| | Pre-Futures | Post-Futures |
|---|---|---|
| Direct Real Estate Volatility | ✖ | ✓ |

Notes: ✓ indicates a strong link between direct real estate volatility and listed real estate low-frequency volatility ✖ indicates a weak link between direct real estate volatility and listed real estate low-frequency volatility

## A closer look into the volatility linkages between listed property and direct property

Given the preceding section shows that a well-established real estate futures market does lead to a stronger link between the low-frequency volatility of listed real estate and futures, this section expands on that analysis to consider the causal relationship between listed real estate and direct property with a pairwise Granger causality. A dedicated study of the casual relationship is of interest for a variety of reasons, including assisting investors' decision-making.

The results are presented in Table 13 and indicate that no strong causal relationship between listed real estate low-frequency volatility and direct property volatility in the pre-futures period. However, strong evidence has been found in the post-futures period. Specifically, a strong one-way relationship between listed real estate and direct property is documented, and there is evidence to support the view that direct property leads listed real estate in the post-futures period. Similar results are found by Tuluca, Myer and Webb (2000) for the US market and Hoesli et al. (2015) for the industrial sector[2]. The results can be attributed to the effectiveness of futures markets in reducing market noise of listed real estate markets. As discussed earlier, futures trading offers a new trading platform that allows investors to gain or reduce their exposure in the listed real estate markets. Importantly, this reduces their reliance of listed real estate markets for speculation activities; thereby speculative activities and market noise can be reduced after the establishment of listed real estate futures markets. Consequently, it allows the listed real estate sector to better reflect market fundamentals. Specifically, the cash flow of real estate stocks, particularly REITs are mainly generated from the underlying direct property assets; thereby the performances of listed real estate and direct real estate are expected to be based on similar direct assets[3] (Hoesli and Oikarrinen, 2014; Lee et al., 2018) The results are also consistent with the findings of Clayton and Mackinon (2003), Lee et al. (2008) and Ling and Naranjo (2015) in which Equity REITs become increasingly sensitive to the performance of underlying real estate. Further, Hoesli and Oikarrinen (2014) found that the volatilities of listed and direct real estate generally do not differ statistically significantly from each other. This implies that real estate stocks are heavily tied to the underlying direct real estate assets (Lee et al., 2018). As such, it is reasonable to document a strong link between direct property and listed real estate volatility in the post futures period.

[2] This indirectly supports the previous findings of Tuluca, Myer and Webb (2000) and Hoesli et al. (2015) in that "a universal lead-lag relationship goes from the public to the private real estate market is not as evident as has generally been though." (Hoesli and Oikarinen and Serrano, 2015; page 106). This also suggests that the lead-lag relationship is a more complex process than initially believed.

[3] This study is unique as it models the low-frequency volatility of listed real estate. The low-frequency volatility, unlike aggregate volatility and high-frequency volatility (e.g. transitory component), describes market fundamentals effectively (Engle and Rangle, 2008). Given the transitory component and market noise have been removed from our analysis, the cash flow of listed real estate, particularly REITs would be heavily tied with the underlying properties; thereby it is not surprising to document the performance of direct property leads the low-frequency volatility of listed real estate. For instance, the movement of direct property value should affect the net asset and book value of a REIT. Then the share price will respond to it accordingly. Recognising the lead-lag relationship is a complex process, it is critical to check the robustness of the study by considering different sub-sectors as Hoesli and Oikarinen and Serrano (2015) found the importance of sub-sector analysis in understanding the lead-lag relationship between both markets. However, a dedicated study of this is beyond the scope of this study, although it warrants further research.

**Table 13: Pairwise granger causality tests between direct property volatility and listed real estate volatility**

| | Pre-Futures | Post-Futures |
|---|---|---|
| Direct Real Estate Volatility does not Granger cause Listed Real Estate Volatility | 7.381 | 7.125** |
| | (0.061) | (0.028) |
| Listed Real Estate Volatility does not Granger cause Direct Real Estate Volatility | 3.255 | 0.126 |
| | (0.354) | (0.939) |

Notes: This table reports the pairwise Granger causality test results. The low-frequency volatility is obtained from a Spline-GARCH model. Volatility series for DP is obtained from the (absolute value of) residuals of AR(1) models. **, *** denotes significance at the 5% and 1% level respectively.

The results thus far discussed have established an entirely one-way causal relationship from direct real estate to listed property in the post-futures period, and this can be attributed to the onset of futures. To further assess the impact of listed real estate futures, the final component of the empirical results involves the casual relationship between listed real estate futures and listed real estate volatilities. Firstly, the low-frequency volatility of listed real estate futures is extracted with the Spline-GARCH. Thereafter, the casual relationship between listed real estate futures and listed real estate futures is investigated with a Granger-Causality test. The results are presented in Table 14.

Results from Table 14 reveal that there is evidence to support that the low-frequency volatility of real estate futures Granger caused the low-frequency volatility of listed real estate. This suggests that futures did lead listed real estate. The results are intuitively appealing and are in line with the finding of the broader stock and futures markets (Pizzi et al., 1998; Ryoo and Smith, 2004; Bohl, et al., 2011). However, the results are not very consistent with the findings of Lee et al. (2016). The divergence of the results can be attributed to the fact that the low-frequency volatility, a long-run volatility component, is used in this analysis. This also highlights the important to decompose aggregate volatility shocks of real estate stocks into their high- and low-frequency components in a volatility analysis. The findings assist real estate investors to understand and analyse real estate and real estate futures more accurately and improve the risk management of institutional investors through an enhanced understanding of the dynamics of the long-term volatility of listed real estate.

**Table 14: Pairwise granger causality tests between listed property futures volatility and listed real estate volatility**

| Test | Post-Futures |
|---|---|
| Listed Real Estate Futures Volatility does not Granger cause Listed Real Estate Volatility | 23.688*** |
| | (0.000) |
| Listed Real Estate Volatility does not Granger cause Listed Real Estate Futures Volatility | 3.467 |
| | (0.177) |

Notes: This table reports the pairwise Granger causality test results. The low-frequency volatility is obtained from a Spline-GARCH model. **, *** denotes significance at the 5% and 1% level respectively.

# Conclusion and Implications

## Conclusion

Given the increasing popularity of listed real estate futures in Europe and internationally in line with the growth of its markets size, a specific study of the impact of European and international real estate futures is a compelling topic for research.

This report examines the impact of futures trading on the volatility linkages between listed real estate and direct real estate. The total returns of real estate stocks in Australia, Japan, the United States, the FTSE EPRA Nareit Developed Europe index and the FTSE EPRA Nareit Eurozone index over January 1990 to March 2019 were assessed with a number of empirical tests (i.e. GARCH, Spline-GARCH and Panel Analysis).

**There are three main findings.**

**1) The inception of listed real estate futures, in general, does improve the market efficiency of listed real estate market.**

It appears that the launch of listed real estate futures, in general, has improved the quality of information flowing to the listed real estate markets. The only exception is the Japanese listed real estate futures market. Specifically, the results suggest that futures markets, in general, improve liquidity and market depth; thereby the volatility of listed real estate can be reduced. As such, the inception of listed real estate futures, in general, does improve the market efficiency of listed real estate market.

**2) The launch of listed real estate futures leads to an enhanced volatility linkage between listed real estate and macroeconomic risk.**

A stronger volatility linkage between listed real estate and market fundamentals has been observed after the introduction of listed real estate futures markets. This can be attributed to the fact that listed real estate futures markets reduce market noise in the underlying listed real estate market by allowing investors to hedge and speculate in the futures markets instead of spot markets, reducing therefore their reliance on spot (listed real estate) market. Consequently, this allows the listed real estate sector to better reflect market fundamentals.

**3)The onset of listed real estate futures leads to a stronger volatility linkage between listed and direct real estate.**

We also documented an enhanced low-frequency volatility linkage between listed and direct real estate after the introduction of listed real estate futures markets. This suggests that listed real estate could behave more like direct property since listed real estate futures contracts being established. Given the listed real estate futures market allows the listed real estate sector to reflect market fundamentals more effectively, it is reasonable to find that a stronger volatility linkage between listed and direct real estate. This also supports the finding of a recent EPRA study in which the risk profiles of privately and publicly traded real estate that are based on similar direct assets are alike (Hoesli and Oikarinen, 2014).

## Implications

1) **Policy makers should encourage the development of listed real estate futures**

The finding of futures markets can improve liquidity provision and depth in an underlying spot market suggests that policy makers should encourage the development of listed real estate futures. Specifically, the futures markets would enhance the information flow and increase the market efficiency of listed real estate sector.

2) **Listed real estate futures facilitate real estate investors' hedging strategy**

Listed real estate futures are an effective investment vehicle for real estate investors. The introduction of listed real estate futures market facilitates real estate investors' hedging strategy in that reducing their reliance on spot hedging strategies. Specifically, it offers an effective platform for real estate investors to hedge the price movement of the underlying asset (i.e. listed real estate). As such, a stabilising effect is also provided by the launch of a futures market on listed real estate.

3) **Investors can gain direct property exposure effectively via listed real estate via listed real estate as the onset of futures markets did reduce the volatility of listed real estate**

The finding of an enhanced relationship between direct and listed real estate would encourage institutional investors to invest in the listed real estate market as listed real estate does behave more like direct real estate, particularly those listed real estate markets with a futures market. Institutional investors, therefore, can gain direct property exposure effectively without any hinders in direct property investment.

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