Upswings of Hong Kong Real Estate Prices in Post-Crisis Surge: Quantitative Easing and REIT Markets Developments

By

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Abstract

This paper examine whether the quantitative easing policy conducted in Japan, EU and the US raised the real estate prices in Hong Kong through the development in the Hong Kong REIT market. The empirical results show that the quantitative easing policy affected the price of real estate, and the H-REIT prices led to a rise in office price after a lag of two periods. This finding appears in a carry trade senior, which seems to be a plausible senior. Moreover, this finding is sharper in the high grade office price than in the low grade office price. These findings imply that the quantitative easing policy spillover did not restrict only to the money market, but also markets in the real sectors immediately through the development in the REIT market. Also, the quantitative easing served as inflow of hot money that had a greater spillover effect on higher office grade than the lower office grade.

Keywords: Quantitative Easing; REIT market developments; real estate prices; carry trade.
JEL Classification Numbers: G01; G12; O16

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Abstract

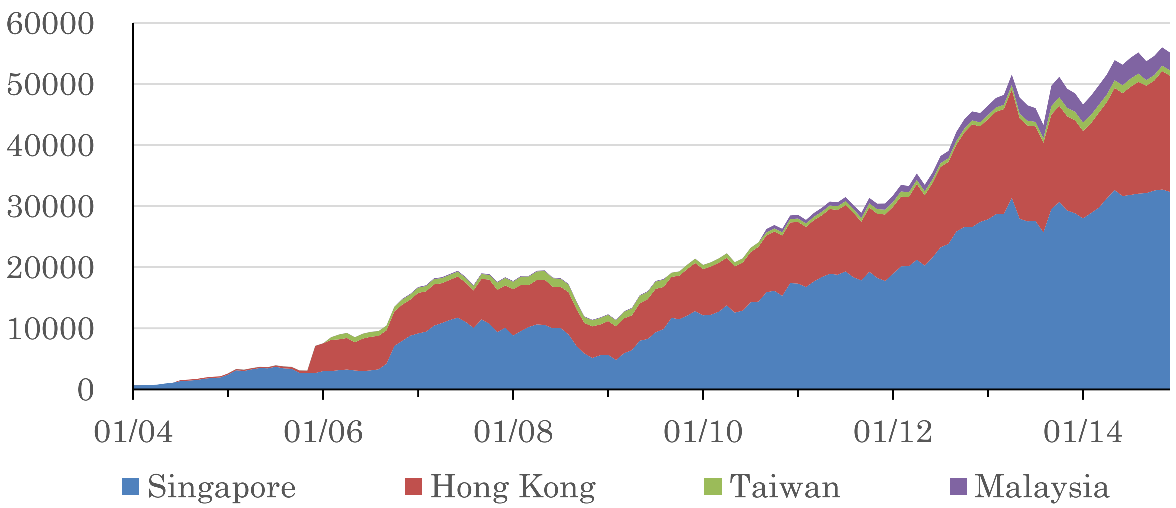
This paper examine whether the quantitative easing policy conducted in Japan, EU and the US raised the real estate prices in Hong Kong through the development in the Hong Kong REIT market. The empirical results show that the quantitative easing policy affected the price of real estate, and the H-REIT prices led to a rise in office price after a lag of two periods. This finding appears in a carry trade senior, which seems to be a plausible senior. Moreover, this finding is sharper in the high grade office price than in the low grade office price. These findings imply that the quantitative easing policy spillover did not restrict only to the money market, but also markets in the real sectors immediately through the development in the REIT market. Also, the quantitative easing served as inflow of hot money that had a greater spillover effect on higher office grade than the lower office grade.

1. Introduction

Simply defined, the quantitative easing (QE) policy was aimed to increase the monetary base through the buying of the government bonds or assets so as to induce lower interest rates. Recent studies have focused on the impact of the QE policy on the stock markets in advanced industrialized countries. Since the 2008 crisis, however, studies in Japan, European Union (EU) and the US have examined the international spillovers of the QE policy on the stock and bond markets. For example, Lim and Mohapatra (2016) and Duca *et al*. (2016) examined the bond prices, Tillmann (2016) found significant effects on the stock prices of developing and developed country. Brana *et al*. (2012) also found that excess liquidity at the global level has spillover to the output and price in Asian and other emerging countries, while the impact on the real estate price in emerging countries is less clear. Engsted *et al*. (2016) used the quarterly data of 18 OECD countries from 1970 to 2013 to study the housing market bubbles, while Vansteenkiste and Hiebert (2011) studied the housing price increase in the Euro area. However, these studies did not touch on the relationship between housing price bubbles and the QE policy,

According to the International Monetary Fund report (IMF, 2014, p. 35) the housing prices in Hong Kong, Malaysia, Singapore and Taiwan had increased rapidly since the 2008 crisis. Such movement in real estate price corresponded closely to the development of the Real Estate Investment Trust (REIT) markets in Asia, as shown in Figure 1. Indeed, the REIT outstanding in Singapore and Hong Kong has, respectively, ranked the 7th and 8th world largest, as seen in Table 1. The REIT provides to its beneficiaries a stream of income derived from rents with long contracts that work similar to real estate ownerships. Since the REIT can diversify its risk in various trust funds traded in the market, the REIT effectively incorporates the merits of stock investment into real estate investment. As such, the developments in the Asian REIT could have enabled the rise in housing price by the finance shock of capital inflow through the REIT markets in the post-2008 crisis period.

Figure 1 Market Capitalization in the Asian REIT Market (US$ million)



Source: Compiled by authors based on S&P data.

The purpose of this paper is to ask whether the QE policy in Japan, EU and the US has increased the real estate prices in Hong Kong through the development in the Hong Kong REIT (H-REIT) market. We use the H-REIT monthly price data from January 2005 to December 2014 mainly because Hong Kong is the only Asian economy that has a complete set of housing, shopping mall and the various grades of office price data. Through the use of the H-REIT development, this study shall clarify whether the QE policy would spillover to influence the real estate market, including the impact on different grades of offices.

Section 2 briefly reviews the data used and the development of the H-REIT markets since 2005. Section 3 describes the econometric methodology. Section 4 shows the preliminary analyses, Section 5 reports the empirical results and examines how the real estate price and the stock price are affecting the H-REIT prices from the two events in 2008 and 2011. Section 6 presents the concluding remarks.

2. Data and Overview

The H-REIT was first listed in the Hong Kong Stock Exchange in November 2005, and by November 2014, a total of 12 H-REITs are listed. As of November, 2014, the H-REIT market has become the third biggest in Asia following Japan and Singapore, and is the world's 8^{th} largest in the amount of outstanding (see Table 1). The share of the US-REIT in the world reached 60.2% at the end of November 2014, which surpassed the second largest of Australia (6.3%) and the third of Japan (6.1%). The world's largest eight REITs occupied 93% of the world total, as shown in Table 1.

Table 1 REITs Outstanding in the World Market (End of November, 2014)

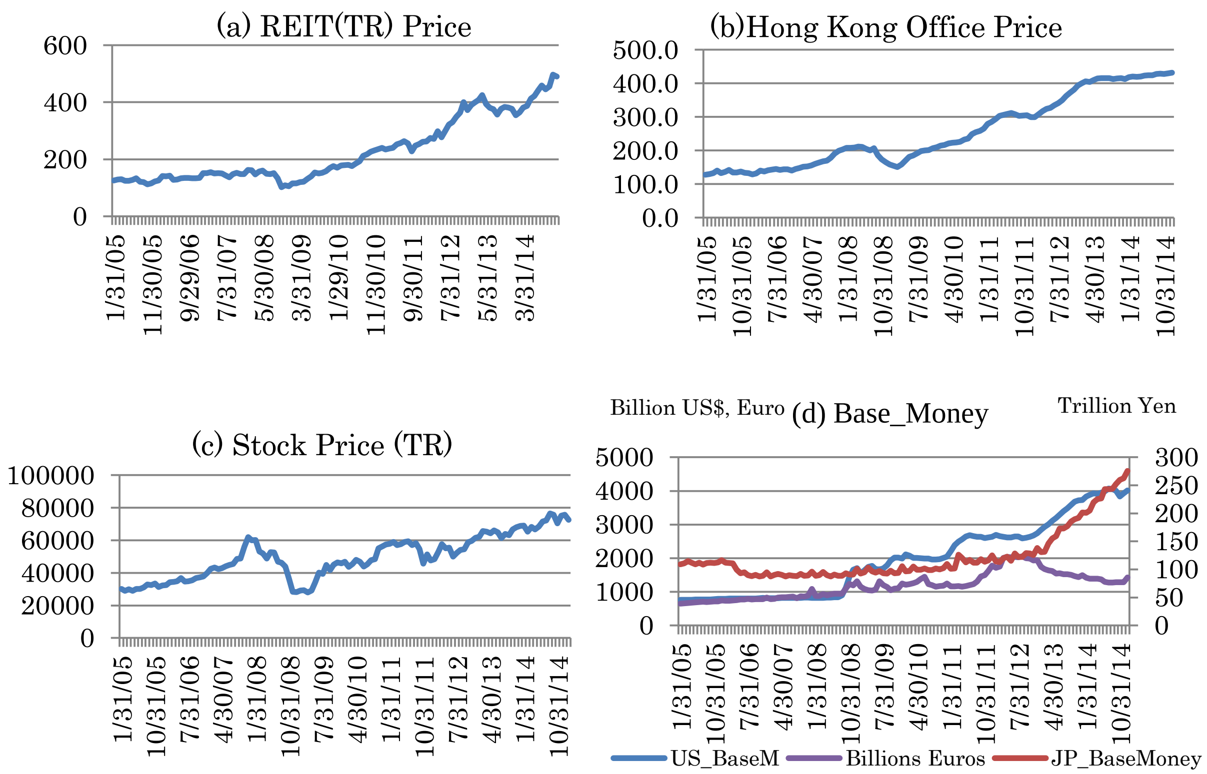
Order	Country	Number of REITs	Market Capitalization (US$ million)	World Ratio (%)
1	USA	231	825,493	60.2
2	Australia	52	86,169	6.3
3	Japan	46	84,100	6.1
4	France	33	75,041	5.5
5	UK	22	66,069	4.8
6	Canada	49	55,549	4.0
7	Singapore	37	52,049	3.8
8	Hong Kong	12	26,812	2.0
	Others	183	100,493	7.3
	Total	665	1,371,775	100.0

Source: MSCI ACWI REIT Index Fact Sheet.

As seen in Figure 2, the total return (TR) of H-REIT that includes the H-REIT price and dividend has increased rapidly from 100 to 500 index points in six years between September 2008 and end of 2014. Corresponding to the increase of the H-REIT(TR) price, the office price in Hong Kong also has a three-fold increase. Similar to other REITs, the H-REIT has various types of real estates in its portfolio, including offices, houses, commercial facilities and hotels, and the unified or composite type that includes several kinds of real estates based on assets holding. Thus, besides the price of office, the prices of houses, commercial facilities and hotels also increased.

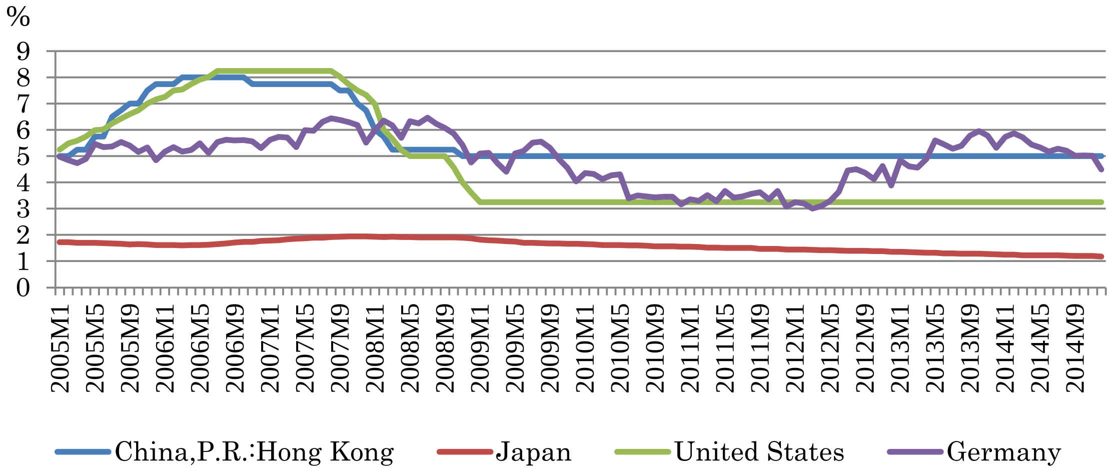
The US and EU have implemented QE policy by increasing the supply of money base beginning from September 2008. In the case of Japan, after conducted the QE policy between 2000 and 2006, the QE policy was redeployed in 2013. Studies, such as Tillmann (2016), have shown the spillover effects of the QE policy to both developed and developing countries. In the case of Hong Kong, the spillover effect from QE to the stock price can visually be seen in Figure 2. However, the world REIT markets shown in Table 1 and Figure 1 are relatively young markets when compared to the more matured stock markets. Although the H-REIT has been established in 2005 and there is strong evidence based on the visual presentation, the spillover effect has to be confirmed using strong analytical methodology.

Figure 2 Office, REIT(TR), STOCK Price Index in Hong Kong and Base Money



The discussion on how the QE has affected the stock prices of Hong Kong is far from adequate. The investigation in this paper includes the use of a carry trade scenario proposed by McKinnon (2011, 2012). This scenario appears when large interest rate differentials have given rise to investment in assets with high interest rate returns or dividends while the investment funds were borrowed at low interest rates. For comparison, the lending rates of Hong Kong, Japan, US and EU are shown in Figure 3.

Figure 3 Lending Rates



3. Econometric Methodology

To examine quantitatively the dependency (co-movement) of the H-REIT price, the stock price and the real estate price expressed in logarithm, we assume that the data used in $Y_t = (y_{1,t}, \cdots, y_{3,t})'$ are possibly generated from a nonstationary VAR(p) model with constant terms of A_0, Γ, Φ, the exogenous variables $\Delta X_{t-1} = (\Delta x_{1,t-1}, \cdots, \Delta x_{3,t-1})'$ and the Gaussian errors ε_t:[1]

$$Y_t = A_0 + \sum_{i=1}^{p} A_i \, Y_{t-i} + \Phi \Delta X_{t-1} + \varepsilon_t, \quad t = 1, \cdots, T. \tag{1}$$

Equivalently expressed in an error correction form, the model becomes:

$$\Delta Y_t = A_0 + \sum_{i=1}^{p-1} \Gamma_i \, \Delta Y_{t-i} + \Pi \, Y_{t-i} + \Phi \Delta X_{t-1} + \varepsilon_t, \tag{2}$$

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[1] The H-REIT price will be given by the discounted sum of future cash flows of real estate. The future cash flows are generally affected by the past housing price index and stock price index, which are assumed to be a linear function of those variables. Other factors affecting the H-REIT price are included in stochastic term. Most empirical studies in time series analysis for stock markets use VAR model.

where $\Pi = I - \sum_{i=1}^{p} A_i$ and $\Gamma_i = -\sum_{j=i+1}^{p} A_j \ (\mathrm{i} = 1, ..., \mathrm{p}-1)$. Johansen (1991) showed that if Y_t is cointegrated, the coefficient matrix Π has a reduced rank of r and can be represented as $\Pi = \alpha\beta^{'}$, where α and β are $n \times r$ matrices. We test the rank of Π in order to determine the precise data generating process.

On the basis of preliminary analysis for cointegration ('non-cointegration' shown in Appendix 1, we apply the following data generating process that consists of the H-REIT price return, the stock price return and the real estate price return:[2]

$$\Delta Y_t = A_0 + \Gamma_1 \ \Delta Y_{t-1} + \Phi \Delta X_{t-1} + \varepsilon_t. \quad t = 1, \dots, T. \tag{3}$$

The error term ε_t follows a multivariate EGARCH model with *constant* conditional *correlation* (CC) proposed by Bollerslev (1990) as $\varepsilon_t | \Omega_{t-1} \sim N(\mathbf{0}, \mathbf{H}_t)$, where Ω_{t-1} denotes the information set up to time t – 1. The variance–covariance matrix ($\mathbf{H}_t$) is factorized into the product of variance and correlation matrices:

$$\mathbf{H}_t = \mathbf{D}_t \mathbf{R} \mathbf{D}_t, \qquad \mathbf{R} = \begin{pmatrix} 1 & \rho_{12} & \rho_{13} \\ \rho_{12} & 1 & \rho_{23} \\ \rho_{13} & \rho_{23} & 1 \end{pmatrix}, \quad \mathbf{D}_t = \begin{pmatrix} \sqrt{h_{11,t}} & 0 & 0 \\ 0 & \sqrt{h_{22,t}} & 0 \\ 0 & 0 & \sqrt{h_{33,t}} \end{pmatrix}, \tag{4}$$

where $\mathbf{D}_t = diag\left(\mathrm{h}_{11,t}^{1/2}, \cdots, \mathrm{h}_{33,t}^{1/2}\right)$ is a diagonal matrix of variances, and $\mathbf{R}$ is an 3×3 constant correlation matrix.[3] The conditional variance of the *i*th element follows a univariate EGARCH model as explored in Nelson (1991):

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[2] The Augmented Dickey–Fuller (ADF) tests for a unit root show that all data are I(1) processes. The Schwartz Information Criterion (SIC) indicates a lag length of p = 2 in (1). There are no cointegration relationships, which is resulted from the trace test. Moreover, for any lag length p=2, 3, 4, and 5, there are no cointegration relationships. Based on these observations, we apply the model in equation (3). See Appendix 1.

[3] We found that the estimated ρ_{12}, ρ_{13} and ρ_{23} yield the positive definite of conditional covariance matrix, H_t.

$$\log(\mathrm{h}_{\mathrm{ii,t}}) = \alpha_{\mathrm{i0}} + \alpha_{\mathrm{i1}}(|u_{\mathrm{i,t-1}}| - E(|u_{\mathrm{i,t-1}}|)) + \beta_{\mathrm{i1}}\log(\mathrm{h}_{\mathrm{ii,t-1}})$$
$$\text{where } \mathrm{u}_{\mathrm{i,t-1}} = \varepsilon_{\mathrm{i,t-1}}/\sqrt{\mathrm{h}_{\mathrm{ii,t-1}}} \quad \text{for i} = 1,2,3 \qquad , \tag{5}$$

where $\alpha_{\mathrm{i2}} < 0$ *in* $\alpha_{\mathrm{i2}}u_{\mathrm{i,t-1}}$ showing asymmetrical effects are excluded for a parameter saving. In fact, we cannot find asymmetrical effects in two of the equations. The CC-EGARCH approach can be summarized as follows. The conditional variance is formulated in Equation (5), and the constant correlation coefficients are formulated in Equations (4).[4] Using the conditional variance and the constant correlation coefficients yields the conditional variance covariance matrix ($\mathbf{H}_{\mathrm{t}}$). The maximum likelihood method is applied to estimate the correlation coefficients ρ, the conditional variance $\alpha_{\mathrm{i0}}, \alpha_{\mathrm{i1}}, \alpha_{\mathrm{i2}}, \beta_{\mathrm{i1}}$ *for* $i = 1,2,3$, and additional parameters in the mean equations in Equation (3). The full set of parameters for both the mean equations in Equation (3) and the multivariate CC-EGARCH specification in Equation (4) and Equation (5) is denoted by θ. Based on a sample of size T, the log-likelihood function L is

$$L(\theta; \Delta Y_1, \ldots, \Delta Y_t) = -\frac{1}{2}\sum_{t=1}^{T}\left\{\log(2\pi) + \log\det(H_t) + \varepsilon_t H_t^{-1}\varepsilon_t'\right\}. \tag{6}$$

We calculate several coefficients using the CC-EGARCH model. The sequence of verification is shown as follows:

1. In Section 4, we describe the statistics of the data and their sources. Tables 2 and 3 report the results.
2. In Section 5.1, we use the maximum likelihood method and estimate the parameters of θ for the CC-EGARCH model in Equations (3), (4) and (5). The results are reported in Table 4 for the causality between the H-REIT, stock and real estate (office prices), together with Japan, the US and the EU QE policy's spillover effects. The estimated results show the determinants

[4] The dynamic conditional correlation (DCC) proposed by Engle (2002) was applied, but we found that the correlation was not dynamic but constant. These results are not shown in the text.

of the office price. The spillover effects of QE policy appears in the H-REIT price, which causes the office price with some time lags. If so, the development in the new H-REIT market created a new channel for the QE policy to spillover to the real estate price. Thus, the financial shock could have an immediate impact on the real economy.

3. In Section 5.2, we show that a carry trade scenario proposed by McKinnon (2011, 2012) appears. Each lending rate is shown in Figure 4. The results are reported in Table 5.
4. In Section 5.3, we use the data for the office price and housing price differently depending on the grade. These results will show which grade is affected by the QE policy with higher or lower grade prices. The results are reported in Table 6.

4. Data Description and Preliminary Analysis

The monthly data comprise of the H-REIT(TR) price index, the STOCK(TR) price index and Office Prices index for the period between January 2005 and December 2014, compiled by using the S&P Capital IQ dataset. We also consider the monthly monetary base of Japan (line:14...ZK.; trillion yen.), US (line:19MA.ZF; billion US$), and the EU (line: 14..UZK; billion Euro) obtained from the International Financial Statistics. We use the following notation.

$\Delta y_{1,t}$: H-REIT(TR) price index return at time t;

$\Delta y_{2,t}$: STOCK(TR) price return at time t;

$\Delta y_{3,t}$: Office price index return at time t;

$\Delta x_{u,t}$: US monetary base growth at time t;

$\Delta x_{j,t}$: Japan monetary base growth at time t; and

$\Delta X_{e,t}$: Euro monetary base growth at time t.

All variables are logarithmic differenced. Figures 2(a), 2(b) and 2(c) show the data for the H-REIT(TR) price index, office price index, stock(TR) price index, respectively. The exogenous variables of the monthly monetary base of the US, Japan and the EU are shown in Figure 2(d). We observe the following characteristics: (i) all variables have changed along with each other over time; and (ii) all variables increased rapidly after the global financial crisis in 2008–2009. Table 2 reports the descriptive statistics for the price index returns, shown as: $\Delta Y_t = \left(\Delta y_{1,t},\ \Delta y_{2,t},\ \Delta y_{2,t}\right)'$, and confirms the stylized facts on asset return in the form of highly significant skewness, high kurtosis, and significant autocorrelations in squared yields. Table 3 shows the contemporaneous unconditional correlations between the different returns. The order of the three market returns are shown according to the degree of correlation with the H-REIT(TR) price index returns. The STOCK(TR) price index return has the highest correlations, while the office price index return has lower correlations.

Table 2 Descriptive Statistics for the Price Index Returns

	Mean	Std. dev	Skew	Ex-Kurt	Q(4)	Q(4)-2
H-REIT(TR) Price	1.17	5.51	-1.31	4.53	1.00	3.38
STOCK(TR) Price	0.81	6.24	-0.79	2.87	3.52	13.22
Office Price	1.12	2.89	-0.30	4.30	40.60	13.02

Notes: Q(4) denotes the Ljung–Box statistic with four lags for the log-difference variable, and Q(4)-2 denotes the corresponding statistics for the squares of those variables. The 10% critical value of the Q(4)-statistic is 7.78.

Table 3 Contemporaneous Unconditional Correlations between Price Returns

	H-REIT(TR) Price	STOCK(TR)	Office Price
H-REIT(TR) Price	1.00		
STOCK(TR) Price	0.61	1.00	
Office Price	0.34	0.39	1.00

5. Empirical Results

5.1. Parameter Estimates

Based on the preliminary analysis shown above, we estimate a VAR model from Equations (4), (5) and (7), shown as:

$$\Delta Y_t = A_0 + \Gamma_1 \Delta Y_{t-1} + \Phi_D \Delta X_{t-1} + \varepsilon_t : \boldsymbol{\varepsilon}_t \big| \Omega_{t-1} \sim N(\mathbf{0}, \mathbf{H}_t) \quad , t = 1, \dots , T \tag{7}$$

$$\Gamma = \begin{pmatrix} \gamma_{1R}, & \gamma_{1S}, & \gamma_{1O} \\ \gamma_{2R}, & \gamma_{2S}, & \gamma_{2O} \\ \gamma_{3R}, & \gamma_{3S}, & \gamma_{3O} \end{pmatrix} , \quad \Phi_D = \begin{pmatrix} \phi_{1U} + \phi'_{1U} D_t & \phi_{1J} + \phi'_{1J} D_t, & \phi_{1E} + \phi'_{1E} D_t \\ \phi_{2U} + \phi'_{2U} D_t & \phi_{2J} + \phi'_{2J} D_t & \phi_{2E} + \phi'_{2E} D_t \\ \phi_{3U} + \phi'_{3U} D_t & \phi_{3J} + \phi'_{3J} D_t & \phi_{3E} + \phi'_{3E} D_t \end{pmatrix} , \quad \Delta X_{t-1} = \begin{pmatrix} \Delta x_{u,t} \\ \Delta x_{j,t} \\ \Delta x_{e,t} \end{pmatrix} ,$$

$$D_t = \begin{cases} 1, & \text{if Sep.2008} \le t \\ 0, & \text{other} \end{cases}$$

The parameters are γ_{1R} (H-REIT to H-REIT), γ_{1S} (STOCK to H-REIT) and γ_{1O} (Office to H-REIT) . The results in Table 4 reveal the first finding that all the estimated EGARCH terms, α_{i1} and β_{i1} in Equation (5), as well as the constant conditional correlations ρ_{12}, ρ_{13} and ρ_{23} in Equation (4) are significant.[5] Moreover, when compared to the alternative model, namely the Dynamic Conditional Correlation-EGARCH (DCC-EGARCH), we found that the dynamic conditional correlations for $\rho_{12,t}, \rho_{13,t}$ and $\rho_{23,t}$ are constant over time by using both statistical test and visual inspection (not shown in the paper). This implies that the CC-EGARCH specification is valid for modeling price index returns. The results in Table 4 reveal the findings for causality. The significant-causality from H-REIT to office price, $\gamma_{1R} = 0.120 > 0$, is shown at 5% significance level. The adverse direction does not hold, while we can find stylized fact such that the causality from stock to office price as pointed out in other studies.

One interesting finding is that the increases of base money in Japan and the EU have a positive causality on the H-REIT(TR) price in pre-2008 period: ϕ_{ij}=1.222 and ϕ_{iE}=0.155. In the post-2008 crisis period, however, the effects of monetary base by Japan and the EU show a positive but smaller price increase on the H-REIT(TR) price: $\phi_{ij}+\phi'_{ij}$ =1.222-1.011=0.211 and $\phi_{iE}+\phi'_{iE}$ =0.155-0.140=0.015. On the other hand, the increases of the monetary base in Japan and the EU have

[5] Note that the asymmetric effect of volatility α_{i2} <0 is not found in the H-REIT, Stock and Office market. We found that the estimated ρ_{12}, ρ_{13} and ρ_{23} yield the positive definite of conditional covariance matrix, H_t. Tables 4 to 6 show the positive definite for H_t.

the same effects on the office price increase, which is the direct effect on the office price, but is smaller than the effect on the H-REIT(TR) price. The result implies that the QE policy in Japan and the EU cause the H-REIT price to increase more than the office price, while the indirect effect on the office price through the H-REIT price is relatively large. Thus, the H-REIT price increase contributes an important role to the increase of office prices in Hong Kong. In Equation (7), we include the lag three variables $0.026\ for \Delta y_{1,t-1}$, $0.008\ for\ \Delta y_{1,t-2}$, $0.120\ for\ \Delta y_{1,t-3}$ in the third equation, $\Delta y_{3,t}$, which gives an equation on the office price. Since it is only the coefficient of 0.120 in the REIT price $\Delta y_{1,t-3}$ is significant, we then denote 0.120** in Table 4. We conclude that impact of the H-REIT price on the office price could have some time lag when compared to the stock price.

Table 4 Parameter Estimates of CC-EGARCH Model

	γ_{iR}	γ_{iS}	γ_{iO}	ϕ_{iu}	ϕ_{ij}	ϕ_{iE}	ϕ'_{iu}	ϕ'_{ij}	ϕ'_{iE}
H-REIT	-0.275**	0.233**	0.089	-0.625**	1.222**	0.155**	0.350**	-1.011**	-0.140**
	(-4.48)	(5.10)	(0.83)	(-6.94)	(3.16)	(2.95)	(3.48)	(-2.59)	(-2.69)
STOCK	-0.292**	0.262**	0.215	-0.600**	1.348**	0.026	0.298**	-1.460**	-0.236**
	(-2.98)	(2.65)	(1.63)	(-4.56)	(3.53)	(0.311)	(2.69)	(-3.21)	(-3.14)
OFFICE	0.120**	0.065**	0.311**	-0.086**	0.388**	0.054**	0.019	-0.375**	-0.022
	(8.77)	(3.06)	(6.45)	(3.46)	(3.21)	(4.75)	(0.78)	(-2.88)	(-1.00)

Notes: T-statistics are shown in parentheses. * and ** are significant at 10% and 5% level, respectively.

5.2. A Carry Trade Scenario

We construct a VAR model from Equations (4), (5) and (8).

$$\Delta Y_t = A_0 + \Gamma_1 \Delta Y_{t-1} + \Phi_D \Delta \tilde{X}_{t-1} + \varepsilon_t : \boldsymbol{\varepsilon}_t \left| \Omega_{t\text{-}1} \sim N\left(\mathbf{0}, \mathbf{H}_t\right) \right. \quad , \text{t} = 1, \dots, \text{T} \qquad (8)$$

$$\Gamma_1 = \begin{pmatrix} \gamma_{1R}, \ \gamma_{1S} \ , \gamma_{1O} \\ \gamma_{2R}, \ \gamma_{2S} \ , \gamma_{2O} \\ \gamma_{3R}, \ \gamma_{3S} \ , \gamma_{3O} \end{pmatrix}, \Phi \ = \begin{pmatrix} \phi_{1U} & \phi_{1J} & \phi_{1E} \\ \phi_{2U} & \phi_{2J} & b_{2E} \\ \phi_{3U} & b_{3J} & \phi_{3E} \end{pmatrix}, \Delta \tilde{X}_{\text{t-1}} = \begin{pmatrix} \Delta \tilde{x}_{u,t} \\ \Delta \tilde{x}_{j,t} \\ \Delta \tilde{x}_{e,t} \end{pmatrix},$$

where

$\tilde{\Delta} x_{u,t} \equiv \max(0,\ Hong\ Kong\ \ lending\ Rate - US\ lending\ rate) * \Delta x_{u,t}$,

$\tilde{\Delta} x_{j,t} \equiv \max(0,\ Hong\ Kong\ \ lending\ Rate - Japan\ lending\ rate) * \Delta x_{j,t}$,

$\tilde{\Delta} x_{e,t} \equiv \max(0,\ Hong\ Kong\ \ lending\ Rate - EU\ lending\ rate) * \Delta x_{e,t}$

Equation (8) is different from Equation (7) in a sense that there are no dummy variable for the post-2008 crisis, and inflow of monetary base of the US, Japan and the EU to Hong Kong are relative to the lending rate spreads. However, the large increase in the lending rate spreads after the 2008 crisis can be used as the dummy variables for Φ_D in Equation (7). The lending rate spreads are positive since the post 2008 crisis.

Table 5 reveals the impacts from the QE policy through the H-REIT market. The H-REIT price determinant was the Japanese monetary base adjusted by the lending rate spread (Japan carry trade) between Japan and Hong Kong (significantly positive $\phi_{1j} = 0.095 > 0$) and not the US carry trade. Japan's lending rate spread of 4% was much larger than the US's lending rate spread of 2%, as seen in Figure 4. The extent of increase from the H-REIT price to the office price can be seen from the coefficient $\gamma_{3R} = 0.123$. In general, the coefficients are similar to those shown in Table 4. As such, the dummy variables in Equation (8) can also be considered by the lending rate spreads. The stylized fact that the stock price increases the real estate price can be found by examining the coefficient $\gamma_{3S} = 0.068$. In Equation (8), we include the lag three variables such that $0.015\ for\ \Delta y_{1,t-1},\ 0.048\ for\ \Delta y_{1,t-2},\ 0.061\ for\ \Delta y_{1,t-3}$ in $\Delta y_{3,t}$ that show the equation for the office price. The coefficients of the REIT price $\Delta y_{1,t-1}, \Delta y_{1,t-2}, \Delta y_{1,t-3}$ are all significantly positive, giving a sum of 0.124.

Table 5 Parameter Estimates with a Carry Trade

	γ_{iR}	γ_{iS}	γ_{iO}	ϕ_{iu}	ϕ_{ij}	ϕ_{iE}
H-REIT	-0.242**	0.183**	0.094	-0.131**	0.095**	0.023
	(-5.60)	(3.73)	(0.73)	(-4.14)	(2.81)	(0.59)
STOCK	-0.265**	0.146*	0.378**	-0.181*	0.057	-0.082
	(-4.04)	(1.69)	(2.48)	(-1.85)	(1.58)	(-1.51)
OFFICE	0.124**	0.068**	0.343**	-0.037**	-0.002	-0.006
	(7.73)	(7.13)	(9.15)	(-3.67)	(-0.22)	(-0.37)

Notes: T-statistics are shown in parentheses. * and ** are significant at 10% and 5% level, respectively.

5.3. The QE Effects on the Different Grades of Offices

We investigate the spillover effects of QE on the price of different office grades (A or C) in Hong Kong. In Hong Kong, grade A offices are located in prime areas, while grade C offices are located in the outskirt of the prime office areas. The data for both grades A and C are shown in Figure 4. The hot money inflow through the QE policy could play a speculative role. If so, the spillover effect would be that the price of grade A office is higher than both the grade C office and the overall price (used in Table 4). Next, we similarly use the VAR model shown in Equations (4), (5) and (8) and replace the overall office data by the office grade A and C data as $\Delta y_{3,t}$.

Figure 4 Hong Kong Office Price Indexes: Grades A and C

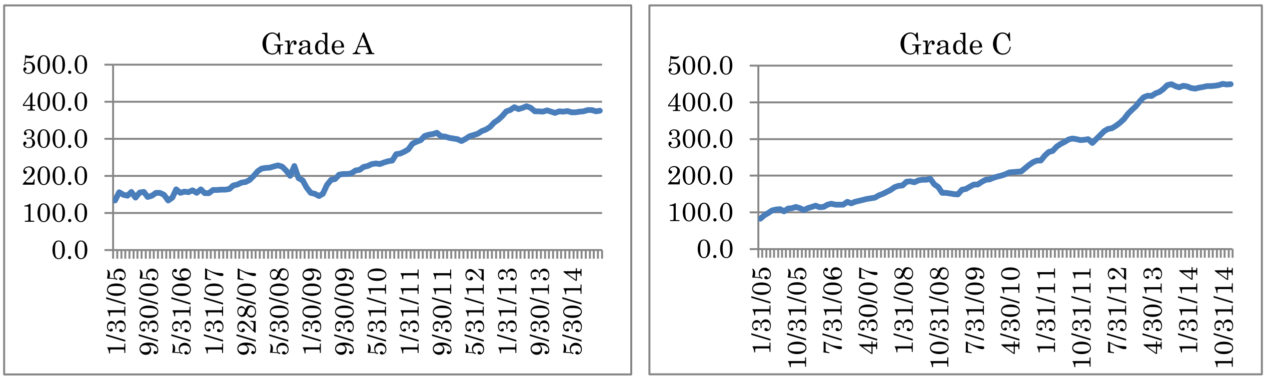

Table 6 reveals the impacts from the QE through H-REIT market on the office price of grades A and C. Based on the high grade A office price data, the H-REIT price determinant in Table 6(a) is Japan's monetary base, with a significantly positive coefficient($\phi_{1j} = 0.111$). This is larger than the coefficient by using a low grade data in Table 6(b) ($\phi_{1j} = 0.083$, insignificant), implying the high grade A office price has a strong effect from the QE spillover. One can consider the impact of the QE in that the extent of the H-REIT price increase on the high grade A office price can be seen from the coefficient of $\gamma_{3R} = 0.238$, which is larger than the low grade C office coefficient of $\gamma_{3R} = 0.053$. In addition, the QE policy did not affect the H-REIT price as seen in Table 6(b) as ϕ_{1u}=-0.082, ϕ_{1j} =0.083 and ϕ_{1E}=0.031 are insignificant. Thus, one can conclude that the QE policy would easily spillover to the high grade A office price, implying that the QE policy led to hot money inflow.

Table 6(a) Parameter Estimates for Hong Kong Office Price Indexes: Grade A

	γ_{iR}	γ_{iS}	γ_{iO}	ϕ_{iu}	ϕ_{ij}	ϕ_{iE}
H-REIT	-0.244**	0.185**	-0.046	-0.126**	0.111**	0.004
	(-6.49)	(2.58)	(-0.91)	(-1.52)	(2.63)	(0.09)
STOCK	-0.269**	0.183**	-0.023	-0.171	0.067	-0.124**
	(-4.46)	(4.18)	(-0.32)	(-1.55)	(1.42)	(-2.19)
OFFICE	0.238**	0.107**	0.068	0.066**	0.012	0.014
	(6.53)	(3.22)	(1.32)	(2.29)	(0.60)	(0.71)

Notes: T-statistics are shown in parentheses. *and** are significant at 10% and 5% level, respectively.

Table 6(b) Parameter Estimates for Hong Kong Office Price Indexes Grade C

	γ_{iR}	γ_{iS}	γ_{iO}	ϕ_{iu}	ϕ_{ij}	ϕ_{iE}
H-REIT	-0.207*	0.204**	0.158	-0.082	0.083	0.031
	(-1.84)	(2.55)	(1.18)	(-0.85)	(1.53)	(0.45)
STOCK	-0.267**	0.200**	0.110	-0.133	0.048	-0.099
	(-2.75)	(2.03)	(0.77)	(-1.20)	(0.92)	(-1.10)
OFFICE	0.053**	0.072**	0.285**	0.021	-0.046**	-0.019
	(1.86)	(3.07)	(4.64)	(0.52)	(-1.97)	(-0.66)

Notes: T-statistics are in parentheses. *and** are significant at 10% and 5% level, respectively.

6. Concluding Remarks

This paper examined whether the quantitative easing policy conducted in Japan, EU and the US raised the real estate prices in Hong Kong through the development in the Hong Kong REIT market. The empirical results show that the quantitative easing policy affected the price of real estate, and the H-REIT prices led to a rise in office price after a lag of two periods. This finding is supported by the appearance of a plausible carry trade scenario. Moreover, this finding is sharper in the high grade office price than in the low grade office price. The empirical study imply that the quantitative easing policy spillover did not restrict only to the money market, but also markets in the real sectors immediately through the development in the REIT market. Also, the quantitative easing served as inflow of hot money that had a greater spillover effect on higher office grade than the lower office grade.

Appendix 1 Unit Root and Cointegration Analysis

Before estimating the data generating process of VAR model in (1) equivalently of ECM model in (2), we must check the stationarity of our time-series data, and further test whether there are cointegrating relationships among those variables if they are not stationary. Table A1 reports the Augmented Dickey–Fuller (ADF) tests for a unit root. All price index are integrated of order one, i.e., I(1) except for the test with τ_μ for J-Housing, which concludes all variables I(1).

Table A1. ADF Tests for Unit Root

		Lag length		ADF Test statistic δ		
		Level	1st Difference	Level	1st Difference	5% Critical Value
y_{1t} (H-REIT)	τ	1	1	2.212	-6.883**	-1.943
	τ_μ	1	1	0.406	-7.276**	-2.882
	τ_τ	1	1	-1.944	-7.395**	-3.442
y_{2t} (STOCK)	τ	1	1	1.218	-6.263**	-1.943
	τ_μ	1	1	-1.498	-6.356**	-2.882
	τ_τ	1	1	-2.571	-6.331**	-3.442
y_{3t} (H-Housing)	τ	1	1	2.654	-4.927**	-1.943
	τ_μ	1	1	-0.241	-5.424**	-2.882
	τ_τ	2	1	-2.352	-5.399**	-3.442

Note: For each time series, we specify the model as

$$\Delta y_t = \boldsymbol{\mu} + \tau \cdot t + \sum_{i=1}^{p-1} \gamma_i \Delta y_{t-i} + \delta y_{t-1} + \varepsilon_t, \qquad \varepsilon_t \sim N\left(\mathbf{0},\ \sigma^2\right)$$

The ADF statistic tests the hypothesis $H_0 : \delta = 0$ vs $H_1 : \delta < 0$. Similarly, we carry out ADF tests for the log-difference variables. MacKinnon (1996)'s 5% critical values are shown. The Schwartz Information Criterion (SIC) is used to choose the lag length. * and ** indicate the level of significance at 10% and 5%, respectively.

We analyze the price indexes by using the model described in Section 3, in which the three variables for the J-REIT index, TOPIX and J-Housing Prices index (with the difference of logarithm) are denoted by $Y_t = \left(y_{1,t},\ \cdots, y_{3,t}\ \right)'$ and Gaussian errors ε_t. It is equivalently in an error correction form is as in (3). We specify the model as:

$$\Delta Y_t = A_0 + \sum_{i=1}^{p-1} \Gamma_i\ \Delta Y_{t-i}\ + \alpha\beta\ '\ Y_{t-i} + \Phi \Delta X_{t-1} + \varepsilon_t, \qquad \text{(A1)}$$

The lag lengths are determined by the Schwartz Information Criterion (SIC). In Table A2, the minimum value of SIC attains at an optimal lag length of p = 2 out of two to five. We may safely conclude that the data generating process follows the model of (A2) with p = 2.

Based upon this finding, we test the hypothesis; $H_0 : rank(\beta) = r$ against $H_1 : rank(\beta) = 3$ by using Johansen's max-eigen value test.[6] The third column of p = 2 in Table A2 reveals that there is no cointegrating relationship for any countries at the 5% level. For checking the robustness of this result, we carry out the trace test for the models with lag length of two through five. As shown in Table A2, there is no cointegrating relationship for any lag length at the 5% level. The result of cointegration test is quite robust against the lag length for the model of (3). Preliminary analysis of this study justifies the model of equation (3) in Section 3 for subsequent analysis.

Table A2. Cointegration Tests

	Lag	p-1 = 1	p-1 = 2	p-1 = 3	p-1 = 4
	SIC	-19.06***	-18.92	-18.62	-18.47
Trace Statistics	H_0: r = 0 vs H_1: r = 1 (5% Critical Value = 35.19)	29.11	25.14	23.68	24.78
	P-Value	(0.066)	(0.161)	(0.221)	(0.175)
	Resulting rank	0	0	0	0

Note: The symbol "***" in SIC denotes the minimum SIC. * and ** indicates the level of significance at 10% and 5%, respectively. Figures in parentheses are p-values (see Mackinnon *et al*., 1999, p.572) .

[6] Strictly speaking, neither the ADF test nor the Johansen's test is applicable. This is because the CC-EGARCH-ECM (Constant Correlation EGARCH Error Correction Model) does not satisfy the assumption of independent identically distributed normal errors. However, for simplicity, we ignore this issue (see Seo (2007) for details).

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