Time Varying Comovements between U.S. and Asia-Pacific REIT ETFs

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Abstract

This paper examines linkages among U.S. and Canada, Australia, Japan and China real estate markets in case of REIT ETFs during 2002-2013. REIT ETFs are financial instruments which have the characteristics of both REITs and ETFs. This analysis also investigates how such linkages stands before and after the global financial crisis.

The results show that, despite locality of real estate markets, Asia-Pacific REIT ETFs have strong long-term equilibrium relationship with U.S. REIT ETF except for Japanese REIT ETF. Such relationship got stronger after the U.S. subprime mortgage crisis. It is also found that U.S. REIT ETF has unilateral causal relationship with Asia-Pacific REIT ETFs. Finally, the evidence shows that the return and volatility spillover effects from U.S. REIT ETF to Asia-Pacific REIT ETFs. In particularly, Canadian and Australian REIT ETFs present a high degree of linkages with U.S. REIT ETF.

Key words: REITs, ETFs, REIT ETFs, U.S. subprime mortgage crisis, Global Financial Crisis

Classification Code: G15, F15, F36

I. Introduction

REIT is an investment vehicle investing in real estates, development project, and real estate related securities. REITs were created in the U.S. in the 1960s as a way for individuals to make relatively small investments in real estate. Since then, REITs have seen its growth with tax benefits and steady income flows, even though REITs also have experience boom and bust cycles.

ETFs are index funds whose stock is traded on the stock exchange like individual stock. Like index funds, ETFs, passively managed funds, tracks specific indexes, allowing investors to gain access to a broad type of asset classes. Compared with general mutual funds, however, ETFs have advantage of low cost, transparency, and high liquidity.

REIT ETFs are a cross between REIT and ETFs. REIT ETFs are investment funds with their performance linking to a specific real estate index, and thereby REIT ETFs can be affected by real estate market as well as equity market factors. Through the global financial crisis, many investors have shifted away from REITs which are likely to be illiquid real estate portfolio. REIT ETFs allow investors to access to more liquid and diversified real estate, particularly on a global basis.[1]

Even though the contagion problem in financial markets has long been discussed, that issue is still of importance as the globalization of capital market has been accelerating. The extent of integration among the international real estate markets also has been studied. There are two contradictory views about the degree of integration across the real estate markets. (Worzala and Sirmans 2003a; Worzala and Sirmans 2003b)

On the one hand, it is argued that real estate markets are affected by supply and demand factors that are highly localized. That is, the real estate markets are thought to be more likely to be affected by domestic factors rather than international factors. (Eichholtz, Gugler, and Kok 2011) Therefore, the correlations of returns between international real estate markets are relatively so low that there could be significant diversification advantages of investing in REITs on a global basis.

On the other hand, it is claimed that the international real estate markets tend to move together on both domestic and overseas economic factors like stocks do. A synchronized downturn was experienced in many property markets around the world due to common factor. (Francesco 2010) Along with the U.S. real estate markets crisis set off, in 2007 and 2008, by the massive U.S. subprime mortgage default, the real estate markets across the world had

[1] iShares REIT ETFs, BlackRock, 2011.

suffered the severe downturn.

Investing in international real estate markets involve risks such as currency, political, and economic risks.[2] When investors invest in foreign assets, they would face much higher information asymmetry than for domestic assets. Along with general risks involving in international equity investment, local real estate conditions adds to the risks. Obviously, it is very difficult to forecast the direction and magnitude of risks involved in investing in foreign real estate assets.

To address the extent of diversification benefits from investing in international real estate markets, this paper examines the linkage among the international real estate markets with two objectives.

First, this study analyzes whether there is co-movement across real estate markets using U.S. and Asia-Pacific REIT ETFs – iShares Dow Jones U.S. Real Estate Index Fund, iShares S&P/TSX Capped REIT Index Fund, SPDR S&P/ASX 200 Listed Property Fund, Guggenheim China Real Estate ETF, iShares FTSE EPRA/NAREIT Developed Asia Index Fund, NextFunds TOPIX-17 Real Estate ETF.

Second, this paper tries to address the impact of the U.S. subprime mortgage crisis on Asia-Pacific real estate markets by analyzing co-movement REIT ETFs across U.S.-Asia-Pacific countries before and after the U.S. subprime mortgage crisis in 2007.

This paper might contribute to literature of linkage of international real estate markets in two ways. First, to my best knowledge, this paper is the first paper looking into REIT ETFs for integration of real estate market across the borders. This paper can contribute to portfolio management by presenting the evidence of linkages across REIT ETFs markets. As ETFs market has grown fast recently in the U.S. as well as Asia-Pacific markets, a variety of REIT ETFs have been listed on the exchange. This paper might enhance the understanding of REIT ETFs.

Second, the previous studies which examine the linkage among international real estate market use real estate markets indices, such indices cannot be invested directly. Although REIT ETFs also follow real estate market indices, REIT ETFs can be invested directly, reflecting quickly relevant information or market conditions.

The remainder of the paper is organized as follows. Section II offers a review of previous

[2] "Indeed, the booms and busts of China equities have less to do with economic fundamentals and more with the vagaries of government policy and speculation by retail investors who chase trends with little regard for stock valuations." Beijing Reforms Raise hope for rally, Financial Times, January 12, 2012

studies on linkages across international real estate markets. Section III briefly describes the data and methodology. Section IV presents the empirical results. Section V summarizes the paper.

II. Previous Literature

The study about REIT ETFs cannot be found as far as the author knows. However, there are some studies about international real estate market linkages.

Garvey, Gary, and Stevenson (2001) study linkages among real estate securities for Australia, Japan, Hong, and Singapore for the sample period of January 1975 to March 2001, using weekly data to avoid non-synchronous trading problem of daily data. Their co-integration analysis shows that there is little evidence of co-integration among four markets - Australia, Japan, Hong Kong, and Singapore, implying that there is no long-term relationship. This evidence suggests that there exist diversification opportunity for global real estate investments.

Zhu and Liow (2005) present evidence of strong long-term and short-term relationships between the Shanghai SE Real Estate Index and Hang Seng Property Index during the period of 1993-2003. Their finding also show that, while there is no co-integration between two markets before 1997 Asian financial crisis, there exists co-integration after financial crisis.

Using synchronously priced indexes instead of close-to-close return data, Michayluk, Wilson, and Zurbruegg (2006) find a significant interaction, on a daily basis, between U.S. and U.K. securitized real estate markets.

With weekly S&P Global Property Index, Liow (2007) examines effect of Asian financial crisis on the time-varying volatility of Asia-Pacific, U.K., and U.S. real estate securities for the sample period of 1992~2004 The findings show that Asian financial crisis increases Asia-Pacific real estate security markets – Hong Kong, Singapore, and Malaysia.

Ellis, Wilson, and Zurbruegg (2007) find that investors can reduce the overall risk of portfolio by investing in U.S., U.K., and Australia real estate markets. However, foreign exchange risk may cut into diversification benefit.

During the sample period of 1988-2008, Liow (2008) examines the international real estate market linkages using several types of indexes for U.S., U.K., Australia, Hong Kong, and Singapore. They document that there is no co-integration relationship among real estate markets of 5 countries. However, it is found that in case of developed real estate markets

such as U.S. U.K. and Australia, there is co-integration relationship.

Bardhan, Edelstein, and Tsang (2008) examine the impact of country's globalization on the real estate firms using 250 real estate companies from a set of 16 countries, including U.S. Germany, Hong Kong, Australia, Japan, and so on. They find that, over the period of 1995-2002, the degree of globalization affect significantly and negatively related to firm returns.

In the analysis of long-term and short-term co-movements between Asia-Pacific and U.S./ U.K. during the period of January 1992-December 2008, Schindler (2009) finds the long-term equilibrium relationships among Asian real estate monthly indices – Hong Kong, Japan, Singapore, Malaysia, Australia, New Zealand, and Philippines. No long-term equilibrium between U.K. and Asia-Pacific real estate markets is found. In addition, U.S. real estate markets have a weak co-integrating relationship with Asia-Pacific real estate markets.

For the period of 1995-2009, Liow (2010) report a cross real estate-stock correlation dynamics. In his paper, he finds eight Asian real estate securitized markets (Australia, Japan, Hong Kong, Singapore, China, Malaysia, Taiwan, and Philippines) have a time varying co-movement with their local stock market, regional stock market, and global stock markets.

Liow and Chen (2011) find the presence of at least one common variance component and co-integration relationships among Asia-Pacific securitized real estate markets in terms of both the first and second moment.

III. Data and Methodology

1. Data

This paper uses the daily prices, not net asset value (NAV), of six REIT ETFs for U.S., Canada, Australia, China, Developed Asia, and Japan - iShares Dow Jones U.S. Real Estate Index Fund, iShares S&P/TSX Capped REIT Index Fund, SPDR S&P/ASX 200 Listed Property Fund, Guggenheim China Real Estate ETF, iShares FTSE EPRA/NAREIT Developed Asia Index Fund, NextFunds TOPIX-17 Real Estate ETF.[3]

The sample period of iShares Dow Jones U.S. Real Estate Index Fund, iShares S&P/TSX

[3] Guggenheim China Real Estate Index Fund is former Claymore AlphaShres China Real Estate. Toronto-based Claymore was a unit of U.S.-based ETF provider Claymore Group Inc., which was acquired by New York-based Guggenheim Partners LLC in 2009.

Capped REIT Index Fund, SPDR S&P/ASX 200 Listed Property Fund, the Dow Jones Industrial Average are from October 22, 2002 to December 31, 2013. Guggenheim China Real Estate ETF has the sample period of December 18, 2007 to December 31, 2013 while iShares FTSE EPRA/NAREIT Developed Asia Index Fund has from January 7, 2008 to December 31, 2013. The sample period of NextFunds TOPIX-17 Real Estate ETF is from March 25, 2008 to December 31, 2013.

It is noted that Guggenheim China Real Estate ETF, iShares FTSE EPRA/NAREIT Developed Asia Index Fund, NextFunds TOPIX-17 Real Estate ETF were listed post-February 7, 2007 in which iShares Dow Jones U.S. Real Estate Index Fund hit its highest point. Thus, both iShares S&P/TSX Capped REIT Index Fund and SPDR S&P/ASX 200 Listed Property Fund are examined to test the degree of integration pre- and post-February 7, 2007.

The data of iShares Dow Jones U.S. Real Estate Index Fund, iShares S&P/TSX Capped REIT Index Fund, Guggenheim China Real Estate ETF, and iShares FTSE EPRA/NAREIT Developed Asia Index fund are obtained from finance.yahoo.com. The prices of SPDR S&P/ASX 200 Listed Property Fund were collected from the website of the Australian Stock Exchange, www.asx.com.au. The website of finance.yahoo.com.jp provides the historical prices of NEXTFunds Topix-17 Real Estate Fund.

iShares Dow Jones U.S. Real Estate Index Fund and Guggenheim China Real Estate ETF are traded on NYSE arca. Guggenheim China Real Estate ETF tracks AlphaShares China Real Estate Index which is designed to measure and monitor the performance of publicly issued common equity securities of public traded companies and real estate investment trusts which derive a majority of their revenues from the real estate development, management and/or ownership of property in mainland China, Hong Kong, and Macau. iShares FTSE EPRA/NAREIT Developed Asia Index Fund are traded on Nasdaq. Toronto stock exchange trades iShares S&P/TSX Capped REIT Index Fund. SPDR S&P/ASX 200 Listed Property Fund is traded on Australian Stock exchange. Tokyo stock exchange trades NextFunds TOPIX-17 Real Estate ETF.

To examine daily returns of REIT ETFs, the closing prices are transformed via a natural log. To consider the trading hours difference between Asia-Pacific and U.S. real estate markets, this paper matches trading dates{t} in the Asia-Pacific markets to trading dates {t-1} in the U.S. market. The inception date, underlying index, fund currency, fund manager, top 5 holdings of six REIT ETFs are provided in Table 1.

Table 1: overview of six REIT ETFs

	Ticker Code	Exchange	Underlying Index	Inception date	Top Holdings
iShares Dow Jones U.S. Real Estate Index Fund	IYR	NYSE	Dow Jones U.S. Real Estate Index	June 19, 2000	Simon Property Group, Equity Residual, Public Storage, Vornado Realty Trust, HCP
iShares S&P/TSX Capped REIT Index Fund	XRE	Toronto	S&P/TSX Canadian REIT Index	Oct. 17, 2002	RioCan REIT, H&R REIT, Canadian REIT, Calloway REIT, Boardwalk REIT
SPDR S&P/ASX 200 Listed Property Fund	SLF	Australia	S&P/ASX 200 Listed Property Trust Index	Feb. 15, 2002	Westfield Group, Stockland Trust, CFS Retail - Property Trust, GPT Group, Dexus Property Group
Guggenheim China Real Estate ETF	TAO	NYSE	Alphashares China Real Estate Index	Dec. 18, 2007	Link REIT, Cheung Kong, China overseas land & investment, Wharf holding, Sun Hung KAI properties
iShares FTSE EPRA/NAREIT Developed Asia Index Fund	IFAS	Nasdaq	FTSE EPRA/NAREIT Developed Asia Index	Nov. 12, 2007	Sun Hung KAI, Westfield, Mitsubushi estate, Mitsui Fudosan, Sumitomo Realty & Development
NextFunds Topix-17 Real Estate Fund	1633	Tokyo	TOPIX-17 Real Estate	March 25, 2008	Mitsbushi Estate, Mitsui Fudosan, Sumitomo Realty & Development, AEON Mall, Tokyu Land

2. Methodology

A. Co-integration Analysis

Even if two or more variables are non-stationary, their linear combination would be stationary. In this context, such set of variables are defined as co-integrated. If the variables are co-integrated, the deviation from long-term equilibrium is removed over the period.

Johansen co-integration methodology use a vector error correction model (VECM) based on VAR model. (Johansen and Juselius, 1988, 1990) The Johansen test involve examining a long run coefficient matrix in the VECM. To determine the rank of the coefficient matrix, the test for number of co-integrating vector is performed by estimating the number of eigenvalues that are significantly different from zero. The fact that eigenvalue is significantly non-zero means the presence of significant cointegrating vectors.

In Johansen methodology, two test statistics – trace and maximum eigenvalue - are formulated as follows:

$$\lambda_{max}(r, r+1) = -T \times \ln(1 - \lambda_{r+1}) \qquad (1)$$

$$\lambda_{trace}(r) = -T \times \sum_{i=r+1}^{n} \ln(1 - \lambda_i) \qquad (2)$$

where λ_i is eigenvalues derived from the π matrix, r is the rank of the matrix.

λ_{max} tests each eigenvalue separately, where null hypothesis is that number of co-integrating vectors is r against an alternative r+1. λ_{trace} is a joint test in which the null hypothesis is that the number of co-integrating vectors is less than or equal to r against an alternative that there are more than r. (Brooks, 2008)

B. Granger Causality Tests

This paper runs bi-directional Granger causality test to examine the short-term relationship between the U.S. and Asia-Pacific real estate markets. Granger causality test is useful to determine whether or not one variable is explained by the lagged another variable

and vice versa. Unlike the weak exogeneity, the bi-directional Granger causality tests can avoid the interactions among the variables in the equations. Brooks (2008) noted that Granger causality means the correlation between current values of a variable and the past values of another variable. This not to say that movement of a variable causes movement of another variable. Granger causality test equation can be rewritten as follows:

$$X_t = \delta_0 + \sum_{i=1}^{k} a_i X_{t-i} + \sum_{j=1}^{l} b_j Y_{t-j} + \varepsilon_t \qquad (3)$$

$$Y_t = \gamma_0 + \sum_{i=1}^{m} c_i Y_{t-i} + \sum_{j=1}^{n} d_j X_{t-j} + \varepsilon_t \qquad (4)$$

where X and Y are variables, δ_0 and γ_0 are constant.

In the equation (3), the null hypothesis is that Y does not Granger-cause X and, in the equation (4), the null hypothesis is that X does not Granger-cause Y. (Mills and Markellos, 2008)

C. Volatility Spillover effect

This paper also examines the spillover effects between U.S. and Asia-Pacific REIT ETFs. A multivariate GARCH model is useful to capture volatility transmission between U.S. and Asia-Pacific REIT ETFs. Liow and Webb (2007) suggest the nonlinearity chaotic behavior in real estate market returns. They argue that, to understand co-integration of real estate markets, it is important to consider non-linear chaotic behavior in the real estate returns. It is also reported that, during the financial crisis, some Asia-Pacific securitized real estate markets are co-integrated in both their first and second moments. (Liow & Chen, 2011)

Several multivariate GARCH methodologies are developed to analyze the time varying nature of time series data. BEKK model is used to analyze the return and volatility spillover effect between the U.S. and Asia-Pacific REIT ETFs.[4] Engle and Kroner (1995) propose the BEKK model in which positivity is easily imposed for a parameterization for *H*, a variance matrix.

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Miao, Ramchandr, Simpson (forthcoming) use BEKK method to analyze return and volatility transmission in U.S. housing markets. Elyasiani et al. (2010) examines the relationships between returns of REIT and those of financial institutions, using bivariate GARCH models. Utilizing asymmetric BEKK model, Hoesil and Reka (2011) analyze the relationship between local and global securitized real estate markets.

Equation (5) shows the conditional variance of the bivariate GARCH (1.1) model.

$$R_{i,t} = \mu_i + \varepsilon_{i,t} \qquad (5)$$

where $R_{i,t}$ is a vector representing the continuously compound percentage return series on REIT ETFs$_i$ between *t* and *t-1*. μ_i is long term drift coefficient and $\varepsilon_{i,t}$ is the error term for the return on REIT ETFs$_i$ at time.

Following Engle and Kroner (1995)'s proposal, in this paper, the conditional covariance matrix of standard BEKK parameterization for the bivariate GARCH (1,1) model can be written as:

$$H_t = C'C + A'\varepsilon_{t-1}\varepsilon'_{t-1}A + B'H_{t-1}B \qquad (6)$$

$$H_t = \begin{bmatrix} h_{11,t} & h_{12,t} \\ h_{21,t} & h_{22,4} \end{bmatrix} =$$

$$\begin{bmatrix} c_{11} & \\ c_{21} & c_{22} \end{bmatrix} + \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}' \begin{bmatrix} \varepsilon^2_{1,t-1} & \varepsilon_{1,t-1}\,\varepsilon_{2,t-1} \\ \varepsilon_{2,t-1}\,\varepsilon_{1,t-1} & \varepsilon^2_{2,t-1} \end{bmatrix} \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} +$$

$$\begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix}' \begin{bmatrix} h_{11,t-1} & h_{12,t-1} \\ h_{21,t-1} & h_{22.t-1} \end{bmatrix} \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix} \qquad (7)$$

where H_t is 2 x 2 matrix of conditional variance-covariance at time *t* and *C* is a 2x2 lower triangle matrix with three parameters. *A* is a 2x2 square matrix of parameters and measures the extent to which conditional variances are correlated past squared errors. *B* is a 2x2 squared matrix of parameters and shows the extent to which current levels of conditional variances are related to past conditional variances. (Brooks, 2009)

The coefficients a_{12} and a_{21} represent effect of the past shocks of one REIT ETFs, or ARCH effects, on the future volatility of another REIT ETFs. It is also called as return shock.

And the coefficient b_{12} and b_{21} capture the presence of transmission of volatility or GARCH effects between two REIT ETFs.

IV. Empirical Results

1. Unit root test

Table 2: Unit Root Tests for S&P 500 index, IYR, XRE, SLF, TAO, IFAS, and NTRE

	DF		PP	
	Level	Difference	level	difference
S&P 500	-0.3127	-24.2038**	-0.5585	-59.1995**
IYR	-1.9487	-26.7097**	-2.4604	-60.1423**
XRE	-1.1331	-24.8821**	-1.5855	-47.6655**
SLF	-0.8010	-28.3312**	-1.1943	-59.7988**
TAO	-1.9833	-18.1797**	-2.0885	-37.2269**
IFAS	-3.1247	-17.4091**	-2.7644	-37.4851**
NTRE	-0.1847	-15.6343**	-0.0896	-34.6275**

Note: lags = 3. The lag length is based on AIC(Akaike Information Criterion). Critical value: DF test: 1%=-3.438, 5%=-2.864, PP test: 1%=-3.438, 5%=-2.864. ***, ** indicates significance at 1%, 5% level.

Table 2 reports the results of unit root test for the S&P 500 index and six REIT ETFs iShares Dow Jones U.S. Real Estate Index Fund, iShares S&P/TSX Capped REIT Index Fund, SPDR S&P/ASX 200 Listed Property Fund, Guggenheim China Real Estate ETF, iShares FTSE EPRA/NAREIT Developed Asia Index Fund, NextFunds TOPIX-17 Real Estate ETF.

The column 2 & 3 of Table 2 shows that, for six REIT ETFs and the S&P 500 index on the level, the null hypothesis of non-stationarity cannot be rejected. However, the null hypotheses can be rejected for the first difference of six REIT ETFs and the S&P 500 index. In column 4 & 5 of Table 3, the Phillips-Perron (PP) test provides the same results.

The unit root test results indicate that all 6 REIT ETFs and the S&P 500 index are not

stationary in level, but stationary after first difference.[5]

2. Co-integration Analysis

Table 3A: Bivariate Co-integration Tests for IYR, XRE, SLF, TAO, IFAS, and NTRE pre-2007.2.7 and post-2007.2.8

Variables		full sample		Pre-February 7, 2007		Post-February 7, 2007	
		λtrace	*λmax*	*λtrace*	*λmax*	*λtrace*	*λmax*
IYR-XRE	r = 0	27.883**	27.874**	31.764***	31.738***	33.284***	33.268***
	r < 1	2.254	2.254	6.375	6.373	5.204	5.203
IYR-SLF	r = 0	36.902***	36.892***	21.159	21.144	28.437**	28.422**
	r < 1	4.153	4.153	7.330	7.328	7.457	7.456
IYR-TAO	r=0	29.408**	29.392**				
	r < 1	10.037	10.035				
IYR-IFAS	r = 0	27.897**	27.881**				
	r < 1	9.758	9.756				
IYR-NTRE	r = 0	13.485	13.476				
	r < 1	4.594	4.592				

Note: all variables are lag = 1. The lag length is based on SC(Schwarz Criterion). The trace tests and maximum eigenvalue are obtained from the Johansen Full Information Likelihood co-integration regressions. The critical value are taken from simulation in RATs, ***, ** indicates significance at 1%, 5% level.[6]

Table 3A provides the results of bivariate co-integration tests for - iShares Dow Jones U.S. Real Estate Index Fund, iShares S&P/TSX Capped REIT Index Fund, SPDR S&P/ASX 200 Listed Property Fund, Guggenheim China Real Estate ETF, iShares FTSE EPRA/NAREIT Developed Asia Index Fund, NextFunds TOPIX-17 Real Estate ETF.

For the full sample, there are statistically significant co-integration relationships between iShares Dow Jones U.S. Real Estate Index Fund and iShares S&P/TSX Capped

[5] Even though the results of unit root test for lag= 1, 2, 3, 4 are not reported in the paper, the unit root tests for lag = 1, 2, 3, 4 show all variables in the sample are non-stationary at the level but stationary at the first difference.

[6] Even though the results of Akaike Information Criteria (AIC) test for lag= 1, 2, 3, 4 are not reported in the paper, the lag = 1 is found to be appropriate.

REIT Index Fund, SPDR S&P/ASX 200 Listed Property Fund, Guggenheim China Real Estate ETF, and iShares FTSE EPRA/NAREIT Developed Asia Index Fund. However, NextFunds TOPIX-17 Real Estate ETF doesn't show any significant co-integration relationship with iShares Dow Jones U.S. Real Estate Index Fund.

This evidence indicates that the U.S. real estate market has a long-term equilibrium with Canadian, Australian, and Chinese real estate markets. This evidence is consistent with Liow (2008) which finds a co-integration relationship among the developed REIT markets such U.S., U.K., and Australia. In particularly, the findings in this paper show that China real estate market has a long-term relationship with the U.S. real estate markets. As Chinese economy has been growing, investors betting on Chinese real estate sector might has been increasingly aware of overseas economic factors. The degree of globalization and financial integration would be related with the performance of real estate firms in one country. (Bardhan, Edelstein, and Tsang 2008)

Amid 2007-2008 global financial crisis and recession followed by credit crunch in the world economy, Chinese government, during the second half of 2008- the first half of 2010, made efforts to boost economy by increasing lending into markets. (Xu and Chen 2011) This evidence implies that, for example, U.S. investors can gain benefits by diversifying into China real estates. However, since the second half of 2011, Beijing sought to rein in money supply in a move to cool real estate boom and achieve a soft landing.

To test the impact of the U.S. subprime mortgage crisis on Asia-Pacific real estate markets, this paper divides the full sample into two subperiods – pre- and post-February 7, 2007 in which iShares Dow Jones U.S. Real Estate Index Fund hit record high level. Because data of pre-February 7, 2007 is available for iShares Dow Jones U.S. Real Estate Index Fund, iShares S&P/TSX Capped REIT Index Fund, and SPDR S&P/ASX 200 Listed Property Fund, this study runs co-integration analysis between iShares Dow Jones U.S. Real Estate Index Fund and iShares S&P/TSX Capped REIT Index Fund or SPDR S&P/ASX 200 Listed Property Fund.

For the period of pre-February 7, 2007, iShares Dow Jones U.S. Real Estate Index Fund and iShares S&P/TSX Capped REIT Index Fund have a significant co-integration relationship whereas iShares Dow Jones U.S. Real Estate Index Fund and SPDR S&P/ASX 200 Listed Property Fund don't have. This evidence is consistent with Liow and Sim (2006) in which the U.S. real estate index has relatively low correlation with the Asian real estate indexes over the period of 1990-2003.

By comparison, after financial crisis, two cases all show significant long-term equilibrium relationship. These results indicate that the U.S. subprime mortgage crisis had weighed on Australia's real estate markets. At the time Australian REITs experienced financing problems due to the global credit crunch resulting from the collapse of global investment banks. According to the report by the September 2009 ASX Investor Update (2009), Australian REIT stock prices have tendency to move in tandem with U.S. large banks stock prices.[7]

Despite bouncing back in home prices quickly in Canada after the global financial crisis and prolong slump in real estate prices in the U.S., U.S. and Canadian REIT ETFs seems to hold on to a long-term relationship before and after the global financial crisis.

Table 3B: Bivariate Co-integration Tests for S&P 500, XRE, SLF, TAO, IFAS, and NTRE pre-2007.2.7 and post-2007.2.8

S&P: S&P 500 index, XRE: iShares S&P/TSX Capped REIT Index Fund, SLF: SPDR S&P/ASX 200 Listed Property Fund, TAO: Guggenheim China Real Estate ETF, IFAS: iShares FTSE EPRA/NAREIT Developed Asia Index Fund, NTRE: NextFunds TOPIX-17 Real Estate ETF.

Variables		full sample		Pre-February 7, 2007		Post-February 7, 2007	
		λtrace	*λmax*	*λtrace*	*λmax*	*λtrace*	*λmax*
S&P-XRE	r = 0	9.565	9.562	17.512	17.498	9.018	9.014
	r < 1	1.833	1.832	7.64	7.162	1.960	1.960
S&P-SLF	r = 0	28.37**	28.270**	17.845	17.832	36.887***	36.869***
	r < 1	2.428	2.428	7.100	7.102	5.895	5.894
S&P-TAO	r = 0	28.298**	28.283**				
	r < 1	10.354	10.352				
S&P-IFAS	r = 0	25.806**	25.792**				
	r < 1	7.885	7.884				
S&P-NTRE	r = 0	13.251	13.242				
	r < 1	4.784	4.783				

Because REIT ETFs are traded on stock exchange like individual stocks, it is claimed that REIT ETFs might be in tandem with stock market index. To test this argument, this study runs bivariate co-integration analysis adding the S& 500 index instead of iShares Dow Jones

[7] Referred from article 'The outlook for listed property,' September 2009 ASX Investor Update, September 16, 2009 (www.asx.com.au).

U.S. Real Estate Index Fund. Liow (2010) compares the behavior of time-varying real estate-stock correlations at the local, regional, and global levels.

Table 3B reports the results of co-integration tests. The results show that there are significant co-integration relationships between the S&P 500 index and Guggenheim China Real Estate ETF, and iShares FTSE EPRA/NAREIT Developed Asia Index Fund, and SPDR S&P/ASX 200 Listed Property Fund. However, the S&P 500 index shows a weak linkage with iShares S&P/TSX Capped REIT Index Fund and NextFunds TOPIX-17 Real Estate ETF

In the pre-February 7, 2007, SPDR S&P/ASX 200 Listed Property Fund have no significant co-integration relationship. But in the post-February 7, 2007, it shows significant long-term equilibrium relationship with the S&P 500 index, suggesting that the influence of U.S. stock markets on Australia real estate markets has been growing after the 2007-2008 financial crisis. This evidence confirmed the argument that financial crisis has tendency to increase co-movement of equity prices across the world.

3. Granger Causality Test

Table 4A presents F-statistics of bi-directional Granger causality test results. The evidence in table 4A indicates that, for the full sample period, all Asia Pacific REIT ETFs are influenced by iShares Dow Jones U.S. Real Estate Index Fund. It is interesting to see that Guggenheim China Real Estate ETF bilateral Granger causality with iShares Dow Jones U.S. Real Estate Index Fund. A possible explanation of this finding is the fact that China was widely seen a signal of economic growth in the world that has been reeling from the global financial crisis. And one of drivers of growth came from the real estate markets and thereby performance of real estate market is being monitored outside of China.[8]

For pre- and post-February 7, 2007, iShares Dow Jones U.S. Real Estate Index Fund has a unilateral causal relationship on iShares S&P/TSX Capped REIT Index Fund and SPDR S&P/ASX 200 Listed Property Fund.

Overall results of Granger causality tests suggest that, for the short-term period, Asia-Pacific REIT ETFs are affected by the performance of U.S. REIT ETFs[9] suggesting that, on a short-term basis, there is little diversification benefits by investing in international real estate markets. These findings are not consistent with decoupling argument in which Asia-

[8] "China: too big to ignore," www.cnnfn.com, January 1, 2010
[9] "Around the world, stock markets fell and rose, together," www.nytimes.com, 2009.9.11.

Pacific stock markets has been moving away from U.S. stock market over years.[10]

Table 4A: Bi-directional Granger causality Tests for IYR, XRE, SLF, TAO, IFAS, and NTRE pre-2007.2.7 and post-2007.2.8

IYR: iShares Dow Jones U.S. Real Estate Index Fund, XRE: iShares S&P/TSX Capped REIT Index Fund, SLF: SPDR S&P/ASX 200 Listed Property Fund, TAO: Guggenheim China Real Estate ETF, IFAS: iShares FTSE EPRA/NAREIT Developed Asia Index Fund, NTRE: NextFunds TOPIX-17 Real Estate ETF.

	full sample	Pre-February 7, 2007	Post-February 7, 2007
IYR → XRE	16.4423***	14.1694***	10.7304***
XRE → IYR	1.4895	3.5563**	3.9524**
IYR → SLF	150.6669***	18.5284***	104.3378***
SLF → IYR	0.7134	1.3044	0.9346
IYR → TAO	3.8556***		
TAO → IYR	4.7248**		
IYR → IFAS	8.3132***		
IFAS → IYR	2.2089		
IYR → NTRE	120.0144***		
NTRE → IYR	0.2726		

Note: F-statistics are reported in the table. The critical value are taken from simulation in RATs, ***, ** indicates significance at 1%, 5% level.

Table 4B reports results of F-statistics of bi-directional Granger causality tests with the S&P 500 index and Asia Pacific ETFs. Contrary to the evidence presented in Table 4A, Guggenheim China Real Estate ETF doesn't show any bilateral causal relationship with the S&P 500 index. It may be interpreted that China has been pushing their own policy to pump up or rein in real estate markets. With such Chinese government policy, the performance of Chinese real estate markets might have weighed on U.S. stock market performance.

Meanwhile, S&P 500 index shows unilateral causal relationship with iShares S&P/TSX Capped REIT Index Fund, SPDR S&P/ASX 200 Listed Property Fund, iShares FTSE EPRA/NAREIT Developed Asia Index Fund, and NextFunds TOPIX-17 Real Estate ETF, implying that, on a short-term basis, the U.S. stock market has an influence on Asia Pacific

[10] "Asian growth revives decoupling concept," www.wsj.com, 2009.9.14.

real estate stock performance.

Table 4B: Bi-directional Granger causality Tests for S&P, XRE, SLF, TAO, IFAS, and NTRE pre-2007.2.7 and post-2007.2.8

S&P: S&P 500 index, XRE: iShares S&P/TSX Capped REIT Index Fund, SLF: SPDR S&P/ASX 200 Listed Property Fund, TAO: Guggenheim China Real Estate ETF, IFAS: iShares FTSE EPRA/NAREIT Developed Asia Index Fund, NTRE: NextFunds TOPIX-17 Real Estate ETF.

	full sample	Pre-February 7, 2007	Post-February 7, 2007
S&P → XRE	9.4205***	9.3181***	4.2569**
XRE → DOW	4.2355**	2.5017	2.8583
S&P → SLF	153.6654***	7.2967***	127.6896***
SLF → S&P	1.0149	1.2238	1.4583
S&P → TAO	1.5995		
TAO → S&P	3.4551**		
S&P → IFAS	8.5995***		
IFAS → S&P	0.4245		
S&P → NTRE	155.1707***		
NTRE → S&P	0.3654		

Note: F-statistics are reported in the table. The critical value are taken from simulation in RATs, ***, ** indicates significance at 1%, 5% level.

4. Spillover Effects

Table 5A.a. shows that, for full sample period, return and volatility spillover effects from iShares Dow Jones U.S. Real Estate Index Fund appear to be statistically significant for all 5 Aisa Pacific REIT ETFs, suggesting an influence of U.S. real estate markets on Asia-Pacific real estate markets. However, there are no significant return and volatility spillover effects from Asia-Pacific REIT ETFs to iShares Dow Jones U.S. Real Estate Index. It is believed that Asia-Pacific real estate markets have their eyes on the U.S. real estate market conditions.

Table 5A.b and Table 5A.c report the return and volatility spillover effects before and after the global finance crisis. Before the global finance crisis, iShares Dow Jones U.S. Real Estate Index Fund has return and volatility spillover effects on iShares S&P/TSX Capped REIT Index Fund, and not vice versa. However, after the global financial crisis, the return

and volatility spillover effects between iShares Dow Jones U.S. Real Estate Index Fund and iShares S&P/TSX Capped REIT Index Fund turn out to be bilateral. In case of SPDR S&P/ASX 200 Listed Property Fund, return spillover effects from iShares Dow Jones U.S. Real Estate Index Fund to SPDR S&P/ASX 200 Listed Property Fund got stronger after the 2007-2008 global financial crisis. That is, the return and volatility spillover effects are more pronounced on the global financial crisis.

These results suggest that, despite of locality of real estate markets, U.S. real estate markets leads Asia-Pacific real estate markets in REIT ETF performance. Particularly, after post-February 7, 2007, bilateral the return and volatility spillover effects got more significant. Hoesil and Reka(2011) report that the U.S. has the largest spillover effects both internationally and domestically. This evidence is consistent with the previous findings that linkage across asset markets becomes stronger in the crisis period. (Liow 2010; Ding and Pu 2011)

Table 5A: Parameter estimates for variance-covariance equations of bivariate GARCH(1.1) for IYR, XRE, SLF, TAO, IFAS, and NTRE

IYR: iShares Dow Jones U.S. Real Estate Index Fund, XRE: iShares S&P/TSX Capped REIT Index Fund, SLF: SPDR S&P/ASX 200 Listed Property Fund, TAO: Guggenheim China Real Estate ETF, IFAS: iShares FTSE EPRA/NAREIT Developed Asia Index Fund, NTRE: NextFunds TOPIX-17 Real Estate ETF.

a. full sample									
	a_{11}	a_{12}	a_{21}	a_{22}	b_{11}	b_{12}	b_{21}	b_{22}	Log-likelihood
IYR-XRE	0.3173 (17.61)***	0.0637 (4.91)***	0.0278 (0.88)	0.2715 (11.84)***	0.9486 (158.94)***	-0.0149 (-3.81)***	-0.0085 (-0.56)	0.9397 (86.13)***	-7991.45
IYR-SLF	0.2771 (17.20)***	-0.0896 (-5.28)***	0.0200 (0.84)	0.3843 (15.45)***	0.9566 (202.88)***	0.0174 (2.61)***	0.0080 (0.58)	0.9079 (80.29)***	-9851.32
IYR-TAO	0.3612 (12.39)***	0.1222 (3.40)***	-0.0477 (-1.74)	0.1856 (6.79)***	0.9406 (100.52)***	-0.0263 (-3.19)***	0.0028 (0.30)	0.9716 (122.32)***	-5661.35
IYR-IFAS	0.2891 (10.01)***	-0.0629 (-2.55)***	0.0683 (2.26)**	0.2788 (11.49)***	0.9622 (96.50)***	0.0363 (3.85)***	-0.0359 (-2.52)**	0.9286 (77.89)***	-5427.23
IYR-NTRE	0.3537 (14.50)***	-0.0869 (-2.28)**	-0.0115 (-0.83)	-0.2605 (-10.57)***	0.9357 (117.45)***	0.0350 (2.56)***	-0.0031 (-0.37)	0.9448 (76.06)***	-5698.23
b. pre-Feb. 7, 2007									

IYR-XRE	-0.2277 (-7.47)***	-0.1095 (-3.53)***	-0.0195 (-0.31)	-0.2613 (-5.05)***	0.9433 (82.92)***	-0.0646 (-3.98)***	0.0188 (0.43)	0.9297 (26.82)***	-2684.36
IYR-SLF	-0.3079 (-9.07)***	-0.0198 (-0.52)	0.0281 (0.70)	0.4304 (-10.91)***	0.8907 (29.53)***	-0.0737 (-1.73)	0.0905 (2.22)**	0.7312 (13.54)***	-3314.45
c. post-Feb. 7, 2007									
IYR-XRE	0.3253 (12.00)***	-0.0553 (-3.16)***	0.2161 (4.74)***	0.2710 (8.26)***	0.9805 (94.65)***	0.0770 (7.55)***	-0.2425 (-9.52)***	0.8605 (57.91)***	-5275.7136
IYR-SLF	0.3946 (14.40)***	-0.1355 (-3.32)***	-0.0073 (-0.28)	-0.1825 (-6.68)***	0.9178 (87.62)***	0.1743 (10.65)**	-0.1519 (-10.48)***	0.9301 (72.97)***	-6501.35

Table 5B: Parameter estimates for variance-covariance equations of bivariate GARCH(1.1) for S&P, XRE, SLF, TAO, IFAS, and NTRE

S&P: S&P 500 index, XRE: iShares S&P/TSX Capped REIT Index Fund, SLF: SPDR S&P/ASX 200 Listed Property Fund, TAO: Guggenheim China Real Estate ETF, IFAS: iShares FTSE EPRA/NAREIT Developed Asia Index Fund, NTRE: NextFunds TOPIX-17 Real Estate ETF.

a. Full sample									
	a_{11}	a_{12}	a_{21}	a_{22}	b_{11}	b_{12}	b_{21}	b_{22}	Log-likelihood
S&P-XRE	0.2419 (17.16)***	0.0504 (3.28)***	0.0381 (2.11)**	0.3355 (12.44)***	0.9647 (220.10)***	-0.0042 (-0.80)	-0.087 (-1.05)	0.9151 (67.68)***	-7106.91
S&P-SLF	0.2412 (17.48)***	-0.0443 (-2.42)**	0.0152 (0.74)	0.4076 (16.73)***	0.9654 (255.12)***	0.0061 (1.12)	-0.0005 (-0.05)	0.9042 (81.48)***	-9024.34
S&P-TAO	0.3120 (8.89)***	0.1849 (3.01)***	-0.0734 (-2.25)**	-0.1934 (-3.68)***	0.9759 (76.34)***	0.3189 (8.86)***	-0.1079 (-9.75)***	0.8126 (36.77)***	-4971.04
S&P-IFAS	0.3421 (10.47)***	0.1447 (3.23)***	-0.0107 (-0.43)	0.1671 (5.39)***	0.9292 (81.62)***	-00505 (-3.39)***	0.0101 (1.34)	0.9898 (113.42)***	-4725.83
S&P-NTRE	0.3305 (13.80)***	-0.1266 (-1.86)**	-0.0247 (-2.14)**	-0.2887 (-10.04)***	0.9376 (117.55)***	0.0888 (2.95)***	-0.0081 (-1.18)	0.9303 (49.73)***	-5238.73
b. Pre-2007.2.7									

S&P-XRE	-0.1939 (-8.66)***	-0.0730 (-2.19)**	-0.0197 (-0.73)	-0.4639 (-9.43)***	0.9773 (175.66)***	0.0020 (0.13)	-0.0072 (-0.35)	0.7404 (14.79)***	-2407.65
S&P-SLF	-0.2087 (-10.30)***	-0.0252 (-0.85)	0.0446 (2.50)**	-0.4590 (-11.68)***	0.9747 (202.94)***	-0.0118 (-0.94)	0.0317 (1.96)	0.6602 (11.24)***	-3112.64
c. Post-2007.2.7									
S&P-XRE	0.2600 (12.57)***	0.0430 (2.14**)	0.0828 (2.43)**	0.3105 (9.55)***	0.9615 (145.44)***	-0.0099 (-1.52)	-0.0266 (-2.44)**	0.9398 (74.32)***	-4662.19
S&P-SLF	0.3235 (16.07)***	-0.1693 (-3.28)***	-0.0805 (-4.29)***	-0.2554 (-10.68)***	0.8736 (58.55)***	0.6102 (24.55)***	-0.3021 (-25.74)***	0.8066 (48.02)***	-5870.09

Table 5B.a shows that, for the full sample period, return spillover effects from the S&P 500 index appear to be significant for all 5 Asia Pacific REIT ETFs with iShares S&P/TSX Capped REIT Index Fund, Guggenheim China Real Estate ETF, and NextFunds TOPIX-17 Real Estate ETF showing bilateral relationship. The volatility spillover effects from the S&P 500 index are significant only for Guggenheim China Real Estate ETF, iShares FTSE EPRA/NAREIT Developed Asia Index Fund, and NextFunds TOPIX-17 Real Estate ETF. These findings indicate that, compared with the U.S. real estate market, the volatility spillover of the U.S. stock market are weak.

Table 5B.b and Table 5B.c show the results of the return and volatility spillover effects before and after the global financial crisis. Before the global financial crisis, the S&P 500 index has the return spillover effect on iShares S&P/TSX Capped REIT Index Fund. However, little volatility spillover effect is found among the S&P 500 index, iShares S&P/TSX Capped REIT Index Fund, SPDR S&P/ASX 200 Listed Property Fund.

After the global financial crisis, the return and volatility spillover effects among the S&P 500 index, iShares S&P/TSX Capped REIT Index Fund, SPDR S&P/ASX 200 Listed Property Fund appear to be strong. The evidence shows that the performance of Asia-Pacific REIT ETFs is driven by U.S. REIT ETFs rather than by U.S. stock market index.

V. Conclusions

The co-movement among international real estate markets has long drawn interests from investors. It is claimed that real estate markets come in all shape and size, each unique to their location and use. Such issue has to do with diversification benefits by investing in international real estates.

This paper addresses the issue of cross-border real estate market integration. To that end, first, this study analyzes linkages between U.S. and Asia-Pacific real estate markets by using a sample of six REIT ETFs – iShares Dow Jones U.S. Real Estate Index Fund, iShares S&P/TSX Capped REIT Index Fund, SPDR S&P/ASX 200 Listed Property Fund, Guggenheim China Real Estate ETF, iShares FTSE EPRA/NAREIT Developed Asia Index Fund, NextFunds TOPIX-17 Real Estate ETF.

Second, this paper tries to address the impact of the global financial crisis on real estate markets by analyzing co-movement across REIT ETFs before and after the U.S. subprime

mortgage crisis.

The findings suggest that Canada, Australia, and China but Japan REIT ETFs, for the long and short term, have strong co-movement with the U.S. REIT ETFs, implying that investors can't obtain benefits of diversified investment by spread their money into international real estate markets. Additional evidence shows that U.S. REIT ETFs lead Asia-Pacific REIT ETFs in term of return and volatility spillover effects. It is confirmed that, after the 2007-2008 global financial crisis, co-movement among U.S. and Asia-Pacific REIT ETFs got stronger. Arguably, the financial globalization might ramp up the linkage of U.S. and Asia Pacific real estate market.

Generally, performance of U.S. real estate and stock markets has a great deal of effects on Asia-Pacific securitized real estate markets. But the results suggest that the real estate market has larger impact than the stock market. The caveat is that, because Guggenheim China Real Estate ETF and iShares FTSE EPRA/NAREIT Developed Asia Index Fund are traded on NYSE, their performance might be partly affected by events in the U.S. stock market.

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