Explosive Bubbles and Cyclical Linkages of the Asia Pacific Housing Prices

Tze-Haw Chan[1,*], Jeng-Hoong Woon[2] & Ruhani Hj. Ali[1]
[1]*Graduate School of Business, Universiti Sains Malaysia*
[2]*Intel Technology Sdn Bhd, Penang, Malaysia*

***Abstract*:** This study assesses the housing bubbles and cyclical linkages of housing prices across ten APE, the US and UK from1990Q1-to2013Q4. The sequential unit root tests (SADF and GSADF) have detected multiple and periodically collapsing bubbles for most economies (except Japan and Thailand), which occurred before the Asia Financial Crisis, during the 2000s boom and after the 2008 subprime crisis. Analysis also reveals that APE housing prices are characterized by comparable cyclical pattern and the cycles are closely linked. Domestic markets are vulnerable to regional and global shocks. The finding may contradict the efficient market hypothesis but the real time feature of the bubble tests makes it appealing to policy makers for early detection and correction of market failure. As for stakeholders, new investment strategies are essential in portfolio diversification. Overall, our study offers adequate instruments for future diagnosis of housing prices. The outcome provides fundamental elements of an early warning system against economic instability.

Keywords: Periodically collapsing bubbles, housing price cycles, market efficiency, GSADF, Asia Pacific economies
JEL classification: C15, E32, G12.

1. Introduction

Housing price upsurge among Asia Pacific economies (APE hereafter) has attracted a great deal of interest lately. Several scholars revealed that liberalization of housing markets and housing finance systems, and more liquid secondary mortgage markets have improved market efficiency, thus stimulated demand and contributed to house price growth (Chung and Kwon 2009; Glindro *et al.* 2008; Pillay and Rangel 2008; among others). Along the similar view, numerous studies at global level have identified macroeconomic fundamentals as major determinants of housing prices. These include the GDP, population, personal income, the business cycle, demographic structure, bank credit, inflation, taxation, producer price, real effective exchange rate and stock market wealth (Shiller 2007; Angelo 2008; Rapach and Strauss 2009; Hui and Yu 2012; Zhang *et al.* 2012; Lean and Smyth 2014). These empirical studies have received well-noted supports, to some extent, by the fundamentalists and policy makers.

Nevertheless, the fundamental views are not entirely convincing. Worries about real estate bubbles have accelerated after a series of global financial crises in the past decades (Mayer 2011). Scholars observed that large capital inflows into the emerging markets began in the aftermath of the 2008 subprime crisis, which resulted in asset investment and real state price surge among the APE (Magud *et al.* 2012; Khan 2012; McKinnon 2013). This was

* Corresponding author: Tze-Haw Chan. Tel.: 604-6535284. Fax: 604-6535867.
Email: thchan@usm.my
Acknowledgements: For any enquiry about the study, kindly write to the corresponding author. Please do not quote or take any excerpt from this paper without the authors' knowledge or prior agreement. All flaws remained are the responsibility of the authors. The first author gratefully acknowledges financial support from the Universiti Sains Malaysia RUI Research Funding [Grant no: 1001/PPAMC/816241].

attributed to the recovery plans taken by giant economies to survive the global recession. In particular, the fiscal expansion and interest rate cuts by the European Union and Japan, the US's three consecutive quantitative easing programmes, followed by China's aggressive credit-driven and infrastructure-based growth strategy. Both World Bank and International Monetary Fund recently warned that capital influx into the Asian economies have amplified the risk of accelerated credit growth and escalating housing prices (IMF 2013; 2015).

Even though there is no immediate threat of a bubble bust, the formation of real estate bubble is hazardous for financial and macro stability. The recent wave of property boom among emerging APE resembles the US subprime crisis prior to 2007. Despite its disputing repercussion on the Efficient Market Hypothesis (EMH hereafter)[1], asset bubble amplifies credit boom by inflating collateral values and gives rise to misallocation of resources, which can have serious effects on real economic activity (Phillips and Yu 2011). History does not repeat itself, but it does rhyme. In such concern, both industrialized and emerging economies would be affected by housing bubble, but the latter tend to incur the heaviest costs (Collyns and Senhadji 2002). To promote financial stability, one needs to detect the bubble early – as soon as prices begin to rise, so that an early warning system can be constructed. Such assessment is obligatory for policymaking but it is evidently lacking in the literature. Simply, identifying asset bubble in real time has been challenging and remains an elusive task (Chen and Funke 2013; Phillips *et al.* 2013).

In streaming through the literature, the feasibility of housing bubble and the transmission mechanism of housing prices across the APE – mostly emerging but at different development level, have not been rigorously explored. Majority of the existing but limited housing studies has an overwhelming focus on advanced economies. For instance, G7 countries by Beltratti and Morana (2010); industrial countries by Knoll *et al.* (2014); Ahearne *et al.* (2005), Otrok and Terrones (2005), European Union countries by Chirinko *et al.* (2004), Egert and Mihaljek (2007); and, Europe and the US by Gros (2007). A comprehensive and scientific study that helps us understand the issue of asset bubbles among APE will definitely contribute towards the building of a sustainable economic development.

This study is hereby sets to explore the feasibility of housing price bubbles and price cycle linkages among the US, UK and ten APE economies during 1990Q1-2013Q4. Before proceeding, several methodological concerns are to be addressed. The conventional unit root and cointegration tests may be able to detect one-off exploding speculative bubbles (Peng 2002; Arshanapalli and Nelson 2008), but are unlikely to detect periodically collapsing bubbles (Phillips *et al.* 2011). To overcome such problem, we employ new recursive procedures which allow testing, identifying and date stamping explosive bubbles in time series that advocated by Phillips *et al.* (2011) and Phillips *et al.* (2013). The so-called right-tailed ADF tests (SADF and GSADF) were proven to have higher bubble detection capability (Homm and Breitung 2012). In addition, the GSADF test has the advantage of detecting multiple bubbles within a window, and able to estimate the starting and ending of the bubbles (Phillips *et al.* 2013).

Then, based on the correlation analysis of housing price cycles, we investigate the linkages of housing markets across the US, UK, Australia, China, Hong Kong, Indonesia, Japan, Korea, Malaysia, Singapore, Taiwan, and Thailand. Putting together, our study shall provide new insights to the existing literature and, ideally, to provide the fundamental elements of an early warning system and adequate instruments for future diagnosis of housing bubbles.

[1] According the EMH, housing prices should follow random walks. Abnormal returns are thereby evitable and the possibility of rational bubbles is excluded. For details, refer to the literature review section.

2. Literature Review on Housing Bubbles

Fama (1970) defines an efficient market as one in which market prices fully and instantaneously reflect all relevant information. Under the condition that new information arrives randomly, the current price of an asset is an unbiased predictor of its future value. In other words, past information should not affect returns in present period. The efficient markets thus do not allow investors to earn more above-average returns without accepting above-average risks (Malkiel 2003). By econometric specification of EMH, house prices should exhibit random walk, where the future price changes should be – for all practical purposes – random and therefore unpredictable. The consequence of this is that any shock will permanently impact on housing price and investors cannot forecast future prices from past prices (Canarella *et al.* 2012). In contrast, if housing prices are trend reverting, a positive demand shock will lead to a temporary increase in house price, because supply is inelastic in the short-run, but in the long-run, allowing for inflation, housing prices will return to their equilibrium growth path (Canarella *et al.* 2012).

By theory, there are two different opinions on housing bubbles formation. Stiglitz (1990) points out that house bubbles exist only if house price growth is not supported by growth of economic fundamentals. Chen and Funke (2013) concur this definition of housing prices bubble as when the actual price deviate from its fundamental value, meaning that analysis of price bubbles should be independent of the influence of macroeconomic factors. Coupled with this definition to analyze house price movement in the US, McCarthy and Peach (2004) could not find evidence of housing bubbles as house price is supported by fundamentals.

Contradict to Stiglitz (1990), Lind (2009) advocates that bubbles should be defined only by the movement of housing prices. There is a bubble as long as there is drastic price increase of an asset. Lind (2009) argues that Stiglitz (1990)'s definition is vague and does not spell out what are the fundamentals that should or should not be included. Lind (2009) also says that housing bubble exists if the price first increases drastically and holds for a period of time and then falls at the same manner. Lind (2009) outlined theoretical framework in explaining conditions for housing bubbles formation; namely macroeconomic situation, structural changes such as boom in stock market, capital and credit market, expectations and incentives.

A sudden surge or collapse in house price would have increased financial instability and lead to negative spillover effects on the overall macroeconomic performance. In most countries, property investment is generally households' largest investment that housing prices fluctuation and misalignment can be considered as the major financial risk (Glindro *et al.* 2008). The impact to the salaried and poor are the greatest (Chung and Kwon 2009). When house price increase, they are badly hit because the earnings and savings they made are not able to catch up with housing prices. When house price bubbles burst, housing prices goes down drastically, mortgage collateral falls to the extent that it becomes well below the amount of loans outstanding. Financial institution may not be able to recover the loan then leading to bankruptcy. The remaining financial institutions would hesitate to issue new loans, with early repayment request from borrowers. Personal bankruptcies would then be on the rise. It would then decrease the consumption and production, and subsequently increase in unemployment (Pillay and Rangel 2008). In 2007, the bubble in US burst because of oversupply in housing. House values were pushed to a level that is lower than mortgage value, which led to increase in default rate. Financial institutions then began to tighten their standards and this further accelerated the price decline (Baker 2008).

While the hazard of housing price bubble is well noted, identifying asset bubble in real time has been challenging and remains an elusive task (Chen and Funke 2013; Phillips *et al.* 2013). In literature, conventional unit root and cointegration tests may be able to detect one-off exploding speculative bubbles (see Peng 2002; Arshanapalli and Nelson 2008; among others), but are unlikely to detect periodically collapsing bubbles (e.g. Phillips and Yu 2009;

Chen and Funke 2013; Phillips *et al.* 2013). It was claimed that conventional unit root tests are not efficient in handling near unit root cases and fail to capture changes from I(0) to I(1) and back to I(0). This further intricates the bubble detection by cointegration procedures, owing to the potential bias and kurtosis (Evans 1991; Gürkaynak 2008). Evans (1991) went on and proved his argument using simulation data to examine the power of unit root and co-integration. Results showed that unit root and co-integration test failed to reject the null of no bubble when collapsing bubbles appeared. Several researchers have come out with different methods to overcome the limitation pointed out by Evans.

Phillips *et al.* (2011) show that the sub Augmented Dickey Fuller (SADF) can considerably improve the bubble detection capability compared to unit root and co-integration test. They address the question of the presence of a speculative bubble in the NASDAQ stock index using new econometric techniques. Their forward recursive regression and right-sided unit root tests is an attempt to overcome the weaknesses of the approach of Diba and Grossman (1988), who argue against the existence of bubbles in the S&P 500. PWY procedure consists in performing Dickey-Fuller unit-root tests against an explosive alternative. The tests have discriminatory power because they are sensitive to the changes that occur when a process undergoes a change from a unit root to a mildly explosive root or vice versa. This sensitivity is much greater than in left-sided unit root tests against stationary alternatives, due to the downward bias and long left tail in the distribution of the autoregressive coefficient in unit root and near stationary cases. In simple term, SADF test is able to estimate the start and end of a bubble on top of increased in bubble detection power. Homm and Breitung (2012) compared several recursive procedures and found that SADF test is more effective as a real time bubble detection method. However, SADF may have limitation in bubbles detection when a series has more than one bubble.

Phillips *et al.* (2013) then show that if there are multiple bubbles in a series and the duration of second bubble is shorter than the first one, the PWY method of SADF cannot determine the starting and ending of the bubble. Detection of multiple bubbles is unavoidable in analyzing a longer time series. PSY have thus proposed a new methodology known as generalized sup ADF (GSADF) to overcome the weakness of SADF. Using the same principle of repeated right-tailed ADF, PSY enhance the fixed starting point with varying the starting and ending point. It is done by employing flexible windows over the range of a series. GSADF is suitable for long time series with big volatility. Both the SADF and GSADF tests will be deployed for the present study.

3. Research Methodology

House Price Indexes of the US, UK and ten APEs are employed in this study. All series are sourced from both the Datastream and Bank for International Settlements, and being crosschecked. The nominal data are then adjusted for inflation (CPI is used as a proxy of inflation) and rebased to 100 at year 1990 to compile real house indexes. For analysis purpose, all data from 1990Q1 to 2013Q4 are being transformed into natural logarithm.

3.1 Bubbles Detection

This study employs new recursive procedures which allow testing, identifying and date stamping explosive bubbles in time series that was advocated by Phillips *et al.* (2011) and Phillips *et al.* (2013) respectively. These tests include the supremum ADF (SADF) and generalized SADF (GSADF). Rejection of the null in each of these tests may serve as empirical evidence for an asset price bubble(s), and in both tests, enables us, as a second step, to date-stamp its occurrence. The tests can be illustrated with the simplest form of a standard DF equation:

$$\Delta P_t = \mu + (\varphi - 1)P_{t-1} + \varepsilon_t \quad (1)$$

where Pt is the time series of the asset price (housing price in the present paper), and εt is the error term. The hypothesis is H_0: $\varphi = 1$ (unit root behavior) against the H_A: $\varphi > 1$ (explosive behaviour). In order to estimate the origination and collapse dates of every bubble, a sup DF statistic with respect to the number of observatiois computed for each alternative last observation in every regression. The resulting series of DF statistics is then compared with an appropriate series of critical values. First of all, let $r0$ be the fraction of the sample that corresponds to the minimum number of observations used in each regression, $r2$ being the fraction corresponding to the last observation, and, $rw \geq r0$ being the fractional window size of the regression, while *n* being the total sample size. The DF test statistic obtained in a regression starts in fraction $r2-rw$ and ends in fraction $r2$ is represented by:

$$DFr2 - rwr2 = [nrw](\hat{\varphi}-1) \quad (2)$$

where $[\cdot]$ represents the integer part. Additionally, the supsup test statistic can be defined as follows:

$$GSADF = suprwsupr2DFr2-rwr2 \quad (3)$$

The right-tailed DF statistic is using multiple recursive regression which allows more flexibility in the estimation windows (Caspi 2013). SADF imposes same starting points for every regression whereas GSADF has different starting points. Phillips *et al.* (2013) derived the limit distribution of the GSADF statistic which is a nonlinear function of $r0$ and Brownian motions. Using this result and Monte Carlo simulation methods, it is possible to compute both asymptotic and finite-sample critical values. The methodology for time stamping bubbles consists of computing a series of sup DF statistics which are defined in the following way:

$$BSDFr2(r0) = supr1\in[0,r2-r0]DFr1r2 \quad (4)$$

3.2 Housing Price Cycle

This study follows the business cycle concept to construct the housing price cycles of the US, UK and ten APEs. Modern definition of business cycle put forward by Lucas (1977) refers to the deviations of aggregate real output from its trend or cyclical component. Thus, the necessary first step of our dynamic analyses is to decompose the real housing prices of respective APE into trend and cycle. We utilize the latest filtering method proposed by Christiano-Fitzgerald (2003) instead of the conventional method of Hodrick and Prescott (1980). Say, we want to construct the housing price cycle in a time series and an orthogonal decomposition exists:

$$xt=yt+\tilde{x}t \quad (5)$$

The yt component is the series of interest and has power only in the housing price cycle frequencies while the $\tilde{x}t$ component has no power in these frequencies. CF shows that an estimate, $\hat{yt}$ of the yt component can be obtained in the frequency domain by minimizing the conditional expected mean squared error such that $Min{:}E\langle((yt-\hat{yt})2|\{xt\})\rangle$., where the $\hat{yt}$ represents the filtered real housing price series. Such method is referred as asymmetric (time-varying) filtering.

3.3 Stylized Facts of Asia Pacific Housing Prices

Asia Pacific is the part of the world in or near the Western Pacific Ocean. It varies in population and economic sizes, but typically includes much of East Asia, South Asia, Southeast Asia and Oceania. Most emerging APEs were experiencing strong growth than the US and European economies during and after the global recession in 2008. Lower fuel prices, dynamic capital and labour markets, robust inflows of remittances and capital, and accommodative monetary policies have boosted regional growth in 2014-2015 (World Bank 2015). Nonetheless, considerable heterogeneity is apparent across the region. China is slowing to a more sustainable pace; Japan is expected to see growth pick-up following a year of stagnation; exporters of non-oil commodities whose prices have fallen sharply (Australia, Indonesia and Malaysia) will be adversely affected by the terms-of-trade swing; elsewhere, however, growth is expected to stabilize or increase (IMF 2015). On the other hand, intra-regional financial flows within APE have increased over the past decade. We expect some extent of asset linkages among regional housing markets, which is to be investigated further in the upcoming section.

House prices have risen more than 50 percent across most APEs since 2007. Figure 1 shows the annual trend of housing price of the US, UK and ten APEs from 1990 until 2014. Several spikes can be observed. First, the property markets of three giant economies are generally on the rise. The UK and China housing prices have gained momentum of moving upwards while the US property market has gradually recuperated after 2010.

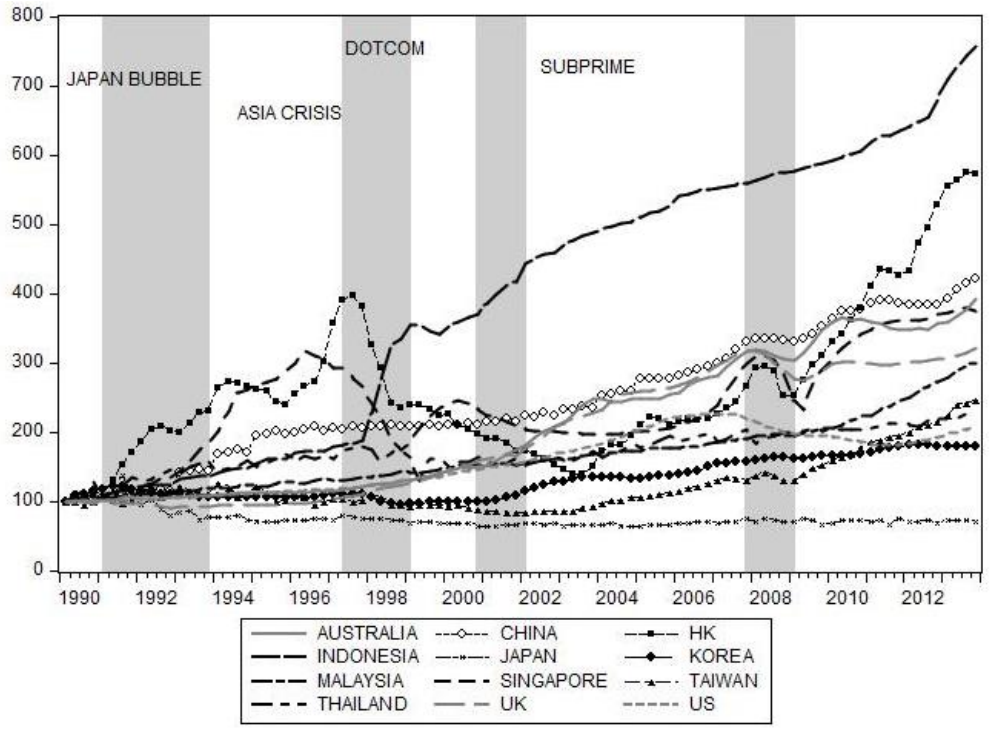

Figure 1: APE Housing Price Indexes, 1990-2014

Source: Self-compilation based on Datastream and Bank of International Settlements.

For UK, it was reported that the rise in property prices started in London but spread to most areas of the nation. The price surge comes amid of limited supply and increased demand driven by rising wage growth and low mortgage rates. As for China, prices for new homes

surged between 8-10 percent nationally since last decade. However, there were divergent trends across the country. While prices have increased averagely about 18-20 percent year-on-year in first-tier cities like Beijing, Shanghai and Shenzhen, they were 7-10 percent in second-tier cities and about 6 percent in third-tier cities in recent years. Then, in the US, property market rebounded for fourth consecutive years since 2010. Still, concern of market mismatch arises when home prices are rising at twice the rate of income growth and inflation, and homeownership rate hit its lowest level since 1989 in early 2015. Contrary, Japanese real estate market has not fully recovered since the asset bubble burst in early 1990s. In fact, Japanese housing price has declined by 37.5% during 1990-1994 and remained stagnant until 2012. The housing prices were rising during 2013-2014 mainly due to the recent reflationary policies that included increasing public infrastructure spending, devaluation of the yen and aggressive quantitative easing by the Bank of Japan.

On the other hand, most of the emerging APE has exhibited upward trend in housing prices, in proportion to domestic growth and low borrowing cost, probably due to the global recovery and capital inflows to the region (Table 1). In particular, housing prices in Australia, Hong Kong, Taiwan, Singapore, Indonesia and Malaysia are growing at double-digit rates in the past ten years, leading to rising concerns of housing bubbles and housing affordability. Among all, the Indonesian housing price surge was more than double during Asia Financial Crisis due to hyperinflation.

Table 1: Percentage changes (%) of APE housing prices by sub-periods

	1990-1994	1995-1999	2000-2004	2005-2009	2010-2014	1990-2014
UK	-2.8	47.8	62.1	9.9	18.1	229.6
US	10.8	19.3	36.6	-11.4	5.4	95.9
Australia	11.5	25.8	65.4	36.6	16.0	295.5
China	67.9	6.3	22.7	27.4	13.8	324.3
HK	141.1	-7.2	-1.0	47.4	69.0	480.2
Indonesia	39.1	110.7	36.1	11.1	25.8	611.7
Japan	-37.5	-4.6	1.1	-1.8	1.9	-37.1
Korea	-7.7	-6.1	32.3	20.3	9.7	62.6
Malaysia	17.3	14.2	12.2	16.4	46.1	199.0
Singapore	165.1	-18.6	-14.3	40.2	24.4	313.9
Taiwan	12.0	-5.6	19.8	35.2	48.5	168.2
Thailand	24.5	-5.7	10.5	3.8	17.0	79.6

Source: Self-compilation based on Datastream and Bank of International Settlements.

4. Empirical and Policy Discussion

4.1 Bubbles Detection

SADF test that was advocated by Phillips *et al.* (2011) considerably improves the bubble detection capability compared to the conventional unit root and co-integration tests. On top of detection power efficacy, SADF is also able to estimate the start and end of a periodically explosive and collapsing bubble. In Table 2, the SADF results can be categorized into several groups – the non-bubble, bubble before 1997/98, bubble in the 2000s and bubble after 2008. The non-bubble group consists of Japan, Thailand, China and Taiwan, as the null hypothesis of no explosive behaviour in the real house price indexes cannot be rejected. Although China and Taiwan were showing a short-lived bubble in 2010 and 2011-2013 respectively, but both series were not statistically significant. Such result could be defected by the single bubble test and one should rely on the GSADF test of multiple bubbles.

As for Singapore and South Korea, the periodically explosive bubble was found prior to the Asia Financial Crisis and collapsed before 1997. Easier access to credit or mortgage and low borrowing cost also been highlighted by Chung and Kwon (2009) as contributors for

raising housing prices in Korea. Whereas for Singapore, its government has decided in the 1980s to reduce the target of state-owned housing from 90 percent of the population to 75 percent, where the balance are private properties. Thus, public housing owners cashed in by selling their houses to buy private residential properties, which led to house price boom in the 1990s. On the other hand, the US, UK and Australia that form group with housing bubbles detected decade-long bubble during the whole 2000s, prior to the global recession in 2008/09. This is the era where the large-size economies dominate the global demand and economic growth. Mikhed and Zemcik (2009) reviewed that house prices in the US during 1997-2006 does not reflect the fundamentals. Variables that were monitored were personal income, population, house rent, stock market wealth, building cost and mortgage rate. Gallin (2006) concludes the same findings for year 2000 onwards, where fundamentals are not able to explain rapid growth of US house price. However, except for Australia, the housing bubble in the US and UK have declined in recent years.

Table 2: Bubble tests

	SADF	Period of Bubble	GSADF	Periods of Bubbles
US	7.8056***	1999Q2-2008Q1	10.0324***	1998-2007, 2013
UK	3.6045***	1997Q4-2008Q3	4.1693***	1999-2011
Japan	-0.7775	-	0.042	-
China	-0.337	-	2.1491*	2008
Hong Kong	1.2060*	2012Q2-2013Q4	2.7811**	2008-2009, 2011-2012, 2012-2013
Taiwan	0.5114	-	2.6717**	2006-2007, 2010-2013
Singapore	4.2338***	1992Q2-1996Q4	14.0684***	1993-1995, 1998, 2006-2008
Korea	1.3911*	1992Q2-1996Q4	3.2962***	1997-1998, 2002-2003
Australia	6.5584***	1998Q2-2013Q4	6.5584***	1998-2000, 2001-2005, 2007-2008, 2009-2010
Malaysia	3.3305***	2010Q4-2013Q4	4.5146***	2011-2013
Thailand	-1.4893	-	0.7681	-
Indonesia	2.9859***	2005Q4-2013Q4	3.0512**	2006, 2008-2009
		Bootstrapped Critical Values		
1%	2.0582		3.1225	
5%	1.4225		2.5449	
10%	1.1006		2.1429	

Notes: *, **, *** represent statistical significance at 10%, 5% and 1% respectively.

The fourth group comprises of Hong Kong, Malaysia and Indonesia with single bubble found in recent years. Following the capital inflows, easy access to credit and the reduced cost of credit have become the crucial factors fuelling the increase in housing prices of these economies. In addition, many house buyers in these markets used real estate asset as a hedge against inflation and financial uncertainty such as the stock market. That is why buying a house is considered as the most important form of investment for most people. Hence, changes in the value of house price have important implication for personal wealth and national economy. Housing prices fluctuations have been getting great traction from both individuals and governments in these small and open APE economies.

While SADF is effective in detecting and date stamping single bubble in time series, Phillips *et al.* (2013) has shown that GSADF is more effective in detecting multiple bubbles. In order to detect subsequent bubbles, GSADF uses the similar hypothesis that $H0$: $\varphi=1$ against HA: $\varphi>1$ in equation (1). However, GSADF changes the initial observation of each regression, versus fixed initial regression in SADF. Of all, both the SADF and GSADF offer no evidence of explosiveness in the real housing index of Japan and Thailand. Thailand was

gripped by unprecedented political unrest for some time. The contraction of economic growth, the shrinking of export and domestic consumption, farm price slump and delayed disbursement of government's spending budget have combined to halt property prices from surging like the neighbouring economies in the Asia Pacific region. As for Japan, property market has been slow down since the bubble burst in early 1990s. The finding is in line with Shimizu and Watanabe (2010) who confirmed that there is little impact of housing demand on Japanese housing pricing.

Ruling out Japan and Thailand, the GSADF test has shown more evidence of explosive and periodically collapsing bubbles. Multiple bubbles are significantly detected for the US, UK, China, Hong Kong, Taiwan, Singapore, South Korea, Australia, Malaysia and Indonesia. In all the ten cases where null hypothesis of $H0$: $\varphi=1$ are rejected, six of the GSADF test statistics are much larger than the 1% critical value, which indicate overwhelming evidence of multiple bubbles in the APE housing markets (see Table 2). These observations are consistent with the findings in Phillips *et al.* (2013) that SADF has limitation in finding multiple bubbles.

Other than the multiple bubbles found on most APEs, the timing of bubbles forming and collapsing are similar to the finding by SADF test. The non-bubble countries remain the same – Japan and Thailand, while China again has a short-lived bubble. Hong Kong, Malaysia and Taiwan are still showing housing bubbles phenomenon in recent years. US is showing signs of housing price appreciation in 2013 since the burst during subprime crisis. Indonesia, Japan, Korea, and Thailand show inflation-adjusted house prices in 2013 are lower than the base value. Other than Japan, the nominal house price is higher than the base value. The results suggest that inflation has a bigger influence on house price than other factors. Thus, in these countries, investing in real estate property is not a good hedge against inflation.

At several points, the outcome of this study is not in line with the efficient market hypothesis. It was observed that many APEs, especially the East Asian economies have shown a strong tendency to use housing policy to boost economic growth (Forrest and Lee 2003). Nevertheless, investors' greed for wealth creation and abnormal returns, as well as mismatch of market confidence and fundamental supports are often leading to the bubble creation. Real estate price surge tends to boost banks' willingness and capacity to lend. With the lax regulation of financial sector, the resulting credit boom may end in severe financial crisis. Though we do not examine the fundamental part of housing price determination, the finding has, to some extent, justified the rationale of misconduct of housing policy that lead to subprime crisis and global recession.

4.2 Housing Price Cycles

Analysis of property cycles has direct linkage to the wellbeing of both individual and institutional investors. On the defense side, the understanding and awareness of the existence of property cycle can certainly alert one from imminent property crash, which happened from time to time in property history. From the perspective of government policy, the intention of reducing the degree of swing (volatility) of the property market is certainly great especially when the housing market is at stake, as that would affect the political support received by government. What is most important, perhaps, is that policy makers is able to construct early warning indicator(s) which could correctly identify the turning points of the property cycle and hence lead to better investment decision.

Figure 2 plots the cycles of real housing price for the US, UK and ten APEs from 1990-2013. The cycles of 8-16 quarter frequency are generated based on the asymmetric (time-varying) filtering method advocated by Christiano-Fitzgerald (2003). The cycle patterns and fluctuations have been quite consistent and similar for most APEs during the 1990s-2000s but amplified after 2009. Of all, the housing price cycle in Hong Kong is of the greatest

widespread, followed by Singapore. Both economies are found to be more cyclical in nature than economies with sizeable domestic markets such as the US, UK, Japan and China. While Hong Kong property is highly demanded by the local residents and Chinese investors, it is odd for Singapore. Singapore property market has been closely monitored and state-owned housing still dominates majority of the market.

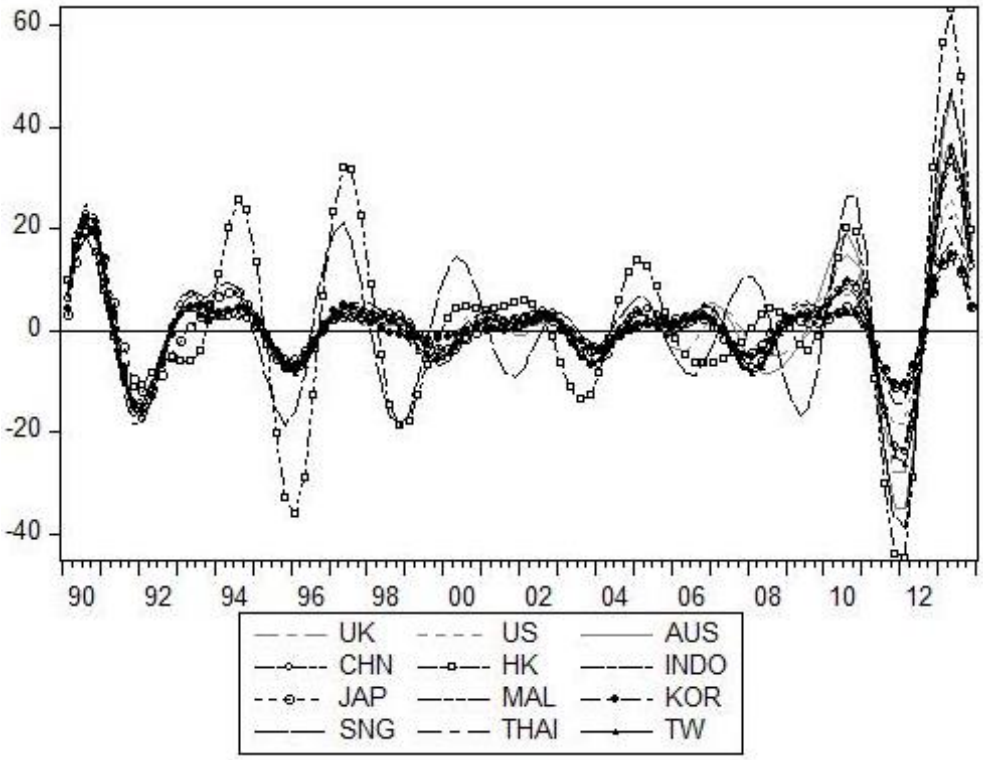

Figure 2: Real housing price cycles of selected APE, 1990Q1-2013Q4

In Table 3, we present the correlation of real housing price cycles among APE. The associations of APE cycles are very high, ranging from 0.62 to 0.97. Most of the APE cycles – especially China and Australia, are most likely to fluctuate with the US and UK cycles. The high association of housing cycles indicates a considerable interdependency among the APE real estate markets. Such finding partly explains the contagion effects during the recent subprime crisis. It also justifies the behaviour of cross-border portfolio diversification.

To a great extent, future fluctuations of housing prices of emerging APE can be determined or forecasted, using a part of the information provided by regional and giant economies, namely, the US, UK and China. Strong internal momentum remains for emerging APE but the rising risks from spillover effect due to the close linkage of housing cycles are to be addressed. Many of the APEs are small and open economies that are heavily exposed to global trade fluctuations and speculative investments. Earlier studies have supported the facts that APEC economies are financially integrated among themselves and with the world, by the cross-border capital flows (Chan and Baharumshah 2005; Chan *et al.* 2007) and business cycle synchronization process (Chan and Khong 2007) during the 1990s-2000s. In such concern, the sovereignty of domestic investment scheme and domestic housing policy would be affected by both the regional and global shocks.

Table 3: Correlation of real housing price cycles, 1990-2014

	UK	US	AUS	CHN	HK	INDO	JAP	MAL	KOR	SNG	THAI
UK	-										
US	0.94	-									
AUS	0.97	0.94	-								
CHN	0.96	0.99	0.95	-							
HK	0.85	0.75	0.82	0.78	-						
INDO	0.90	0.97	0.86	0.96	0.72	-					
JAP	0.84	0.92	0.81	0.91	0.73	0.95	-				
MAL	0.96	0.99	0.95	0.99	0.81	0.96	0.90	-			
KOR	0.85	0.93	0.81	0.92	0.71	0.97	0.96	0.91	-		
SNG	0.86	0.68	0.81	0.73	0.87	0.65	0.62	0.73	0.66	-	
THAI	0.88	0.96	0.85	0.95	0.72	0.98	0.92	0.95	0.97	0.64	-
TW	0.97	0.97	0.97	0.98	0.84	0.93	0.88	0.99	0.89	0.77	0.93

5. Conclusion

Uncontrolled house prices and an event of house price bubble burst will potentially deteriorate the social and economic conditions of individual, society, and the nation. The question arises as to whether the growth in housing prices is supported by fundamentals, or is it driven by bubbles. Our empirical finding has made it clear that periodically collapsing bubbles did and do exist among most of the housing markets in APE, except for Japan and Thailand. At several points, the empirical evidence may contradict the efficient market hypothesis but the real time feature of the SADF and GSADF methods makes it appealing to policy makers for the purpose of early detection and correction of market failure. As for stakeholders, new investment strategies are essential in portfolio diversification.

On the other hand, recent global economic slowdown – fuelled the by the fall in crude oil prices and debts accumulation – and the currency depreciation against USD are essentially the precedence challenges for most APE in the coming years. Lying in between these tasks, housing affordability is typically crucial in the pragmatics of viable living standards. However, the housing problems cannot be resolved by autonomous policies based on the heterogeneous development across APE. Our study has confirmed that housing prices of APE are characterized by comparable cyclical pattern and the cycles are closely linked. Such concern should be taken into account to mitigate and cope with domestic housing issues. The authority's intervention should also be justified on efficiency grounds to sustain economic growth. Overall, this study provides the adequate instruments for future diagnosis of housing prices. The outcome is expedient to the fundamental building of an early warning system against economic instability.

References

Ahearne, A.G., J. Ammer, B.M. Doyle, L.S. Kole and R.F. Martin. 2005. House prices and monetary policy: A cross-country study. Retrieved on December 25, 2016 from *https://www.federalreserve.gov/Pubs/ifdp/2005/841/ifdp841.pdf*

Arshanapalli, B. and W. Nelson. 2008. A co-integration test to verify the housing bubble. *The International Journal of Business and Finance Research* 2(2): 35-43.

Baker, D. 2008. The housing bubble and the financial crisis. *Real-world Economics Review* 46: 73-81.

Beltratti, A. and C. Morana. 2010. International house prices and macroeconomic fluctuations, *Journal of Banking and Finance* 34(3): 533-45.

Canarella, G., S.M. Miller and S.K. Pollard. 2012. Unit roots and structural change: An application to US house-price indices. *Urban Studies* 49(3): 757-776.

Caspi, I. 2013. Rtadf: Testing for Bubbles with EViews.

Chan, T.-H., A.Z. Baharumshah and E. Lau. 2007. Real financial integration among the East Asian Economies: A SURADF Panel Approach. *Capital Markets Review* 11: 23-40.

Chan, T.-H. and A.Z. Baharumshah. 2005. Measuring capital mobility in the Pacific Rim. In: A.Z. Baharumshah (Ed.) *Open Economy Macroeconomics in East Asia* 167-195. Farnham: Ashgate Publishing

Chan, T.-H. and W.L.R. Khong. 2007. *Business Cycle Correlation and Output Linkages among the Asia Pacific Economies*. MPRA Paper 11305.

Chen, X. and M. Funke. 2013. Real-time warning signs of emerging and collapsing Chinese house price bubbles. *National Institute Economic Review* 223(1): 39-48.

Chirinko, R.S., L. De Haan and E. Sterken. 2004. Asset price shocks, real expenditures, and financial structure: a multi-country analysis. Retrieved on December 25, 2016 from *http://www.cesifo-group.de/portal/page/portal/DocBase_Content/WP/WP-CESifo_Working_Papers/wp-cesifo-2008/wp-cesifo-2008-07/cesifo1_wp2342.pdf*

Christiano, J. and T. Fitzgerald. 2003. The band pass filter. *International Economic Review* 44(2).

Chung, H.S. and H.I. Kwon. 2009. Housing speculation and housing price bubbles in Korea. Retrieved on December 25, 2016 from *http://umrefjournal.um.edu.my/filebank/published_ article/5051/housing%20speculation%20Korean%20bubbles.pdf*.

Collyns, C. and A. Senhadji. 2002. Lending booms, real estate bubbles and the Asian crisis. IMF Working Paper 20. Retrieved on December 25, 2016 from *https://www.imf.org/external/pubs/ft/wp/2002/wp0220.pdf*

Diba, B.T. and H.I. Grossman. 1988. Explosive rational bubbles in stock prices? *The American Economic Review* 78(3): 520-530.

Égert, B. and D. Mihaljek. 2007. Determinants of house prices in Central and Eastern Europe. *Comparative Economic Studies* 49(3): 367-388.

Evans, G.W. 1991. Pitfalls in testing for explosive bubbles in asset prices. *The American Economic Review* 81: 922-930.

Fama, E.F. 1970. Efficient capital markets: A review of theory and empirical work. *The Journal of Finance* 25(2): 383-417.

Forrest, R. and J. Lee. 2003. *Housing and Social Change*. London: Routledge.

Gallin, J. 2006. The long-run relationship between house prices and income: Evidence from local housing markets. *Real Estate Economics 34*(3): 417-438.

Glindro, El, T. Subhanij, J. Szeto and H. Zhu. 2008. Determinants of house prices in nine Asia-Pacific economies. BIS Paper No.52, 340-370. Retrieved on December 25, 2016 from *https://pdfs.semanticscholar.org/dc2e/ce59e489c5f26399fb818ccb118e52c00937.pdf*

Gros, D. 2007. Bubbles in real estate? A longer-term comparative analysis of housing prices in Europe and the US. CEPS Working Documents, 239. Retrieved on December 25, 2016 from *https://www.files.ethz.ch/isn/44136/276_Bubbles%20in%20real%20estate.pdf*

Gurkaynak, R.S. 2008. Econometrics test of asset price bubbles: Taking stock. *Journal of Economic Surveys* 22(1): 166-186.

Hodrick, R.J. and E.C. Prescott. 1980. Postwar U.S. business cycles: An empirical investigation. *Journal of Money, Credit and Banking* 29(1): 1-16.

Homm, U. and J. Breitung. 2012. Testing for speculative bubbles in stock markets: A comparison of alternative methods. *Journal of Financial Econometrics 10*(1): 198-231.

Hui, E.C., and K.H. Yu. 2012. The impact of pricing strategies on time-on-market under various economic conditions. *International Journal of Strategic Property Management* 16: 56-70.

International Monetary Fund. 2013. Retrieved on December 25, 2016 from *https://www.imf.org/external/pubs/ft/weo/2013/02/weodata/index.aspx*

International Monetary Fund. 2015. Retrieved on December 25, 2016 from *https://www.imf.org/external/pubs/ft/weo/2015/01/weodata/index.aspx*.

Knoll, K., M. Schularick, and T. Steger. 2014. No Price Like Home: Global House Prices, 1870–2012, *CEPR Working Paper 10166*. Retrieved on December 25, 2016 from *http://piketty.pse.ens.fr/files/Schularicketal2014.pdf*

Lean, H.H. and R. Smyth. 2014. Dynamic interaction between house prices and stock prices in Malaysia. *International Journal of Strategic Property Management 18*(2): 163-177.

Lind, H. 2009. Price bubbles in housing markets: Concept, theory and indicators. *International Journal of Housing Markets and Analysis 2*(1): 78-90.

Lucas J.R.E. 1977. Understanding business cycles. In Brunner, Karl and Meltzer, Allan H. (Eds.), *Stabilization of the Domestic and International Economy, Carnegie-Rochester Conference Series*

on Public Policy, No. 5: 85-107. Reprinted in Kydland, Finn E. (Ed.), Business Cycle Theory, Aldershot: Edward Elgar.

Malkiel, B. 2003. The Efficient Market Hypothesis and its critics. *Journal of Economic Perspectives* 17(1): 59-82.

Magud, N., C. Reinhart and E. Vesperoni. 2012. Capital inflows, exchange rate flexibility, and credit booms. IMF Working Paper WP/12/41, February. Retrieved on December 25, 2016 from *https://www.imf.org/external/pubs/ft/wp/2012/wp1241.pdf*

Mayer, C. 2011. Housing bubbles: A survey. *Annual Review of Economics* 3:559-577.

McCarthy, J. and and R.W. Peach. 2004. Are home prices the next bubble? *Federal Reserve Bank of New York Economic Review*, 1-17.

McKinnon, R. 2013. *The unloved dollar standard. From Bretton Woods to the rise of China*, Oxford. University Press, New York.

Mikhed, V. and P. Zemčík. 2009. Do house prices reflect fundamentals? Aggregate and panel data evidence. *Journal of Housing Economics 18*(2): 140-149.

Otrok, C., and M.E. Terrones. 2005. *House price, interest rates and macroeconomic fluctuations: International evidence*. International Monetary Fund, mimeo.

Peng, W. 2002. What drives property prices in Hong Kong? HKMA Quarterly Bulletin, August. Retrieved on December 25, 2016 from *http://www.hkma.gov.hk/media/eng/publication-and-research/quarterly-bulletin/qb200208/fa2.pdf*

Phillips, P.C.B. and J. Yu .2009. *Limit theory for dating the origination and collapse of mildly explosive periods in time series data.* Sim Kee Book Institute (SKBI) for Financial Economics Discussion Paper, Singapore Management University.

Phillips, P. C. B. and J. Yu. 2011. Dating the timeline of financial bubbles during the subprime crisis. *Quantitative Economics* 2(3): 455-491.

Phillips, P.C., S.P. Shi and J. Yu. 2013. *Testing for multiple bubbles: Historical episodes of exuberance and collapse in the S&P 500*. Research Collection School of Economics, Singapore Management University.

Phillips, P.C., Y. Wu and J. Yu. 2011. Explosive behavior in the 1990s NASDAQ: When did exuberance escalate asset values? *International Economic Review 52*(1): 201-226.

Pillay, S. and G.J. Rangel. 2008. Evidence and determinants of real estate bubbles: The case of Singapore. Retrieved on December 25, 2016 from *https://www.researchgate.net/profile/Gary_Rangel/publication/228164032_Evidence_and_Determinants_of_Real_Estate_Bubbles_The_Case_of_Singapore/links/0deec5326f72b622ac000000.pdf*

Rapach, D. and J. K. Strauss. 2009. Differences in housing price forecastability across US States. *International Journal of Forecasting* 25: 351-372.

Shiller, R.J. 2007. *Understanding Recent Trends in House Prices and Home Ownership*, Yale University Economics Department Working Paper No. 28.

Shimizu, C. and T. Watanabe. 2010. Housing bubbles in Japan and the United Sates. *Public Policy Review* 6(3): 431-472.

Stiglitz, J.E. 1990. Symposium on bubbles. *The Journal of Economic Perspectives 4*(2): 13-18.

World Bank. 2015. Retrieved on December 25, 2016 from *http://www.worldbank.org/en/publication/wdr2015.*

Zhang, Y., X. Hua and L. Zhao. 2012. Exploring determinants of housing prices: A case study of Chinese experience in 1999–2010. *Economic Modelling* 29(6): 2349–2361.