HOUSE PRICE OVERVALUATION IN HONG KONG: IDENTIFYING THE MARKET FUNDAMENTALS AND UNDERSTANDING THE 'BUBBLE'

Philip Arestis, University of Cambridge, UK,

Department of Land Economy, 19 Silver Street, Cambridge, CB3 9EP

Tel: +44 (0)1223 766971

e-mail: pa267@cam.ac.uk

 Ana Rosa González-Martínez (Corresponding Author), Cambridge Econometrics, UK,

Reuben House, Covent Garden, Cambridge, CB1 2HT

Tel: +44 (0)1223 533100

e-mail: ar.gonzm@gmail.com, agm@camecon.com

JIA Lu-kui, University of Cambridge, UK

Department of Land Economy, 19 Silver Street, Cambridge, CB3 9EP

Tel: +44 (0)1223 766971

e-mail: lj297@cam.ac.uk

HOUSE PRICE OVERVALUATION IN HONG KONG: IDENTIFYING THE MARKET FUNDAMENTALS AND UNDERSTANDING THE 'BUBBLE'

Abstract

After a period of intense activity in the Hong Kong housing market in the past 10 years, it reached an unprecedented high level at the end of 2013, in terms of both rents and prices. In view of these facts, the existence of a severe bubble in this particular market is raised. If this were to be confirmed, it is possible that its consequences would be more serious than the 1997 bubble episode. In this context, this contribution is structured in two parts. Firstly, we propose a theoretical framework to identify the fundamentals of the market. In the second step, we decompose house prices into fundamentals, frictions and bubble episodes for a better understanding of the evolution of house prices during the period 1996:Q3-2013:Q3. Finally, further research is carried out in an attempt to provide some conclusions regarding the future path of the Hong Kong housing market.

Keywords: House Prices, Hong Kong, Structural Breaks, Housing Bubble.

JEL Classification: C22, R31.

1. Introduction

The modern history of Hong Kong property market can be traced back to the late 1940s, when a sharp increase of population led to the first boom in the housing sector. The Hong Kong housing market has experienced several boom and burst phases since 1980. The most recent and distinct housing boom started in 1984 and peaked in 1997. Then the subsequent recessionary phase lasted until 2004, when the current upswing started. The high volatility of house prices in Hong Kong has been previously acknowledged by other contributions; see, for example, Zhu (2006) and Glascok et al. (2008). More specifically, Glascok et al. (op. cit.) conclude that Hong Kong dwelling assets cannot be considered as a safe 'haven'.

Moreover, this housing market has been attracting increasing interest in recent years. This is due to the fact that housing prices have exhibited an extremely sharp upward trend since 2010. For example, real annual house price appreciation was above 23.6% in 2012 (Knight Frank, 2013). However, the latest available data on this market show that house prices continue to rise, although the rates of growth of house prices since then are lower. This can be interpreted as a slowdown in the activity of the Hong Kong market (Global Property Guide, 2014). This observation along with government attempts to curb demand, a rising supply and expectations about an imminent increase in interest rates are fuelling fears of a possible collapse of the market with severe consequences (South China Morning Post, 2014). More specifically, the main actions that have been implemented by the Hong Kong authorities can be summarised as follows: (a) enhance the supply of land; (b) introduce Home Owner Schemes (HOS) to improve the liquidity of second hand properties; and (c) rise in the existing stamp duty, with new rates, which go from 1.5% to 8.5% of the total transaction value depending on the value of the residential asset. All these factors turn the Hong Kong property market into an important case study.

The analysis carried out for the purpose of this paper is structured around two pillars. First, we need to identify the main drivers of housing prices in the Hong Kong housing market. In a second step, further research is provided to confirm the existence of a house price overvaluation, which has driven the market into a bubble episode. Then we proceed to decompose housing prices in Hong Kong into three components, i.e. fundamentals, frictions and bubbles, by using filtering techniques (Christiano and Fitzgerald, 2003).

Although our procedure to identify 'bubble' episodes is based on Glindro and Delloro (2010), we modify their procedure by including a different filtering technique,

which is more suitable due to the 'random-walk' nature of housing prices in the Hong Kong market. In order to check properly for the existence of unit roots in the data set, the Lee and Strazicich (2003) approach to unit roots is applied. The use of this test means an advance with respect to other contributions, which do not take into account the existence of structural breaks in the data. This is paramount in order to avoid inconsistency in the empirical results through time.

The availability of relevant and official statistics for the Hong Kong housing market compels us to focus just on the recent developments in this market. More precisely, this contribution analyses quarterly data for the period 1996:Q3 to 2013:Q3. This time horizon permits us to have a full 'picture' of the developments in the housing market after the Asian crisis of 1997. For the purposes of this contribution, the ARDL bounds test of cointegration (Pesaran and Shin, 1999; Pesaran et al., 2001) is utilised. Then, we proceed to estimate our model by means of the Least Squares with the Breakpoints method (EViews, 2013) due to the lack of co-movement between the variables in the long run. Then, we proceed to discuss the results of our price decomposition exercise.

Our contribution goes beyond the existing literature since we combine in the same piece of research, firstly, an exercise to identify the main drivers of house prices, and subsequently, we proceed to examine in detail whether house prices are far away from their fundamentals; we also examine its causes, i.e. speculation *versus* short-run fluctuations in the market. In addition to that, our contribution pays special attention to the existence of structural breaks in the time series under consideration. In doing so, the unit root tests and the econometric technique employed deal explicitly with the existence of break points in the historical data, which other contributions, for example Leung et al. (2008), do not undertake. Moreover, we provide more update research in the case of this market, which is needed, since the existing body of work is focused on the events that took place in 1997; see, for example, Kalra et al. (2000). However, there is no much research that concentrates on the study of the dynamics of the Hong Kong housing market after the 1997 peak.

The layout of this paper is organized as follows. Section 2 elaborates on our theoretical framework. Section 3 discusses the econometric techniques employed and describes the data sources, which were utilised for the purpose of this research. Our empirical results are reported and interpreted in Section 4. Section 5 presents further discussion of our empirical results. Finally, Section 6 summarises and concludes.

2. Theoretical Framework

2.1. Fundamentals of the Hong Kong Housing Market

In general terms, the dynamics of the housing market could be easily summarised by means of the interaction of the demand for and supply of housing assets.[1] On the one hand, previous research has modelled demand for housing as a function of income, real price of housing services, and mortgage rates (Holly and Jones, 1997). In addition to that, other variables, which have been considered as demand shifters are rental prices (Klyuev, 2008), demographic elements and credit (Bover, 1993). On the other hand, supply of housing has been explained as positively related to house prices, population and housing stock (Muellbauer and Murphy (1997). We proceed with further fundamentals that relate closely to the Hong Kong housing market. For simplicity, we assume that new properties are acquired by households who do not possess already another property, which could be sold to finance a new purchase.[2] We may also note that the impact of the mortgage rate and households' debt service burden can be jointly introduced into the model via a new variable, i.e. the volume of mortgages, which are held by home buyers. In other words, the effective volume of the mortgages that are issued by commercial banks is a proportion of the total demand for mortgages, i.e. the volume of loans for housing depends on the financial needs of the credit-worthy borrowers. In this context, an increase in the cost of obtaining resources is translated into higher monthly repayments, which 'excludes' from the housing market some of its potential participants. This provokes a decline in the aggregate volume of mortgages in the system. Moreover, we propose to represent the supply side of the housing market through the rental prices. This variable, which also affects the market through the demand side, reacts more rapidly than households' residential investment to an exogenous shock in the relevant market.[3] This is so since rental payments are affected by the actual supply of housing, while the level of housing starts and real residential

---

[1] Several alternative frameworks have been developed since the Poterba's (1984) seminal contribution. For example, Madsen (2011) extends the Poterba's (1984) model to optimise investors' behaviour and accounts for the role of taxes in the optimization process. Moreover, Miles (2012) also bases his analysis on Poterba (1984) with a special focus on the role of demographics.

[2] Due to data constraints, net real estate of households is not included in our analysis.

[3] We may also note that low rental prices reduce the supply of housing services since there are some investors or home owners who 'withdraw' their properties from the market. This is so since the risks, which are related to a rental operation, are not compensated by the certainty of obtaining rental incomes. This kind of behaviour is an option for those participants who own several properties, which do not have an associated mortgage; for example, properties that are inherited. The relevance of this phenomenon depends strongly on the institutional settings. Specifically, a regulation, which permits to evict quickly those tenants who do not respect their contractual obligations, enhances this behavioural path. Alternatively, high rental prices encourage some home owners to rent second properties, i.e. those properties, which they own but they use as 'temporary' residence.

investment are part of this supply in the future. In view of these assumptions, our proposed equations for demand and supply of housing are as in equations (1) and (2):

$$\delta^H = \delta^H(\pi, Y^D, M^H, \Gamma^H) \qquad (1)$$
$$\quad - \quad + \quad + \quad +$$

$$\varsigma^H = \varsigma^H(\pi, M^D, \Gamma^H) \qquad (2)$$
$$\quad + \quad + \quad +$$

Equation (1), describes housing market demand, δ^H, which is negatively related to house prices, π, while real disposable income, Y^D, the volume of loans to acquire housing assets, M^H, and dwelling rental prices, Γ^H, have positive impacts on the demand for housing. Likewise, on the supply side of the housing market, which is explained by equation (2), house prices, π, the volume of loans to develop new housing project, M^D, and rental prices, Γ^H, are positively related to the housing supply, ς^H. The sign below each variable shows the partial derivative of the dependant variable with respect to each element.

When the housing market is in equilibrium, demand for, δ^H, and supply of housing, ς^H, can be set equal to each other, and upon solving for house prices equation (3) can be derived:

$$\pi = \pi(Y^D, M, \Gamma^H) \qquad (3)$$
$$\quad + \quad + \quad +$$

where the symbols are defined as in previous equations,[4] with the exception of M. Due to data availability constraints, the variables M^H and M^D are merged into a single variable, M, which accounts for the volume of credit that is provided to the participants of the housing market, either home buyers or property developers. This new variable is consistent with the data, which is published by the Hong Kong Monetary Authority.

Equation (3) suggests that house prices, π, are determined by the volume of loans to acquire housing assets and develop real estate projects, M, real disposable income, Y^D, and dwelling rental prices, Γ^H. This equation shows how the demand for housing, and the resulting equilibrium house prices, depend on how home buyers are financially constrained. In general terms, home buyers need to get into debt to purchase

---

[4] In the second part of this contribution, we assume a linear relationship amongst the variables and proceed to test this equation econometrically. More specifically, a log-log specification is estimated where all the variables are expressed in logarithms.

real estate assets. In this sense, the volume of disposable income is a key variable. This is so since it influences the maximum volume of external finance that commercial banks are willing to lend to a particular household; and also, the conditions that borrowers need to accept in order to access bank credit, i.e., the prime that they have to face in view of their potential insolvency risk or length of the provided mortgage.[5] Moreover, equation (3) accounts for the role of the volume of mortgages, which is a proxy for the credit standards established by the central bank.[6] Finally, rental prices are also included since they are a proxy for the cost of the services, which are provided by dwelling assets.[7]

2.2. Price Overvaluation

The first 'pre-condition', which is needed for a house price bubble to take place, is the existence of price overvaluation. However, the simple presence of price overvaluation would not lead the market automatically to an unsustainable position, which finally would explode, thereby provoking the so-called 'bubble' episode. More precisely, a first intuition to characterise this kind of episodes is that housing bubbles take place in those cases where housing prices are not driven by the evolution of their fundamentals.

Hilbers et al. (2008) encapsulate the literature about housing bubbles by defining two types of them: (a) *rational bubbles*, which appear in those situations where current housing prices capture future capital gains and rental income; i.e. current housing prices are the sum of the value of the fundamentals of the market and the present future value of real estate assets, namely, the bubble;[8] and (b) *irrational bubbles*, which emerge in those markets where there are rational investors and trading agents whose behaviour cannot be modelled. In the latter type, the existence of a bubble can be measured as the difference between the current market price and the price, which would emanate from a market where all the investors behave rationally.

---

[5] The volume of mortgages, which are held by home buyers, also accounts for the role of interest rates implicitly. This is so since an increase in the interest rate forces some potential home buyers to abandon the market since they could not afford their repayments in this new scenario. This decline in demand for housing has a reflection on the demand for mortgages, and eventually, it results to a lower volume of mortgages issued by commercial banks.

[6] Gerlach and Peng's (2003) findings highlight a strong contemporaneous correlation between bank lending and real estate prices in the case of Hong Kong. Wong et al. (2007) suggest that serious banking distress in Hong Kong could emanate from an extreme shock of property prices.

[7] Rental prices are an important element in order to assess the presence of house price overvaluation by means of the metric price-to-rent ratio. For example, in the case of the United States this ratio was around 50% at the peak of the market. See, also, Poterba (1984) for further details on rental prices as a determinant of housing prices. See, also the study by Favilukis et al. (2012), which considers financial liberalisation as a key element to explain increases in the price-to-rent ratio.

[8] In other words, rational bubbles surge in those cases where homebuyers are willing to pay a price, which is far away from its fundamentals. This is so since they expect a housing price appreciation in the near future and they try to anticipate their purchases to a coming context characterised by less affordable assets. In this particular case, economic literature suggests that housing prices can be decomposed into fundamental and bubble components.

Seminal contributions to the study of rational bubbles in the housing market are Shiller (1981), West (1987), and Campbell and Shiller (1987). Special attention deserves to be paid to the two-step methodology proposed by Campbell and Shiller (op. cit.). In the first step, this approach suggests to study the order of integration of the actual housing prices and its fundamental component. Two possible cases could indicate the presence of a rational bubble in the market. On the one hand, a rational bubble is identified if the actual house price is first-difference stationary and its fundamental component is stationary. On the other hand, unit root tests could also establish the case where the house prices and their fundamentals are first-difference stationary. The former requires a second step, where cointegration is used to investigate a possible co-movement between house price and its fundamental components. If cointegration is found, then the conclusion is the absence of a 'bubble' episode.[9]

We follow the approach proposed by Glindro and Delloro (2010), who adopt a procedure in three steps to decompose prices, namely fundamental, cyclical and bubble component. To the best of our knowledge, this procedure has not been employed to study house prices in Hong Kong. First of all, long-run price overvaluation, π^o_t, is calculated by subtracting the long-run trend price, π^l_t, from the actual price of the housing asset, π_t, as shown in equation (4):

$$\pi^o_t = \pi_t - \pi^l_t \tag{4}$$

In a second step, the portion of house prices overvaluation, which is caused by the cyclical component, i.e. short-run frictions, π^s is calculated as indicated in formula (5):

$$\pi^s_t = (\pi_{t-1} + \pi^c_t) - \pi^l_t \tag{5}$$

where $(\pi_{t-1} + \pi^c_t)$ is the short-run price, i.e. the short-run friction; π^c_t is the short-run cyclical component, and π^l_t, which accounts for the long-run trend price.

Finally, the bubble component is calculated as the difference between equation (4) and (5). In other words, the bubble component is calculated as the difference between housing price overvaluation and the proportion of price overvaluation, which is explained by the short-run frictions, as shown in (6):

---

[9] We may also note that other procedures have been developed to assess the existence of bubbles in the housing market. For example, the study by Glindro et al. (2008) that elaborates on their procedure based on cointegration techniques. Moreover, Phillips et al. (2011) propose the use of a right-tailed Dickey-Fuller test repeatedly.

$$\pi_t^b = \pi_t^c - \pi_t^s \tag{6}$$

where all the symbols have the same meaning as above, with the exception of π_t^b, which is the bubble component.

Alternatively, this procedure permits us to calculate housing price by summing up housing prices in the last period, its cyclical and bubble components, as shown in (7):

$$\pi_t = \pi_{t-1} + \pi_t^o + \pi_t^b \tag{7}$$

where the variables have the same meaning as in equation (6).

Glindro and Delloro's (2010) contribution employs the Kalman (1960) filter to decompose house prices.[10] For the purpose of this contribution, we modify Glindro and Delloro's (2010) approach by using the Christiano and Fitzgerald (2003) filter. A different technique is applied in our approach in view of some particular features of the Christiano and Fitzgerald (2003) filter, which make it the most suitable option for our study, as it is discussed in the next section. Our choice is justified on the basis that this filter assumes that the raw time series behave as a random-walk process. The Christiano and Fitzgerald (2003) filter is optimal in the case of a random-walk process. In other words, this filter is more suitable than other filtering techniques, as for example when compared to the Baxter and King (1999) filter. This is so since the Christiano and Fitzgerald (2003) filter is particularly focused on time series, which are first-order integrated processes. As discussed earlier in this section, that is the case with house prices in Hong Kong during the period under investigation. The fact that the Christiano and Fitzgerald (op. cit.) filter is not symmetric, i.e. it does not remove second-order deterministic or second-order integrated processes, could be a weakness to employ this technique in some particular cases. However, this is not relevant for the purpose of our study since the time series under consideration are stationary. As far as we are aware, this filter has not been applied before in the context of decomposing housing prices.

---

[10] Another contribution, which also applies filtering techniques to study housing prices overvaluation, is Tkacz and Wilkins (2006). Tkacz and Wilkins (op.cit.) capture the presence of misalignments in asset prices by applying the Hodrick and Prescott filter (Hodrick and Prescott, 1980) in the case of Canada.

3. Empirical Analysis of Hong Kong Real Estate Market

3.1. Econometric Technique

First of all, the order of integration of the time series, which are utilised in our study, needs to be checked. In order to do that, we apply the Augmented Dickey-Fuller unit root test (Dickey and Fuller 1979, 1981), the Phillips-Perron unit root test (Phillips and Perron, 1988) and the Kwiatkowski-Phillips-Schmidt-Shin (Kwiatkowski et al., 1992) test. However, the results of these tests can provide misleading conclusions regarding the order of integration of the time series under analysis in those cases where the data present structural breaks.[11] To avoid biased results, which could lead us to choose the wrong econometric technique to estimate our model, we apply the Lee and Strazicich's (2003) unit root test with two structural breaks endogenously determined.[12] The results of all these tests conclude that the time series under consideration are stationary with a structural break.

In order to test empirically our testable hypothesis we apply the Least Squares technique with breakpoints (Bai and Perron, 2003), which accounts specifically for the existence of structural breaks.[13] This method determines the relevant structural breaks endogenously by means of the Bai and Perron (op. cit.) approach and provides specific and different estimations for each sub-sample. In other words, the main advantage of this technique is that it allows the estimated coefficients of the regression to change across observations.[14]

The validity of the estimated model is checked by means of the following tests: a) the White (White, 1980) test, with and without cross terms, which checks for the homoscedasticity of the residuals; b) the Breusch-Godfrey Serial Correlation LM (Breusch, 1979; Godfrey, 1978) one, which tests for the absence of autocorrelation; and c) the ARCH (Engle, 1988) test, which checks for the lack of ARCH effects. Moreover,

---

[11] To make the point some events, which could have provoked structural breaks in the time series under scrutiny, can be mentioned. For example, the 1997 Asian financial crisis and the 2007 subprime mortgage crisis. However, we consider more appropriate the utilisation of a unit root test, which accounts for structural breaks, endogenously determined instead of a test that allows the researcher to impose the break points exogenously. This is so since the mentioned events are not important in the same way for all the time series that are included in our model. More specifically, we can expect that interest rates reacted quicker to the 1997 Asian financial crisis than GDP per capita.

[12] GAUSS 10.0 is the econometric package, which was employ to conduct the Lee and Strazicich's (2003) unit root test. The rest of the unit root/stationarity tests are undertaken by employing the EViews 8.0.

[13] See, also, Bai (1997) and Bai and Perron (1998).

[14] Perron and Yamamoto (forthcoming) recommend the use of Ordinary Least Squares (OLS) rather than the Instrumental Variables (IV) technique under the presence of structural breaks even if some of the regressors involved in the estimation are endogenous. In particular, OLS is preferable to IV since the former avoids potential weak identification problems related to weak instruments. Additionally, with the exception of some knife-edge cases, OLS also produces more accurate estimates of the break dates than IV.

the stability of the parameters of our model is tested by means of the CUSUM and the CUSUM of squares tests (Brown et al., 1975).

EViews 8.0 is the econometric package utilised to estimate the models and conduct the relevant tests.

3.2. Data

For the purpose of this contribution, we focus on the evolution of the housing market in Hong Kong over the period 1996:Q3 to 2013:Q3. This time horizon permits us to study the dynamics of this property market since its last peak in 1997.

The main data provider is the *Hong Kong Rating and Valuation Department*, which publishes quarterly data on house prices and rental prices. [15]

Moreover, other data sources have been consulted. The *Hong Kong Monetary Authority* provides monthly time series on the volume of mortgages and the Hong Kong base window rate.[16] The monthly data on Treasury notes rate and mortgage rate in the US market, which are utilised in the descriptive section are obtained from the *Federal Reserve Bank* website. [17, 18] In particular, we use the rate of the 20-year US Treasury note to build our proxy for the mortgage rate in Hong Kong. We make that assumption as the duration of this note is similar to the average length of mortgages. Apart from that, the Hong Kong Monetary Authority is the data provider of time series on total mortgages.[19]

The lack of data on real disposable income per capita with quarterly frequency compels us to build our own time series by using quarterly data on Gross Disposable Income and semi-annual data on Total Population. The former is published by the *Government of the Hong Kong Special Administrative Region*, while the latter can be downloaded from the *Hong Kong Census and Statistics Department* website. We may

---

[15] This data is available at:
http://www.rvd.gov.hk/en/property_market_statistics/index.html

[16] The 'volume of mortgages' that we analyse in this contribution is defined as the aggregate amount of mortgages, which are outstanding in each period of time. In particular, the 'volume of mortgages' refers to residential mortgage loans, i.e. loans (including refinancing loans) to private individuals for the purchase of residential properties, including uncompleted units, but other than those properties under the Home Ownership Scheme, Private Sector Participation Scheme and Tenants Purchase Scheme. Mortgage loans to corporate clients are excluded from this indicator that is elaborated by the Hong Kong Monetary Authority.

[17] These time series are available at:
http://www.hkma.gov.hk/eng/market-data-and-statistics/economic-and-financial-data-for-hong-kong.shtml;
http://www.federalreserve.gov/releases/h15/data.htm

[18] In the case of these particular time series, quarterly time series are obtained by calculating the average value of the relevant montly data.

[19] The data on mortgages, which is computed in our econometric analysis, accounts for loans to purchase private residential properties and also loans for property development.

also note that quarterly data on total population has been obtained by interpolating the original semi-annual data.[20]

Finally, additional data is also needed for the descriptive section of this contribution. For example, quarterly time series on gross average wages. This data is provided by the *Hong Kong Census and Statistics Department*.[21] Apart from that, the *Hong Kong Monetary Authority* publishes quarterly time series on the volume of foreign currency reserves. The rates on homeownership, which are reported, are published by *Hong Kong Rating and Valuation Department*.[22]

3.3. Descriptive Analysis and Stylized Facts

To begin with the descriptive analysis of the Hong Kong housing market a comment about the rate of home ownership in this market is needed in order to give an idea about the importance of investment in residential properties in this market. At the beginning of the period analysed, the rate of home ownership was around 45%, although it exhibited a moderate upward trend in the last 15 years, reaching a 51% of the households by the end of 2013. Figure 1 shows the evolution of house price and rental price index of Hong Kong in real terms.[23] This figure shows that the market is at a peak level, which is above the peak of the previous collapse of the market. The last peak of the market is shown in 1997:Q3. The comparison of the current values for both indices with their values in the latest peak suggests that house prices are a 30.75% higher than in the third quarter of 1997. However, rental prices exhibit a different path. Rental prices fall after the collapse of the market, although they have already reached that value. More specifically, rental prices were 1.15% above the 1997:Q3 level in the third quarter of 2013.[24]

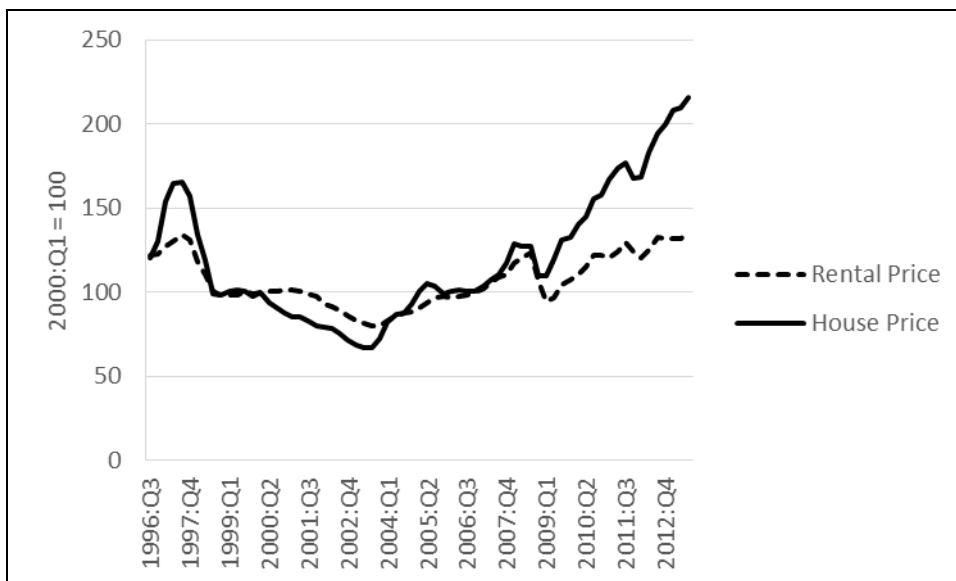[20] This data can be obtained from: http://www.censtatd.gov.hk/hkstat/sub/bbs.jsp
[21] The lack of availbility of consistent time series on gross average wages for the period under consideration prevents us from using this variable as a proxy for the credit worthiness of the potential home buyers.
[22] Time series for *owner-occupiers as a proportion of total number of domestic households* are available at: http://www.censtatd.gov.hk/hkstat/sub/sp150.jsp?tableID=005&ID=0&productType=8
[23] The reported house price index has been obtained by analysing all the effective transactions in a given period, which were scrutinised for stamp duty reasons. See, Hong Kong Rating and Valuation Department (2014) for further details.
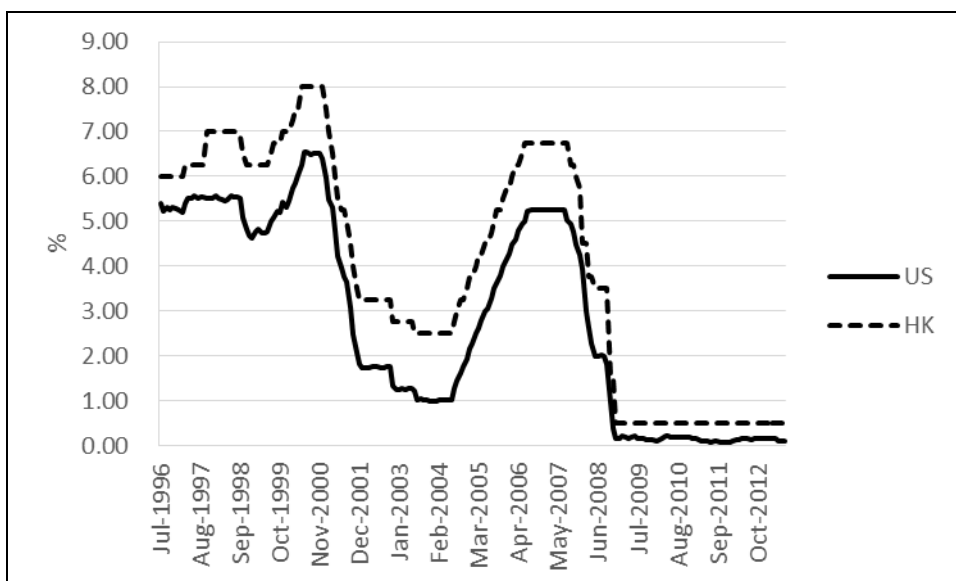[24] Rental prices are calculated by the Hong Kong Rating and Valuation Department and are based on the value of real transactions.

FIGURE 1 HONG KONG REAL HOUSE PRICE AND REAL RENTAL PRICE INDEX
(1996:Q3-2013:Q3)

Source: Hong Kong Rating and Valuation Department, authors' calculations.

FIGURE 2 NOMINAL BASE INTEREST RATE IN THE UNITED STATES AND HONG KONG
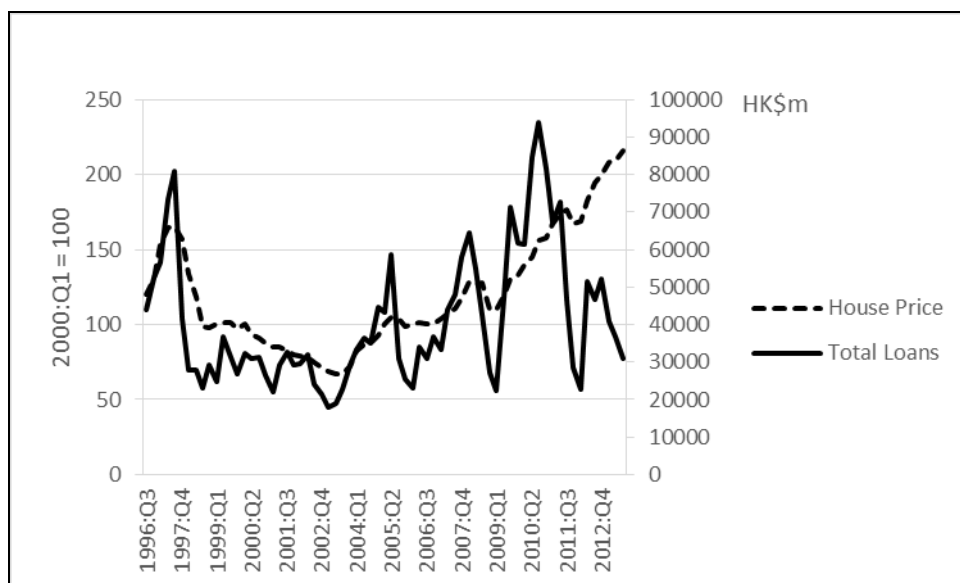(1996:JUL-2013:OCT)

Source: Federal Reserve Bank, Hong Kong Monetary Authority; authors' calculations.

The special foreign currency exchange mechanism in which Hong Kong dollars are pegged to the United States dollar, suggests that the interest rate in the Asian economy under consideration responds to a change in the United States economy almost instantly. As shown in Figure 2, the base window rate in Hong Kong and the US federal funds rate display the same profile. This is the justification, which permits us to approximate the Hong Kong mortgage rate by means of the United States mortgage rate in our econometric analysis in view of the lack of historical data on the Hong Kong mortgage rate.

Figure 3 shows a common trend between the volume of mortgages and house prices in Hong Kong during the vast majority of the period analysed. However, in the last part of the period both variables followed an opposite trend. This difference could indicate an increase in foreign investment in residential assets. This is so since the increase in housing prices, due to an increase in demand for housing, does not have a reflection in terms of domestic indebtedness. However, this hypothesis would need further investigation to be considered as the key explanation of this suggestion.[25]

FIGURE 3 REAL MORTGAGE AND HOUSE PRICE INDICES
(1996:Q3-2013:Q3)

Source: Hong Kong Rating and Valuation Department, Hong Kong
Monetary Authority. Authors' calculations.

---

[25] The estimated correlation between real house prices and the volume of mortgages in the overall period is 0.61.

4. Empirical Results

4.1. Housing Price Analysis

This section presents the estimates for the equations, which follow from our theoretical framework. The estimation process starts by applying the ARDL bounds cointegration test (Pesaran and Shin, 1999; Pesaran et al. 2001). In view of the presence of trend stationarity and first-difference stationary time series in our sample, the ARDL bounds test for cointegration is the most suitable technique.[26] The results of the ARDL bounds-testing approach suggest the acceptance of its null hypothesis, i.e. the lack of a significant relationship among the variables in the long run relationship. Due to the fact that this test does not find cointegration among the variables under consideration in the case of our house prices equation we take first differences of those variables, which contain a unit root, and proceed to estimate our model by means of the Least Squares with Breakpoints technique. This model in first-differences can be interpreted as a short-run specification. This is so since our preliminary results do not identify co-movement between the variables in the long run.

Table 1 displays the estimated parameters, along with the statistics/diagnostics, which validate our results. These statistics/diagnostics permit us to evaluate some properties of the residuals of our model; these are: the lack of autocorrelation, heterocedasticity and ARCH effects, as discussed in Section 3.1.

TABLE 1 HOUSE PRICE RELATIONSHIPS

House Price Relationship					
Period	Constant	DL_Y^D	DL_Γ^H	DL_M	DL_π
1997Q1:2008Q4	-0.0024	0.2700*** (1)	0.9141*** (0)	0.0983*** (0)	0.2458*** (1)
2009Q1:2013Q3	0.0349***	0.1789 (1)	0.7001** (0)	0.0625** (0)	-0.3423 (1)
Statistics/Diagnostics					
R-squared	0.8007				
LM (1)	0.002181 (0.9629)				
LM (2)	0.275325 (0.7604)				
LM (3)	0.192747 (0.9009)				
LM (4)	0.740367 (0.5687)				
White	0.725209 (0.7839)				
White (X)	0.453283 (0.9847)				

[26] This cointegration test has been undertaken by utilising Microfit 5.02. All the relevant results can be obtained from the authors upon request.

ARCH(1)	0.862686 (0.3565)
ARCH(2)	3.048994 (0.0546)
ARCH(3)	0.127175 (0.9436)
ARCH(4)	0.163574 (0.9560)

Note: ***, ** and * indicate statistical significance and rejection of the null at the 1, 5 and 10 percent significance levels, respectively. In the bottom part of the table, numbers in parentheses show the lag(s) of the relevant variable.

The econometric technique employed for the purpose of this analysis identifies a breakpoint in 2009(Q1). The estimated model is able to explain 80% of the fluctuations of house prices during the period of investigation. At first sight, the main difference between the model estimated for the period 1997(Q1)-2008(Q4), and the one that spans from 2009(Q1) to 2013(Q3), is the role played by disposable income. More precisely, this variable is a significant explanatory one in the former case, while it is insignificant in the latter case.[27] The estimated elasticity in the first period is 0.27%.

In both cases the variable, which has a higher impact on the explanation of house prices, is the rental price of dwellings. The estimated coefficients are positive in both cases (0.91 and 0.70 respectively), as suggested by our theoretical framework.

Our empirical findings also highlight a positive effect of the credit standards, which are approximated by the volume of mortgages that are issued by commercial banks. The influence of this variable in both periods is quite stable. The estimated coefficients are 0.09 and 0.06 respectively.[28]

In addition to that, the lagged term of the dependent variable, i.e. house prices, exerts a significant and positive impact (0.24) in the period 1997(Q1)-2008(Q4).

Furthermore, Table 1 also presents the diagnostics and statistics, which are employed to validate our econometric estimations. In both cases, the estimated house price relationships satisfy the hypothesis of homocedasticity, as checked by the White (1980) test with and without crossed-terms. In addition to that, the ARCH (Engle, 1988) test does not find significant Autoregressive Conditional Heteroscedastic (ARCH) effects in the residual time series, i.e. there is no conditional heteroscedasticity or

---

[27] The positive impact of house prices on real disposable income, which is found in our contribution, is along the lines of Leung et al. (2008). However, the value of the estimated parameter for this variable is lower than in the case of Leung et al. (2008).

[28] We may also note that some preliminary work, which includes explicitly the mortgage rate in the model utilised in this section, produces no impact of the interest rate on house prices in the Hong Kong housing market during the period under investigation. This empirical finding is along the lines of previous contributions, which study the role of monetary policy in other housing markets, for example, Del Negro and Otrok (2007) who focus on the United States case.

autocorrelation in the squared residual time series.[29] Finally, the Breusch–Godfrey Serial Correlation Lagrangian Multiplier test (Godfrey, 1978; Breusch, 1979) confirms the lack of autocorrelation of first-, second-, third- and fourth-order in the residuals of the model. [30,31]

4.2. Identification of the Price Overvaluation

Once the fundamentals of the housing market are identified, we proceed to decompose house prices into their fundamental, cyclical and 'bubble' components as explained in the theoretical part of this contribution. House price overvaluation could be driven by two alternative forces, either the cyclical component, or the 'bubble' component. In those cases, where the cyclical component is stronger than the 'bubble' one, this technique does not identify a bubble episode. The economic interpretation of a house price decomposition along these lines is the following: the 'bubble' component captures the evolution of house price overvaluation, which is due to the behaviour of those agents that invest in dwelling since they expect increases in the price of this asset in the future. The cyclical component collects the fraction of price overvaluation, which evolves due to an imbalance between demand and supply of housing. For example, we could expect a rapid increase in this component if there is a strong rise in immigrant inflows.
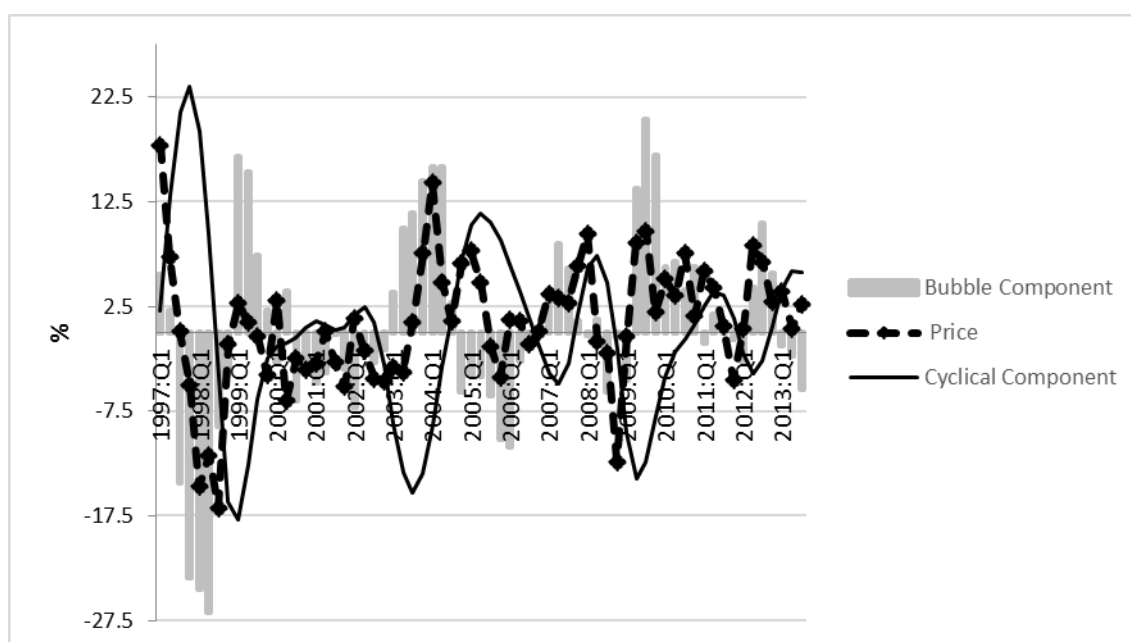
Figure 4 shows the rate of growth of the Hong Kong house price during the period under consideration. This figure also displays the proportion of house prices, which corresponds to the 'bubble' component, along with the proportion of house prices that are due to the evolution of the cyclical component.

---

[29] This test has been conducted by including up to 4 lags. In all the cases the results confirm the lack of ARCH effects.

[30] In order to study the stability of the estimated coefficients, we apply the CUSUM and the CUSUM of squares tests (Brown et al. 1975). In both cases, the values are within the bounds, which correspond to the 5% significance level. The relevant results are available from the authors upon request.

[31] As a robustness test, the same specification is estimated without including the lagged term of house prices. In both cases, all the variables keep the same sign and significance as in the model above. In this alternative exercise, the relevant break point is also 2009(Q1). The relevant results are available from the authors upon request.

FIGURE 4 PRICE DECOMPOSITION: BUBBLE COMPONENT

Source: Authors' calculations.

The first period where there is a rise in the value of the 'bubble' component starts in 1996(Q4). This period is also identified by previous contributions, for example, Yiu et al. (2013), who find the start of this episode in December 1996.[32]

Moreover, our procedure to decompose house price in its components points to the period 1998(Q3)-1999(Q3) as a 'bubble' episode.[33]

The most important period of dominance of the 'bubble' component took place during 2008(Q3)-2010(Q3). More precisely, the highest increase in this component during the period under consideration occurred in 2009(Q3), where the weight of the 'bubble' component increased by 20.3% with respect to the previous quarter. Previously, another period when the proportion of house price appreciation, which was not driven by the fundamentals, grew substantially was 2002(Q3)-2004(Q2). Special attention deserves the high increase in the weight of the 'bubble' component since 2003(Q4)-2004(Q2).[34]

Furthermore, our analysis also identifies another housing bubble in 2006(Q3)-2007(Q2). Periods where house prices are the furthest away from their fundamentals are 2007(Q2) and 2007(Q3).

---

[32] Yiu et al. (2013) apply the approach developed by Phillips at al. (2011).
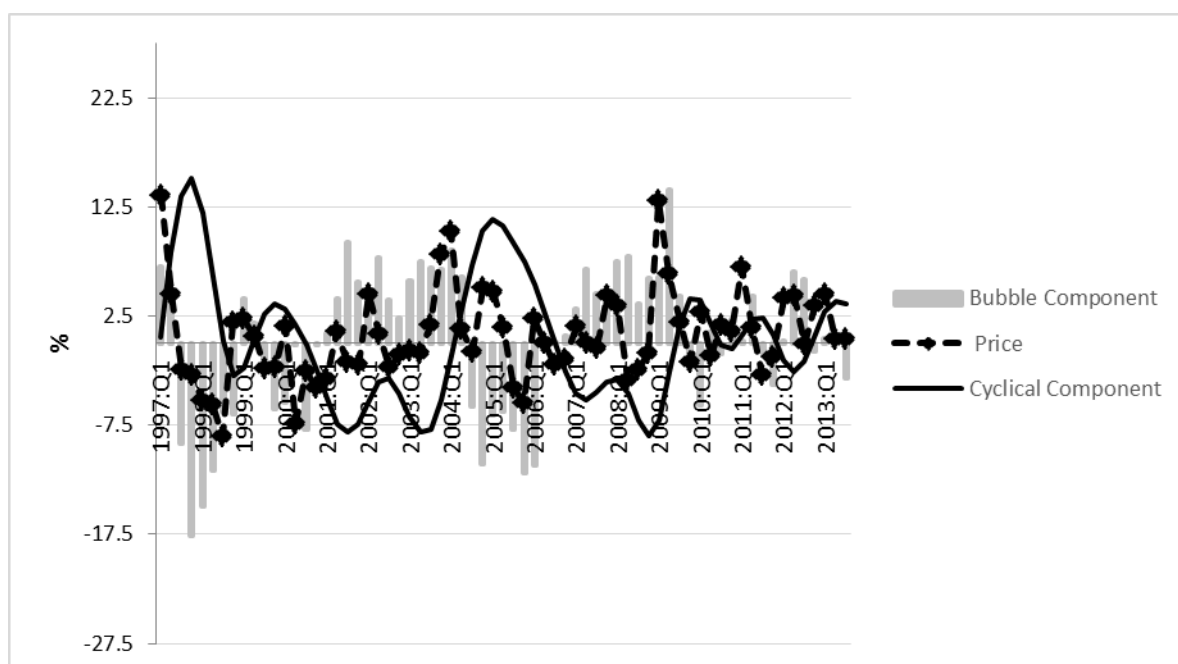[33] This finding contradicts Yiu et al. (2013).
[34] Yiu et al. (2013) also find a 'bubble' episode in 2004(M01)-2004(M04).

Apart from that, 'bubbles' in the Hong Kong housing market are also found in the period 2001(Q1). However, this episode was weaker than the other ones discussed above.

The most recent period where the 'bubble' component became quite relevant was in 2012(Q1)-2012(Q3). The highest increase in proportion of the 'bubble' component is found in 2012(Q3) (10.35%).

Some of the periods, which have been identified as 'bubble' periods, deserve further investigation. This is so since this approach considers two periods, which are characterised by stable house and rental prices, as driven by speculation. More specifically, we refer to the periods 1998(Q3)-1999(Q3) and 2006(Q3)-2007(Q2). In order to explore deeper the behaviour of house prices between the mentioned dates we apply our proposed technique to the price-to-rent ratio.[35] The decomposition of the price-to-rent ratio into its fundamental, cyclical and 'bubble' component is presented in Figure 5.

FIGURE 5 PRICE-TO-RENT RATIO DECOMPOSITION: BUBBLE COMPONENT

Source: Authors' calculations.

---

[35] Average rents are based on the information recorded by the Valuation Department on effective fresh lettings in the month under consideration. Rents are analysed on net basis i.e. exclusive of rates, management and other charges. The rental and price indices that we have employed for our analysis are based on the same dataset. Both indices measure value changes by reference to the factor of rent or price divided by the rateable value of the mentioned property rather than by reference to the rent or price per square metre of floor area. By using rateable values, these indices take into account floor area and other qualitative differences between properties.

The analysis of this metric suggests that the price-to-rent ratio has been driven by the bubble component in the following periods: (a) 1996(Q4); (b) 1998(Q4)-1999(Q1); (c) 2000(Q3)-2004(Q2); (d) 2006(Q2)-2009(Q2); (e) 2011(Q1); and (f) 2011(Q4)-2012(Q2). In general terms, the comparison of these periods with the 'bubble' periods, which have been identified above, confirm those findings highlighted previously.

First of all, both decompositions find the first 'bubble' period in 1996(Q4). Moreover, both approaches indicate that a bubble took place between 1998(Q4)-1999(Q1), although the analysis of house prices finds that this bubble occurred during a longer period.

In addition to that, the study of the price-to-rent ratio has identified a new period in which the dynamics of the market have been strongly influenced by speculation, i.e. 2011(Q1). Moreover, in both cases the last 'bubble' period, which has been identified, is similar, although it started one quarter earlier in the event of the price-to-rent ratio analysis.

However, some differences are found in the case of the period 2000:Q3-2004:Q2, which is considered as driven by speculation in the case of the price-to-rent ratio. More specifically, the analysis of house prices concludes that the 'bubble' component is the main driver of house prices only during the period 2002(Q3)-2004(Q2). Another important difference is found in the case of the 'bubble' period 2006(Q2)-2009(Q2), which according to our first set of results could be split into two different bubble periods, the first one which finishes in 2007(Q2) and the second one which starts in 2008(Q3).

In terms of the purpose of this alternative analysis, we can conclude that despite the stability of house and rental prices during 1998(Q4)-1999(Q1) and 2006(Q3)-2007(Q2) 'bubble' episodes took place in those particular periods.

In view of these results we may note that the Hong Kong housing market is moving into a dangerous position. This is so since in the first two quarters of 2013, house price overvaluation was driven by the cyclical component. However, in the last quarter, which is considered in this contribution, 2013(Q3), we can observe a dramatic change in the evolution of these two elements, namely, the cyclical and bubble component. In other words, there is an increase in the proportion of prices that are explained by the development of the bubble component, which is accompanied by a decrease in the proportion of price overvaluation driven by the cyclical component. In addition to that, we may add that these two changes are asymmetric, i.e. the growth of

the bubble component is higher than the decrease of the cyclical component. This indicates that overvaluation is rising at the same time and that speculators are playing a more important role in the market. If this trend is maintained, the Hong Kong housing market will be near to collapse when this embryonic 'bubble' explodes in the future.

5. Further Comments

5.1. Discussion of the Theoretical and Empirical Results

As advanced in our theoretical framework, house prices are positively influenced by the evolution of housing rents. This fundamental, which captures the value of those services that are provided by dwelling assets, is found as the key driver in both periods. Moreover, the volume of mortgages also exerts a significant and positive effect on house prices during the period 1997(Q1)-2013(Q3). Real disposable income and the lagged value of house prices are positively related to house prices before 2009.

Two contributions are particularly relevant for our study, and for comparative purposes. On the one hand, Leung et al. (2008), who apply cointegration analysis to the Hong Kong market quarterly data that spans the period 1986-2007, find a cointegrating relationship among real house prices, real per-capita income, real interest rate, land supply and the residential investment deflator. On the other hand, the study by Yiu et al. (2013) identifies several 'bubble' episodes over the period March 1993 to March 2011.

In terms of our first set of results, i.e. the econometric model, two main differences can be identified between those findings of Leung et al. (2008) and our study. On the one hand, Leung et al. (op. cit.) identify a cointegrating relationship among house prices, interest rates and disposable income, while our results cannot find any co-movement among these variables in the long run. On the other hand, our results do not find a significant effect on house prices of interest rate changes. However, Leung et al. (2008) and our contribution consider disposable income as a fundamental determinant of housing prices in the Hong Kong market.

Regarding our analysis of house price overvaluation in the market under consideration, our results are along the lines of the findings highlighted by Yiu et al. (2013). Yiu et al. (op. cit.) identify the following bubble episodes: 1994(M03), 1996(M03), 1996(M12)-1997(M06), 2004(M01)-2004(M04), 2004(M10), 2005(M02)-2005(M04), 2007(M11)-2008(M02), 2009(M04)-2009(M07) and 2011(M02)-2011(M03). Our results identify periods where the 'bubble' component becomes particularly relevant in the following dates: 1997(Q1), 1998(Q3)-1999(Q3), 2000(Q1),
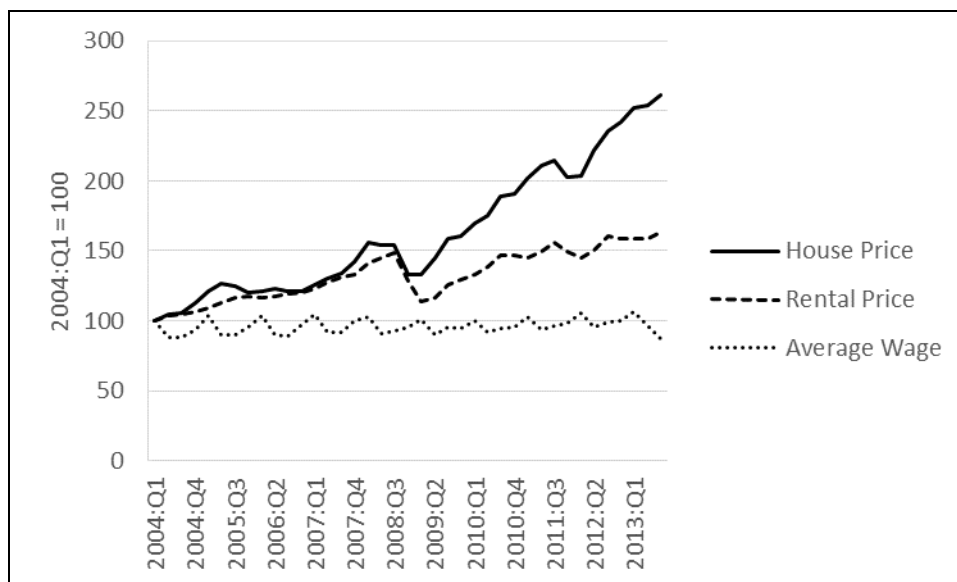
2002(Q3)-2004(Q2), 2006(Q3)-2007(Q2), 2008(Q3)-2010(Q3). Our results also identify a 'bubble' episode in 2012(Q1)-2012(Q3). [36]

In general terms, the estimated coefficients for our model reinforce our theoretical framework. All the parameters present the expected sign.

5. 2. Forecasts and Potential Future Movements

The objective of this section is to provide some ideas regarding the future development of housing prices in the Hong Kong housing market and its eventual possible correction.

FIGURE 6 REAL AVERAGE WAGE, RENTAL AND HOUSE PRICE INDICES (2004:Q1-2013:Q3)

Source: Authors' calculations, based on Hong Kong Rating and Valuation Department, Hong Kong Census and Statistics Department data.
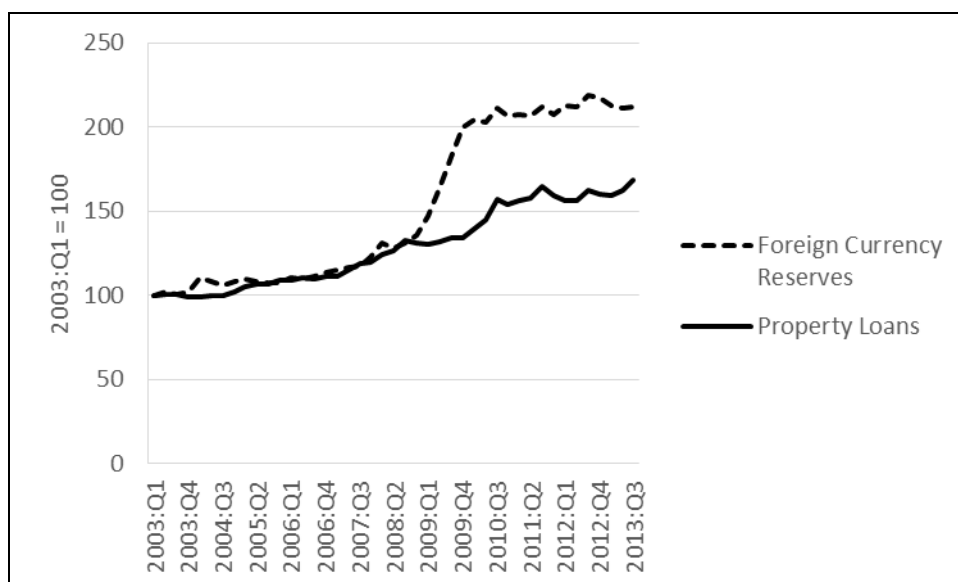
To begin with, Figure 6 displays how the average real income of Hong Kong residents has been stable since 2004. This fact reinforces the testable hypothesis that the driver of rising house prices in Hong Kong is the volume of bank credit to home buyers. However, we also note that due to the special mechanism to determine exchange rates in Hong Kong, the assumption of horizontal supply of money-credit needs to be enhanced to account for foreign capital flows.

More specifically, Figure 7 represents the evolution of the foreign currency reserves and total mortgages in the Hong Kong banking system. Overseas money

---

[36] Some differences in the periods, which are considered as 'bubble' episodes by both contributions, are due to the difference in the frequency of the data employed in both studies.

inflows increased dramatically after the 2007 financial crisis, when a huge amount of capital left developed countries to the emerging markets and safe 'havens'.

FIGURE 7 MORTGAGE AND FOREIGN CURRENCY RESERVES (2003:Q1-2013:Q3)

Source: Authors' calculations, based on Hong Kong Monetary Authority data.

The surge of housing prices after 2004 is supported by the increase in bank credit, which resulted from foreign capital inflows, especially after the 2007 financial crisis. However, more recently, a change in the direction of Hong Kong capital flows has been observed. This is related to the end of Quantitative Easing and the recovery in the United States. The decline of foreign capital flows may give rise to a decrease in bank credit, which could lead to dampened demand for housing, eventually to falling housing prices. The 'loop' between bank credit and house prices may amplify the response of housing prices to changes in bank credit via the 'collateral' channel and the 'wealth' effect. After the August 2007 financial crisis, the United States government and the Federal Reserve Bank have implemented a package of stimulating programs to improve the US economy. This led to a situation of 'abnormally' low interest rates in the United States. As a result, interest rates in Hong Kong are 'abnormally' low as well. As the 'normalization' of interest rate starts, it will move up the interest rate back to its 'conventional' level. As discussed in the theoretical section of this contribution, the increase of interest rate will negatively impact the demand for mortgages.

To calculate a possible future price correction in this market we apply the Discounted Cash Flow method (Baum and Hartzell, 2011), *DCF* hereinafter, which is

well-known in real estate valuation. The DCF method suggests that the price of a real estate asset, π^A, can be calculated as follows:

$$\pi^A = \sum_{t=0}^{n} \frac{c_k}{(1+r)^t} \qquad (8)$$

where c_k represents the cash flow, which is generated at time period t, n is the holding period of the asset and r is the discount rate.[37] The rationale behind the DCF method is the assumption that real estate assets are cash-generating elements. This permits us to appraise the value of investment in real estate assets by means of the sum of the discounted cash flows, which are generated by the asset under appraisal. This approach also assumes an efficient housing market where home buyers are rational. The outcome of this assumption is that the actual price that a given participant in the housing market needs to face when purchasing a property is equal to the profitability of the investment associated to that particular asset.
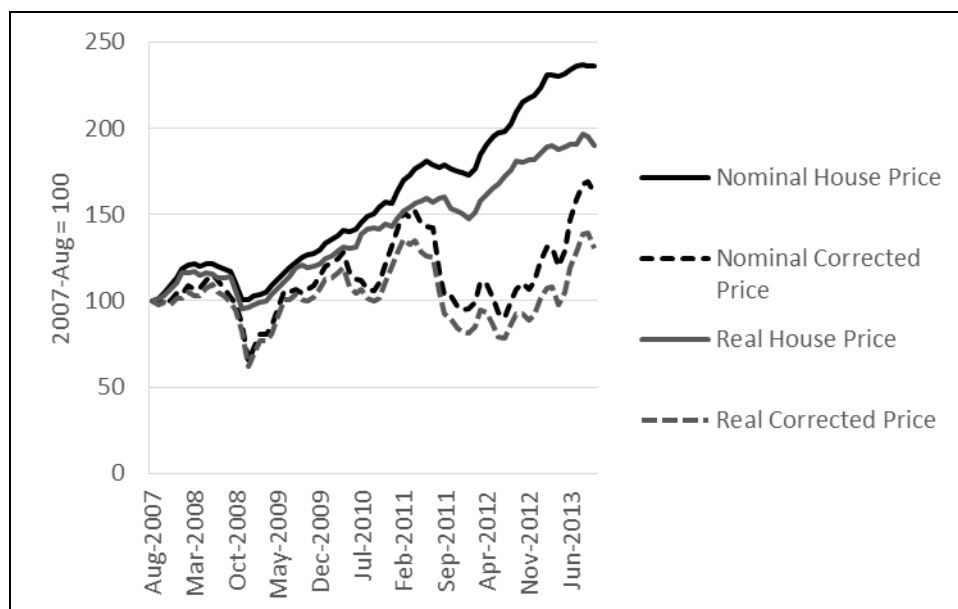
More specifically, Baum and Hartzell (2011) suggest that rental incomes are the key determinant of property value, i.e. a change in rental income will proportionally affect the property value. Early work by Benjamin and Sirmans (1997) also confirm that rent plays a vital role in property valuation since any positive or negative influence on rent would in turn affect the value of the property. In the long run, the value of a real estate asset should be consistent with its rental income level, as shown in Figure 1, which also captures that of prior to 2007. Domestic residential rent index and price index are considerably consistent; in other words, any deviation of the price index from the rent index is corrected rapidly in the following period. However, after the August 2007 financial crisis, the housing price index deviates from the rent index. In the recent past this gap has reached an unprecedented large scale, which indicates a potential drastic correction.

Finally, we use the 20-year debt interest in Hong Kong as a proxy of the discount rate. This is so since this interest rate has a similar horizon as some mortgages. In this paper, we calculate the average of 20-year debt interest rate in Hong Kong from 1990 to 2007 as the 'conventional' interest rate, which will be running in the long run. The comparison of the calculation of housing price indices in a context ruled by

---

[37]For simplicity reasons, we assume that $n \rightarrow \infty$, since for the vast majority of the households housing is an asset, which is held for long-run purpose4s. Moreover, we also adopt the premise that the generated cash flows in each period are equal to the constant rental income.

'abnormally' low interest rates and an alternative scenario characterised by the 'conventional' interest rate provides the results included in Figure 8.

FIGURE 8 ESTIMATED HOUSE PRICE ADJUSTMENT

Source: Hong Kong Rating and Valuation Department. Authors'calculations.

6. Summary and Conclusions

The main results of this research highlight that prices in the Hong Kong housing market are quite above their last peak, which took place in mid-1997. More precisely, our research finds that real house prices are around a 31% higher than their historical maximum value.

The econometric analysis and empirical results carried out in this contribution confirm the relationships, which are put forward in our theoretical model. Our econometric results suggest that house prices are positively related to disposable income. Moreover, our empirical results support our testable hypothesis regarding the evolution of bank credit. As mentioned above, the demand for loans to acquire housing assets is an endogenous element, whose evolution can be explained in terms of household demand for housing. Finally, our empirical findings also support the testable hypothesis of a positive impact on house prices of a change in rents.

In the second part of this contribution, we tackle the issue of detecting the existence of housing bubbles. In doing so, a procedure based on filtering techniques is applied. In view of our findings, the Hong Kong authorities should closely monitor housing prices and try to 'cool' them down in order to contain the evolution of the bubble component. This is particularly relevant since during 2013 the cyclical

component of the house prices has been weakening, which could lead the market to a dangerous position where the bubble component becomes 'dominant', if the current trend is maintained through time. Finally, we proceed to assess the issue of a potential correction in the housing market in an economic scenario defined by higher interest rates. Our results suggest an eventual possible correction of up to 46% of house prices with respect to their 2013(Q3) level.

All this discussion highlights the urgency of taking further action in terms of prudential policy, in view of a harmful future context, which could be motivated by rising interest rates and a sudden change in the direction of capital flows in the Hong Kong case. More specifically, the measures implemented by a number of countries in terms of commercial banks 'stress tests' should be welcomed and applied in Hong Kong and elsewhere.

References

Bai, J. (1997), "Estimating Multiple Breaks One at a Time", *Econometric Theory*, 13 (3): 315-352.

Bai, J. and Perron, P. (1998), "Estimating and Testing Linear Models with Multiple Structural Changes", *Econometrica*, 66 (1): 47-78.

Bai, J. and Perron, P. (2003), "Computation and Analysis of Multiple Structural Change Models," *Journal of Applied Econometrics*, 18 (1): 1-22.

Baum, A. and Haartzell, D. (2011), *Global Property Investments: Strategies, Structures, Decisions*, Chichester: Wiley-Blackwell.

Baxter, M. and King, R.G. (1999), "Measuring Business Cycles Approximate Band-Pass Filters for Economic Time Series", *The Review of Economics and Statistics*, 81(4): 575-593.

Benjamin, J.D. and Sirmans, G.S. (1997), "Mass Transportation, Apartment Rent and Property Values", *Journal of Real Estate Research*, 12: 1–8.

Bover, O. (1993), "Un Modelo Empírico de la Evolución de los Precios de la Vivienda en España (1976-1991)", *Investigaciones Económicas*, 17 (1): 65-86.

Breusch, T.S. (1979), "Testing for Autocorrelation in Dynamic Linear Models", *Australian Economic Papers*, 17 (31): 334–355.

Brown, R.L., Durbin, J., and Evans, J.M. (1975), "Techniques for Testing the Constancy of Regression Relationships over Time", *Journal of the Royal Statistical Society*, Series B, 37 (2): 149-163.

Campbell, J., and Shiller, R. (1987), "Co-integration and Tests of Present Value Models", *Journal of Political Economy*, 95 (5): 1062–1088.

Christiano, L.J. and Fitzgerald, T.J. (2003), "The Band Pass Filter", *International Economic Review*, 44 (2): 435-465.

Del Negro, M. and C. Otrok (2007), "99 Luftballoons: Monetary Policy and the Housing Boom Across US States", *Journal of Monetary Economics*, 54: 1962-1985.

Dickey, D. A. and Fuller, W.A. (1979), "Distribution of the Estimator for Autoregressive Time Series with a Unit Root", *Journal of the American Statistical Association*, 74 (366): 427-431.

Dickey, D.A. and Fuller, W.A. (1981), "Likelihood Ratio Statistics for Autoregresssive Time Series with a Unit Root", *Econometrica*, 49 (4): 1057-1072.

Engle, R.F. (1988), "Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom Inflation", *Econometrica*, 96 (5): 893-920.

EViews (2013), *EViews 8. User Guide II*, Irvine: IHS Global Inc.

Favilukis, J., Kohn, D., Ludvigson, S.C. and Van Nieuwerburgh, S. (2012), "International Capital Flows and House Prices: Theory and Evidence", *NBER Working Paper* no. 17751, Cambridge MA: National Bureau of Economic Research.

Gerlach, S. and Peng, W. (2003), "Bank Lending and Property Prices in Hong Kong." *HKIMR Working Paper No. 12/2003*. Hong Kong: Hong Kong Institute for Monetary Research.

Glascok, J.L., Feng, L., Fan, L. and Bao, H.X. (2008), "Inflation Hedging Characteristics of Real Estate Assets in Hong Kong", *Working Paper Series*. Available at: http://ssrn.com/abstract=1180658 or http://dx.doi.org/10.2139/ssrn.1180658.

Glindro, E.T., Subhanij, T., Szeto, J. and Zhu, H. (2008), "Determinants of House Prices in Nine Asia-Pacific Economies", *Bank for International Settlements WP* No. 263, Geneva: *Bank for International Settlements*.

Glindro, E.T. and Delloro, V.K. (2010), "Identifying and Measuring Asset price Bubbles in Philippines", *BSP Working Paper, N*o. 2010-02, Manila: Bangko Central ng Pilipinas.

Global Property Guide (2014), *House Price Rises Slowing in Hong Kong*, January 04. Available at: http://www.globalpropertyguide.com/Asia/hong-kong/Price-History.

Godfrey, L.G. (1978), "Testing Against General Autoregressive and Moving Average Error Models when the Regressors Include Lagged Dependent Variables", *Econometrica*, 46 (6): 1293–1302.

Hilbers, P., Hoffmaister, A.W., Banerji, A. and Shi, H. (2008), "House Prices Developments in Europe: A Comparison", *IMF Working Paper* no. 211, Washington, D.C.: International Monetary Fund.

Hodrick, R.J. and Prescott, E.C. (1980), "Postwar U.S. Business Cycles: An Empirical Investigation", *Carnegie Mellon University Discussion Paper* no. 451, Pittsburgh: Carnegie Mellon University.

Holly, S. and Jones, N. (1997), "House Prices since 1940s: Cointegration, Demography and Asymmetries", *Economic Modelling*, 14 (4): 549-565.

Hong Kong Rating and Valuation Department (2014), "Technical Notes". Available at: http://www.rvd.gov.hk/doc/en/statistics/15_technotes.pdf

Kalra, S., Mihaljek, D. and Duenwald, C.K. (2000), "Property Prices and Speculative Bubbles: Evidence from Hong Kong SAR", *IMF Working Paper* No. 00/2, Washington, D.C.: International Monetary Fund.

Kalman, R.E. (1960), "A New Approach to Linear Filtering and Prediction Problems", *Journal of Basic Engineering*, 82 (1): 35–45.

Klyuev, V. (2008), "What Goes Up Must Come Down? House Price Dynamics in the United States", *IMF Working Paper* No. 08/187, Washington, D.C.: International Monetary Fund.

Knight Frank (2013), "Hong Kong Tops 2012 Mainstream Global House Price Table", *Residential Research Global House Price Index*, London: Knight Frank.

Kwiatkowski, D., Phillips, P.C.B., Schmidt, P. and Shin, Y. (1992), "Testing the Null Hypothesis of Stationarity against the Alternative of a Unit Root: How Sure Are We that Economic Time Series Have a Unit Root?", *Journal of Econometrics*, 54 (1-3): 159-178.

Lee, J. and M. Strazicich (2003), "Minimum LM Unit Root Test with Two Structural Breaks", *Review of Economics and Statistics*, 85: 1082-1089.

Leung, F., Chow, K. and Han, G. (2008), "Long-term and Short-term Determinants of Property Prices in Hong Kong", *Working Paper no. 15/2008*, Hong Kong: Hong Kong Monetary Authority.

Madsen, J.K. (2011), "A *Q* Model of House Prices", *Department of Economics Discussion Paper* no. 03/11, Victoria: Monash University.

Muellbauer, J and Murphy, A. (1997), "Booms and Busts in the UK Housing Market", *The Economic Journal*, 107 (445): 1701-1727.

Miles, D. (2012), "Demographics, House Prices and Mortgage Design", *Bank of England External MPC Discussion Paper* no. 35, London: Bank of England.

Perron, P. and Yamamoto, Y. (forthcoming), "Using OLS to Estimate and Test for Structural Changes in Models with Endogenous Regressors", *Journal of Applied Econometrics*, http://dx.doi.org/10.1002/jae.2320

Pesaran, M.H. and Shin, Y. (1999), "An Autoregressive Distributed Lag Modelling Approach to Cointegration Analysis", In S.S. Strom, S. Holly and A.P. Diamond(eds.), *Centennial Volume of Rangar Frisch*, Cambridge: Cambridge University Press.

Pesaran, M. H, Shin, Y, Smith, R. J. (2001), "Bounds Testing Approaches to the Analysis of Level Relationships", *Journal of Applied Econometrics*, 16 (3): 289-326.

Phillips, P.C.B. and Perron, P. (1988), "Testing for a Unit Root in Time Series Regression", *Biometrika*, 75 (2): 335-346.

Phillips, P.C.B., Shi, S., and Yu, J. (2011), "Testing for Multiple Bubbles", Unpublished Manuscript, Singapore: Management University.

Poterba, J.M. (1984), "Tax Subsidies to Owner-Occupied Housing: An Asset-Market Approach", *Quarterly Journal of Economics*, 99 (4): 729-752.

Shiller, R. (1981), "Do stock prices move too much to be justified by subsequent changes in dividends?", *American Economic Review*, 71: 421–436.

South China Morning Post (2014), "Dark Clouds Over Hong Kong's Property Market as 'Perfect Storm' Looms", 10 March.

Teng, H.J., Chang, C.O. and Chau, K.W. (2012): "Housing Bubbles: A Tale of Two Cities", *Habitat International*, 39 (3): 8-15.

Tkacz, G. and Wilkins, C. (2006), "Linear and Threshold Forecasts of Output and Inflation with Stock and Housing Prices", *Bank of Canada Working Paper* 06-25, Ottawa: Bank of Canada.

West, K. (1987), "A Specification Test for Speculative Bubbles", *Quarterly Journal of Economics*, CII (3): 553–580.

White, H. (1980), "A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity", *Econometrica*, 48 (4): 817–838.

Wong, J., Wong, T.C. and Leung, P. (2007), "A Leading Indicator Model of Banking Distress – Developing an Early Warning System for Hong Kong and Other EMEAP Economics", *Hong Kong Monetary Authority Working Paper No. 22/2007*, Hong Kong: Hong Kong Monetary Authority.

Wong, T.C., Fong, T., Li, K.F. and Choi, H. (2011), "Loan-to-Value Ratio as a Macroprudential Tool - Hong Kong's Experience and Cross-Country Evidence", *Systemic Risk, Basel III, Financial Stability and Regulation*. Available at: http://dx.doi.org/10.2139/ssrn.1768546

Yiu, M.S., Yu, J. and Jin, L. (2013), "Detecting Bubbles in Hong Kong Residential Property Market", *Journal of Asian Economics*, 28: 115-124.

Zhu, H. (2006), "The Structure of Housing Finance Markets and House Prices in Asia", *BIS Quarterly Review*, December: 55-69.