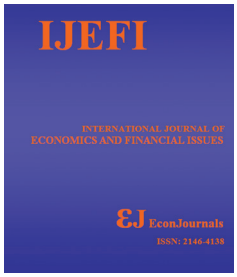

International Journal of Economics and Financial Issues

ISSN: 2146-4138

available at http: www.econjournals.com

International Journal of Economics and Financial Issues, 2016, 6(1), 26-36.

The Responsiveness of Hong Kong Private Residential Housing Prices

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ABSTRACT

Long-run equilibrium house price is determined by demand and supply factors. On the demand side, previous studies on housing prices often use gross domestic product (GDP) and population or GDP per capita as purported driver(s), yet little attention has been paid to the role of households. On the supply side, using land supply or new unit completions and construction cost as inherited factors is most common. In this article, we rely on a reduced-form ordinary least squares equation encompassing selected demand and supply fundamentals to explain Hong Kong private residential house price movements. We aim to: (i) Evaluate the superiority of GDP per household versus GDP per capita, and (ii) assess the relative price responsiveness to various factors like interest rate and mortgage lending across different submarkets. From our investigation, no conclusive evidence can be drawn on (i). Regarding (ii), we find that while larger-sized units are invulnerable to interest rate movements, on geographical area basis, higher interest rate sensitivity tends to accompany lower population density. Moreover, larger-sized units and those located at Hong Kong Island are more responsive to the overall economic conditions (i.e., GDP). Lastly, we point out that in view of the potential threats in 2015, more downward pressure will be exerted on house prices.

Keywords: Gross Domestic Product, Household, Population, Hong Kong, House Price Responsiveness
JEL Classifications: E43, R31

1. INTRODUCTION

Using median house price to annual median household income ratio (PIR) as the barometer, Hong Kong (private residential) housing price has again been rated the least affordable by Demographia (2015a)[1]. According to its interpretation, any market with PIR of 5.1 or above can be rated as severely unaffordable regarding its house price[2]. Hong Kong's PIR has reached at 17.0. It is the 5th consecutive year for Hong Kong be rated as such since it was included in the survey in 2010.

There are growing concerns around the world with regard to housing unaffordability that extensive studies have been performed on various countries over the past decade. For instance, Hou (2010) deploys different indicators to detect housing bubbles in Beijing and Shanghai. McDonald and Stokes (2013) and Miles (2014) examine the responsiveness of US house prices to different interest rate benchmarks. In the context of Hong Kong, Lin and Lin (2011) reveal that the equity and property markets are partially integrated (but no causal relationship). Yiu et al. (2013) find an efficient way to identify housing bubbles so that timely remedies can be implemented.

Housing unaffordability is a very complicated issue. Apart from local and external economic factors, it has to deal with demographics, housing supply, land-use regulations, and the solutions behind often entice political judgments. In this article, we select Hong Kong private residential sector as our research focus for several reasons. Not only is its house price the least affordable in the world, but also Hong Kong is one of the ten urban areas with highest population density (Demographia, 2015b). The more densely populated is a region, the lower would be its

1 Hong Kong is the only market of China included in the survey. For comparison with other Chinese cities, Demographia (2015a. p. 23-24).

2 PIR is an oft-cited measure of housing affordability thanks to its simplicity; yet it also draws criticisms; Abelson (2009). Hou (2010) suggests some other indicators.

price elasticity of housing supply (Caldera and Johansson, 2013). Second, after the takeover of Hong Kong by China in 1997, the ties between the two parties are getting integrated. Meanwhile, under the pegged exchange rate system (PERS), the government has lost its autonomy in setting interest rate policy to influence the economy. He et al. (2015) demonstrate that Hong Kong economic growth is highly synchronized with that of China as well as US. Lastly, the problem is so acute in Hong Kong that it has jeopardized the social relationships between Hongkongers and Mainlanders (including tourists from China) and caused some kinds of political instability to the society[3].

As a result, the market has aroused the research interest of not only the academia but also the policymakers. However, amongst the wide range of topics covered by prior literature, very few of them have examined the role of household. Studies based on inter-segment analysis (according to different unit size and geographical area) are scant[4]. This article is to fill the void, by investigating: (i) The superiority of real gross domestic product (GDP) per household versus real GDP (*RGDP*) per capita as a predictor of price movements, and (ii) the relative price responsiveness to different factors across segments in order that tailor-made precautionary measures can be taken. The rest of the article is structured as follows: Section 2 describes the data and their sources. Section 3 details the methodology. Section 4 presents the empirical findings. The article ends with the limitations in our study and concluding remarks in Section 5.

2. DATA DESCRIPTIONS

The whole territory (ALL) of Hong Kong can be segregated into three geographical areas for interarea analysis: Hong Kong Island (HK), Kowloon (KWN), and New Territories (NT). Here we have our first dataset of price indices, which are The University of Hong Kong all residential price index (HKAPI) and its sub-indices (HKU-H real price indices [RPI], HKU-KRPI, HKU-NRPI). Those indices track the price levels of territory wide Hong Kong, and specific areas of HK, KWN and NT correspondingly. The data series in our study span the period 1991-2014 (24 observations)[5]. All price indices are first deflated with the composite consumer price index and then rebased such that 1991 = 100. For consistency, we instead use *ALL_RPI*, *HK_RPI*, *KWN_RPI*, and *NT_RPI* to denote the respective RPIs. On the other hand, Hong Kong house prices can also be tracked with the official price indices pertaining to different sizes (classes) or various composite class indices compiled by the Rating and Valuation Department: Class A – <40 m^2 (A), Class B – between 40 and 69.9 m^2 (B), Class C – between 70 and 99.9 m^2 (C), Class D – between 100 and 159.9 m^2 (D), and Class E – between 160 m^2 or above (E); composite of Class D and E (DE) and all classes (ALL). This is our second dataset, and we use annual indices covering the period 1989-2014 (26 observations). Likewise, all price indices are first deflated and then rebased such that 1989 = 100. For easy identification, the RPI of A and ALL would be respectively denoted as *A_RPI* and *ALL_RPI2*, as examples.

The time-series RPIs by area and by class are plotted in Figures 1 and 2 respectively. As displayed, all RPIs have been falling since the 1997 Asian Financial Crisis (AFC) and bottomed out right after the 2003 severe acute respiratory syndrome (SARS) epidemic. They then started to rebound remarkably. Comparatively, their growth rates indicate that the smaller the unit size, the faster its RPI has been escalating since 2006. Relative to *KWN_RPI* and *NT_RPI*, *HK_RPI* has attained the largest positive growth in the 5-year period before the 2008 global financial crisis (GFC). A turnaround then followed, which was more noticeable for HK (Figure 1) and larger-sized (C and DE, Figure 2) units. In the aftermath of GFC, all RPIs regained momentum to soar. Recently, some obvious signs of slow-down have again been observed for HK and C and DE units in 2014.

Figure 1: Real price indices by area

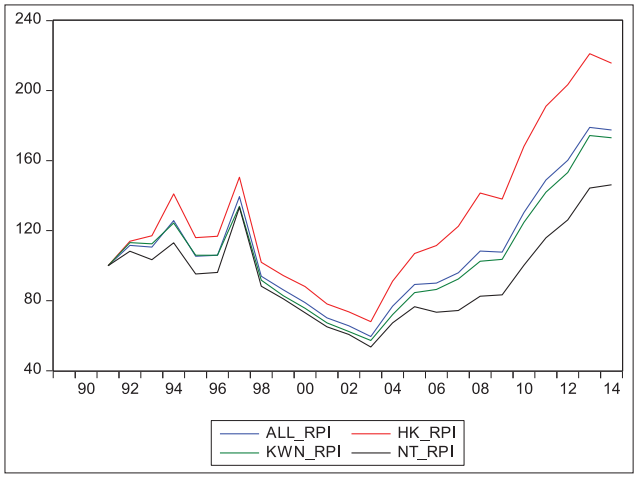
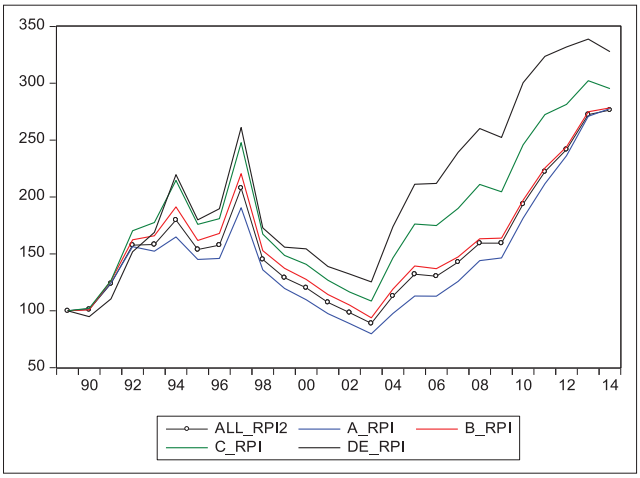


Figure 2: Real price indices by class



3 Mainlanders are blamed for fueling Hong Kong housing prices because under the Capital Investment Entrant Scheme introduced in End-2003 by the Government, qualified Chinese were eligible for residency in Hong Kong by investing in real estates. Housing unaffordability is also said to be one of the reasons leading to the "Occupy Central Movement 2014," where young protestors were expressing their wrath against the Government for its impotence to tackle the problem (Li, 2015).

4 To the best knowledge of the author, the only exception probably comes from Cheung et al. (1995) where the lead-lag relationships among prices and rents in all submarkets are investigated.

5 The original data series are released on monthly basis. We take simple averages for each year. For technical details about the indices, Chau (2006).

In an efficient housing market, long-run equilibrium price is determined by demand and supply fundamental factors. With reference to several recent papers (Ciarlone, 2015; Craig and Hua, 2011; Glindro et al., 2011; Worthington and Higgs, 2013), those demand-related factors essentially embody real (disposable) income, *RGDP* (per capita), real interest rate, population, number of households, real mortgage lending, and stock market. Supply-side factors mainly comprise housing or land supply, real construction costs, and new unit completions. In our study, we would select the following variables (with their expected signs of impacts on RPI put in parentheses): *RGDP* per capita (+), *RGDP* per household (+), real best lending rate (*RBLR*) (−), real residential mortgage lending (*RRML*) (+), new unit completions (−), and demolition of units (+). Some elaborations are of note.

2.1. Households

We have introduced a rarely-used variable, *RGDP* per household (*RGDP_HLD*)[6]. Relatively, our younger generation (so-called generation Y) have stronger desire for homeownership, especially after marriage (Li, 2015). Meanwhile, the average household size (HLD_SIZE) has been contracting from 3.6 persons in 1989 to 2.9 persons in 2014. This means that the growth rate of number of households (HLD) is higher than that of population (POP), or equivalently, the growth rate of *RGDP_HLD* is lower than that of *RGDP* per capita (*RGDP_C*), as illustrated in Figures 3 and 4, respectively. There are important implications for policymakers on this. First, merely focusing on population growth would underestimate the overall housing needs. Second, disregarding the shrinking HLD_SIZE would overlook the higher relative demand for smaller-sized units.

2.2. Housing Supply

Usually either land or housing supply is chosen as one of the supply-side determinants of prices. Indeed, Demographia (2015a) suggests that the root cause of housing unaffordability lies with restriction on land supply. Nonetheless, this is only part of the story. This is well documented that housing supply is a more reliable explanatory factor than land supply, for three reasons. First, increase in land supply does not necessarily lead to more new unit completions, as those "new lands" may simply be added to their land banks by developers as replenishments and they will "time the market" for building and selling new units (Peng and Wheaton, 1994; Tse, 1998; Hui, 2004; Leung and Tang, 2015a). Tse (1998) and Leung and Tang (2015a) further point out that land supply for residential use can be increased not only by land sales, but also via converting agricultural or industrial lands. To certain extent, the plot ratio can also be revised so that more units could be built on the same piece of land, subject to government approval. Second, it takes around 3 years to build. Using housing supply can largely overcome all such problems and the substantial lag. Third, by using housing supply instead of land supply, we postulate that the former has already incorporated the construction cost component, thereby freeing up more degrees of freedom.

Some studies (e.g., Gerlack and Peng, 2005) would treat new unit completions as additional housing supply. However, this would exaggerate the actual figures (sometimes seriously) due to its neglect of the amount demolished during the year. Despite little press attention received, demolition is not trivial in some areas or years covered in our study. In Figures 5 and 6, we have expressed annual demolition as ratio to completions for interarea and interclass comparison, respectively. Figure 5 shows that the

Figure 3: HLD and POP growth rates, and *HLD_SIZE*

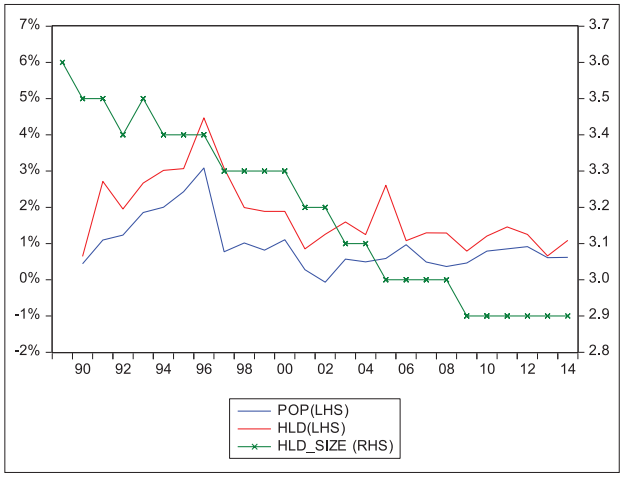


Figure 4: *RGDP_C* versus *RGDP_HLD* growth rates

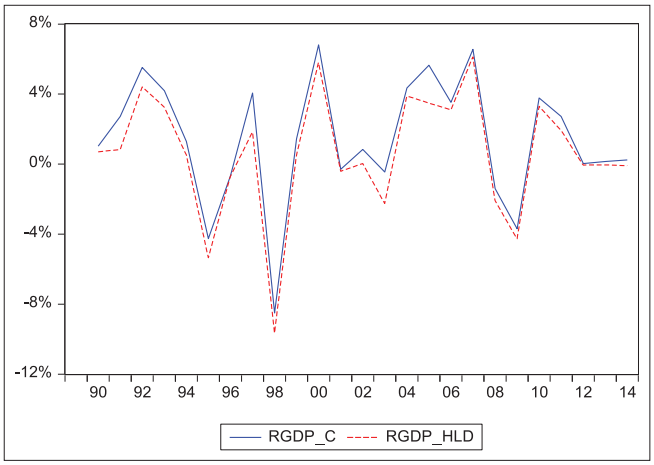
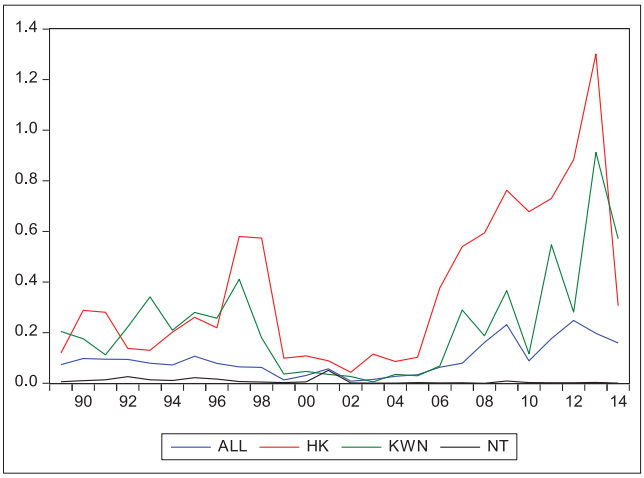


Figure 5: Demolition-to-completion ratio by area



6 Hui (2004) has acknowledged (without demonstration) that household income (rather than income per capita) is a much better explanatory variable to house prices, for the reason that housing decision is primarily a family (instead of an individual) decision. We use *RGDP_HLD* as distant proxy for household income.

ratio is rapidly rising in HK since 2005. In 2013, it has reached 1.3, implying a 30% drop in the net new supply. Similarly, Figure 6 reveals that the situation is worsening for A units since 2007. Net decrease in its new supply occurred in 2009. Cursory inspection of Figure 1 versus 5 and Figure 2 versus 6 yields another finding – the periods during which such ratios are rising have coincided reasonably well with that of their price surges. In order to truly reflect the reality, another variable – net new unit completions (*NCOMP*) – is created, referring to new completions minus demolition per year. Figure 7 illustrates the *NCOMP* of all the markets. Surprisingly, in contrast to the steady growth of HLD and POP over the past 15 years (Figure 3), the *NCOMP*s of the overall Hong Kong and many segments have trended downwards. The situation is more accentuated for HK, KWN and A submarkets.

2.3. BLR

Low interest rate is commonly believed to help inflate prices (Wong et al., 2003; Ahuja and Porter, 2010; McDonald and Stokes, 2013)[7]. The mortgage rate in Hong Kong lies somewhere between the BLR and Hong Kong interbank offered rate (HIBOR). Miles (2014) unveils that US house prices are more responsive to long-term interest rate, rather than the overnight fed funds rate (FFR). As for Hong Kong, as depicted in Figure 8, both the BLR and HIBOR indeed co-move with the FFR under the PERS. The HIBOR lies consistently below the BLR, except in 1997 AFC when there was drastic hike in HIBOR. This can be verified by their high and positive correlation coefficients in Table 1. We choose BLR owing to its high correlation with HIBOR (0.91) and FFR (0.90), and also longer history of usage in mortgage lending in Hong Kong.

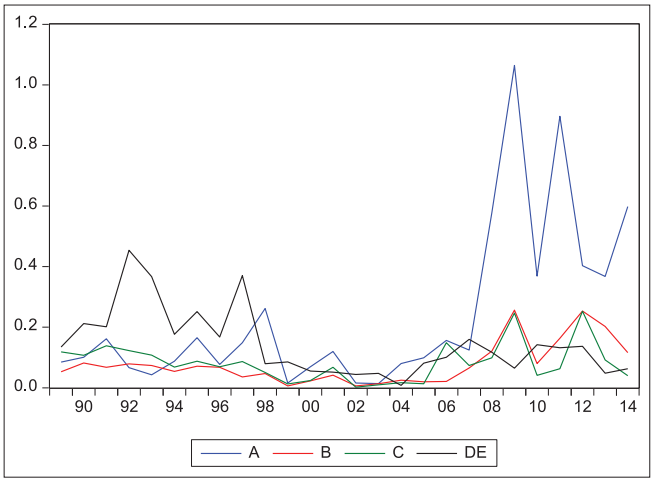
7 Exception is possible, where Shi et al. (2014) recommend using macroprudential measures since raising interest rates would only hurt the economy.

Table 1: Correlation matrix of BLR, FFR and HIBOR

Benchmarks	HIBOR	BLR	FFR
HIBOR	1.000000	0.914218	0.839372
BLR	0.914218	1.000000	0.901897
FFR	0.839372	0.901897	1.000000

BLR: Best lending rate, HIBOR: Hong Kong interbank offered rate, FFR: Fed funds rate

Figure 6: Demolition-to-completion ratio by class



A comprehensive summary of all our variables with their sources is provided in Appendix 1. Table 2 reports the descriptive statistics.

3. METHODOLOGY

We compute all growth rates by taking the first natural logarithm differences of the variables (denoted with DL-prefix) such that the growth rate of *RGDP_C* is measured by: $DL\_RGDP\_C_t = L\_RGDP\_C_t - L\_RGDP\_C_{t-1}$ where, $L\_RGDP\_C_t$ is the natural log transformation of *RGDP_C* at time *t*. Such transformation are executed on all variables (except for *NCOMP*s and *RBLR*) in the first place before further investigation.

Hui (2004) estimates price movements with a reduced-form ordinary least squares equation encompassing relevant explanatory factors. We start with its adapted version using heteroscedasticity- and autocorrelation-consistent (HAC) standard error method, with our aforesaid fundamental variables in all the (sub)markets. In order to compare the relative explanatory power of *RGDP_C* and *RGDP_HLD* as a regressor, they are included in Model 1 and Model 2 accordingly:

Model 1: $$L\_RPI = \varnothing_0 + \varnothing_1 L\_RGDP\_C + \varnothing_2 L\_RRML + \varnothing_3 RBLR + \varnothing_4 NCOMP + \varnothing_5 \sum D_i + \varepsilon_1$$

Model 2: $$L\_RPI = \omega_0 + \omega_1 L\_RGDP\_HLD + \omega_2 L\_RRML + \omega_3 RBLR + \omega_4 NCOMP + \omega_5 \sum D_i + \varepsilon_2$$

Where, D_i is dummy variable = 1 during the year *i* and zero otherwise (*i* = 1998, 2003 or 2008) such that *D1998*, *D2003* and *D2008* stand for the 1998 AFC, 2003 SARS outbreak, and 2008 GFC respectively. We aim at retaining only those significant regressors in the final model. Later on, the models would further be modified as:

Model 3: $$L\_RPI = \alpha_0 + \alpha_1 L\_RGDP\_C + \alpha_2 RBLR + \alpha_3 NCOMP + \alpha_4 D2003 + \alpha_5 D2008 + \varepsilon_3$$

Model 4: $$L\_RPI = \beta_0 + \beta_1 L\_RGDP\_HLD + \beta_2 RBLR + \beta_3 NCOMP + \beta_4 D2003 + \beta_5 D2008 + \varepsilon_4$$

Model 5: $$L\_RPI = \tau_0 + \tau_1 RBLR + \tau_2 NCOMP + \tau_3 D2003 + \tau_4 D2008 + \varepsilon_5$$

To test for parameter stability, two diagnostic tests based on recursive estimation would be conducted. First, plot the recursive residuals and check if they lie outside the two-standard-error bands (RR test). Second, run the cumulative sum of squares test to see if the test statistics fall outside the 5% critical lines (cumulative sum

Figure 7: Net new unit completions

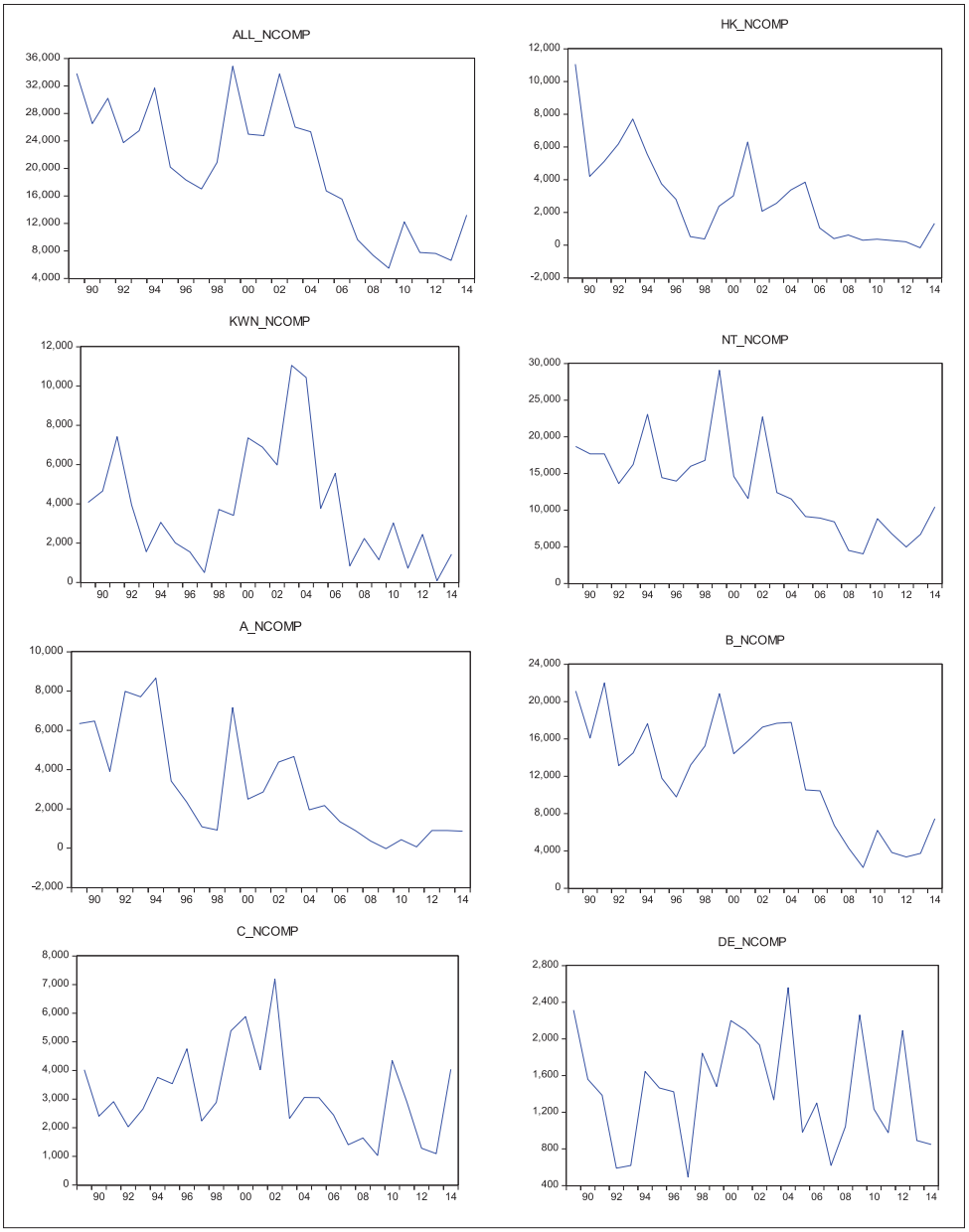
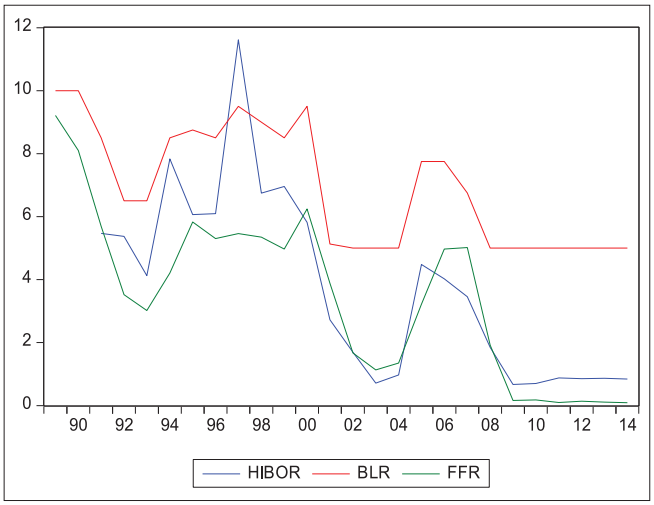


Figure 8: Best lending rate, fed funds rate and Hong Kong interbank offered rate



squared [CUSUMSQ] test)[8]. The last step is to examine any co-integrating relationship between the RPI and the selected factors so as to figure out any long-run equilibrium.

4. EMPIRICAL FINDINGS

4.1. Unit Root (Stationarity) Tests

They are performed to check for stationarity of all non-dummy variables in levels and first differences, by conducting (i) Dickey–Fuller generalized least squares test, (ii) Phillips–Perron test, and (iii) Kwiatkowski, Phillips, Schmidt, and Shin stationary test. The test results as tabulated in Table 3 indicate that all variables are integrated of order one, I(1), except that *HK_NCOMP*, *NT_NCOMP*, *A_NCOMP*, *C_NCOMP* and *DE_NCOMP* are I(0).

8 Technical details can be referred to EViews 8.1 User's Guide II, IHS Global Inc., Irvine CA, USA.

Table 2: Descriptive statistics

Variables	Mean	Max	Min	SD	Expected sign on RPI	Observations
ALL_RPI	109.04	178.94	59.53	32.97	-	24
HK_RPI	127.92	221.09	67.97	43.98	-	24
KWN_RPI	105.90	174.32	57.26	32.24	-	24
NT_RPI	94.22	146.16	53.54	25.82	-	24
ALL_RPI2	156.63	276.46	88.83	51.88	-	26
A_RPI	147.31	277.80	79.74	53.22	-	26
B_RPI	162.22	278.33	93.70	51.69	-	26
C_RPI	184.81	302.26	100.00	59.83	-	26
DE_RPI	204.90	338.90	94.83	75.45	-	26
ALL_NCOMP (units)	19,997	34,870	5498	9272	−	26
HK_NCOMP	2893	11,065	−160	2791	−	26
KWN_NCOMP	3804	11,053	88	2931	−	26
NT_NCOMP	13,185	29,072	4044	6149	−	26
A_NCOMP	3089	8662	−24	2737	−	26
B_NCOMP	12,196	21,996	2230	5993	−	26
C_NCOMP	3165	7190	1031	1515	−	26
DE_NCOMP	1430	2559	493	595	−	26
RGDP_C ($)	114,329	134,749	94,361	13,708	+	26
RGDP_HLD ($)	370,483	406,743	332,159	23,046	+	26
RBLR (%)	3.39	13.69	−2.79	4.43	−	26
RRML ($billion)	304.09	445.59	110.00	100.27	+	26

RPI: Real price indices, RRML: Real residential mortgage lending, RGDP: Real gross domestic product, RBLR: Real best lending rate, SD: Standard deviation

Table 3: Unit root (stationary) test results on variables

Variables	Levels			First difference			I (*d*)
	DF-GLS	PP	KPSS	DF-GLS	PP	KPSS	
L_ALL_RPI	−1.0824	−0.8850	0.1667**	−5.1425***	−5.1449***	0.1096	1
L_HK_RPI	−1.1995	−1.0560	0.1610**	−4.9655***	−4.9281***	0.1034	1
L_KWN_RPI	−0.9167	−0.6920	0.1682**	−4.7356***	−4.7824***	0.1039	1
L_NT_RPI	−1.0711	−0.6906	0.1693**	−5.5233***	−5.5188***	0.1115	1
L_ALL_RPI2	−1.2184	−1.1728	0.1354*	−4.4705***	−4.2708**	0.1504**	1
L_A_RPI	−0.9091	−0.9102	0.1469**	−4.1801***	−3.9970**	0.1573**	1
L_B_RPI	−1.3251	−1.3178	0.1279*	−4.4681***	−4.2685**	0.1525**	1
L_C_RPI	−1.7316	−1.7828	0.1117	−4.7032***	−4.4958***	0.1150	1
L_DE_RPI	−1.9651	−1.9252	0.0938	−4.9434***	−4.7709***	0.0960	1
ALL_NCOMP	−2.9141*	−2.7621	0.1102	−6.1882***	−6.4510***	0.0991	1
HK_NCOMP	−3.7731***	−4.3665**	0.0926	−5.1228***	−6.7039***	0.1094	0
KWN_NCOMP	−2.5579	−2.4461	0.1117	−6.9048***	−6.6141***	0.0709	1
NT_NCOMP	−4.2134***	−4.0222**	0.1401*	−6.7243***	−11.1120***	0.1856**	0
A_NCOMP	−3.9676***	−3.7965**	0.0630	−6.8834***	−8.7419***	0.1417*	0
B_NCOMP	−2.8962*	−2.7174	0.1064	−6.6176***	−6.9519***	0.0937	1
C_NCOMP	−3.8646***	−3.6781**	0.1254*	−6.8621***	−12.0054***	0.1695**	0
DE_NCOMP	−4.5380***	−4.6639***	0.0923	−7.9707***	−13.0889***	0.1579**	0
L_RGDP_C	−2.1580	−2.1849	0.1073	−4.6597***	−4.4627***	0.1014	1
L_RGDP_HLD	−2.0051	−1.9690	0.1299*	−4.6068***	−4.5021***	0.1035	1
RBLR	−1.5068	−1.5869	0.1777	−4.5574***	−4.7367***	0.1893	1
L_RRML	−1.3786	−2.4094	0.1839**	−3.3154**	3.2338	0.1088	1

*.**.***Indicate significance at 10%, 5% , 1% level respectively. For DF-GLS and PP tests, the null hypothesis is I (1), whereas for KPSS test, it is I (0). All tests are run using test equation with intercept and trend, except for *RBLR* (intercept only). The integrated order *d* is decided upon the majority test results. DF-GLS: Dickey–Fuller generalized least squares test, PP: Phillips–Perron test, KPSS: Kwiatkowski, Phillips, Schmidt, and Shin, RPI: Real price indices, RRML: Real residential mortgage lending, RGDP: Real gross domestic product, RBLR: Real best lending rate

4.2. Model Testing Results

The results of Model 1 and 2 are presented in Tables 4 and 5 respectively. *L_RGDP_C* (or *L_RGDP_HLD*), *L_RRML*, and also *D1998* are insignificant in almost all the markets. Even for *RBLR*, it appears significant at 10% level for only the NT and A segments with Model 1. As for *NCOMP*, it seems to be a valid predictor on area basis. Despite the overall explanatory power is satisfactory, with R^2 ranging from 0.5000 to 0.7896, many regressors appear statistically insignificant. This is a typical sign of multicollinearity. In Appendix 2 we have summarized in a matrix listing all the correlation coefficients between the independent variables. *L_RRML* can be removed for the reasons that it is highly correlated with most of the other regressors (except *KWN_NCOMP*, *C_NCOMP* and *DE_NCOMP*) and also that it is price which affects banking residential lending rather than *viz*. (Gerlack and Peng, 2005). Although *L_RGDP_C* and *L_RGDP_HLD* are also highly correlated with other explanatory variables (especially *NCOMPs*), we tend to keep them at this stage. *D1998* would also be discarded.

Table 4: Model 1 regression results

Regressors	Interarea				Interclass				
	ALL	HK	KWN	NT	ALL	A	B	C	DE
Constant	−0.9122	−7.9177	4.4982	−4.1405	−0.7342	−4.4953	2.3671	−13.0932	−18.0663
	(−0.0566)	(−0.5434)	(0.3290)	(−0.3028)	(−0.0406)	(−0.2566)	(0.1371)	(−0.8222)	(−1.2357)
L_RGDP_C	0.4174	1.1028	−0.1165	0.6083	0.3321	0.5530	0.0596	1.4702	1.8578
	(0.2617)	(0.7473)	(−0.0830)	(0.4242)	(0.1889)	(0.3080)	(0.0351)	(0.9227)	(1.2670)
L_RRML	0.1719	0.0273	0.3186	0.2694	0.3789	0.5532	0.4026	0.2233	0.3353
	(0.3078)	(0.0519)	(0.6313)	(0.4586)	(0.6917)	(0.8076)	(0.7484)	(0.4348)	(0.7016)
RBLR	−0.0401	−0.0400	−0.0417	−0.0513*	−0.0416	−0.0555*	−0.0395	−0.0289	−0.0168
	(−1.4806)	(−1.6899)	(−1.6608)	(−1.8449)	(−1.5794)	(−1.7795)	(−1.6366)	(−1.4465)	(−0.9571)
NCOMP	-6.33×10^{-6}	-5.03×10^{-5}**	-4.84×10^{-5}***	$+1.72\times10^{-5}$*	-5.41×10^{-6}	$+2.18\times10^{-5}$	-1.15×10^{-5}	-7.83×10^{-8}	-9.41×10^{-5}
	(−0.6202)	(−2.3235)	(−4.6842)	(1.8474)	(−0.4627)	(0.7517)	(−0.7549)	(−0.0020)	(−0.9446)
D1998	0.0456	−0.0474	−0.0196	0.1065	0.0980	0.2106	0.1000	0.1966	0.2073
	(0.2385)	(−0.2408)	(−0.1282)	(0.5804)	(0.4502)	(0.8985)	(0.5087)	(0.8510)	(1.1829)
D2003	−0.3775**	−0.3715***	−0.1167	−0.3327**	−0.3954**	−0.4642**	−0.3773**	−0.3542*	−0.3542**
	(−2.5795)	(−2.9635)	(−1.0525)	(−2.6450)	(−2.5808)	(−2.3118)	(−2.3587)	(−1.8631)	(−2.3764)
D2008	−0.2497**	−0.2214**	−0.2204**	−0.2279**	−0.2525**	−0.2521**	−0.2500**	−0.1586**	−0.1052*
	(−2.5690)	(−2.4607)	(−2.8406)	(−2.5404)	(−2.6297)	(−2.3367)	(−2.8867)	(−2.3783)	(−1.7768)
Adjusted R^2	0.5736	0.7403	0.7257	0.5000	0.5524	0.5386	0.5203	0.6258	0.7698

*.**.***Indicate significance at 10%, 5%, 1% level respectively. t-statistics are reported in parentheses. RGDP: Real gross domestic product, RBLR: Real best lending rate, RRML: Real residential mortgage lending

Table 5: Model 2 regression results

Regressors	Interarea				Interclass				
	ALL	HK	KWN	NT	ALL	A	B	C	DE
Constant	−12.1544	−20.9892	2.2516	−13.3463	−16.6966	−16.8184	−14.4220	−32.0184	−38.1764
	(−0.5413)	(−0.8645)	(0.0949)	(−0.5881)	(−0.6713)	(−0.5891)	(−0.5483)	(−1.4684)	(−1.6457)
L_RGDP_HLD	1.2461	1.9685	0.0892	1.2498	1.5580	1.4703	1.3928	2.7560	3.1662
	(0.6738)	(0.9816)	(0.0455)	(0.6531)	(0.7656)	(0.6131)	(0.6506)	(1.5426)	(1.6704)
L_RRML	0.1847	0.1415	0.2717	0.3121	0.3381	0.5328	0.3180	0.3419	0.5271**
	(0.4927)	(0.4212)	(0.9202)	(0.7908)	(0.9423)	(1.1020)	(0.9661)	(1.3773)	(2.1501)
RBLR	−0.0352	−0.0351	−0.0396	−0.0471	−0.0336	−0.0479	−0.0307	−0.0209	−0.0112
	(−1.3154)	(−1.4867)	(−1.5549)	(−1.6646)	(−1.2364)	(−1.5009)	(−1.2276)	(−1.0330)	(−0.6686)
NCOMP	-4.76×10^{-6}	-4.97×10^{-5}**	-4.72×10^{-5}***	1.74×10^{-5}	-2.85×10^{-6}	2.04×10^{-5}	-5.76×10^{-6}	-4.21×10^{-8}	-7.25×10^{-5}
	(−0.5331)	(−2.4815)	(−4.1381)	(1.6714)	(−0.3031)	(0.6705)	(−0.4753)	(−0.0012)	(−0.7380)
D1998	0.1150	0.0114	0.0013	0.1522	0.2050	0.2775	0.2081	0.2822	0.2814
	(0.6389)	(0.0565)	(0.0078)	(0.7978)	(1.0211)	(1.2364)	(1.0311)	(1.4539)	(1.5151)
D2003	−0.3380*	−0.3253**	−0.1121	−0.2969**	−0.3368*	−0.4090*	−0.3279*	−0.2843*	−0.2781
	(−2.1180)	(−2.2562)	(−0.9543)	(−2.2635)	(−2.0144)	(−1.7908)	(−1.9261)	(−1.7934)	(−1.6871)
D2008	−0.2487**	−0.2153**	−0.2267***	−0.2272**	−0.2552**	−0.2603**	−0.2559***	−0.1533**	−0.0884*
	(−2.6377)	(−2.6182)	(−3.1639)	(2.6942)	(−2.6066)	(−2.3908)	(−3.0157)	(−2.3253)	(−1.7770)
Adjusted R^2	0.5863	0.7561	0.7255	0.5130	0.5726	0.5543	0.5377	0.6633	0.7896

*.**.***Indicate significance at 10%, 5%, 1% level respectively. t-statistics are reported in parentheses. RGDP: Real gross domestic product, RBLR: Real best lending rate, RRML: Real residential mortgage lending

Next we turn to Model 3 and 4, with results tabulated in Tables 6 and 7 respectively. The aforementioned removal has resulted in more significant regressors observed (especially for *RGDP* and *RBLR*). Several notable findings are revealed. First, contrary to our expectation, *RGDP_HLD* does not seem to be superior to *RGDP_C*[9]. Model 3 suggests that larger-sized (C and DE) units seem immune to interest rate movements. This is possibly because those purchasers are generally more affluent and do not care about mortgage interest burdens. Gauging the responsiveness to *RBLR* of other segments, an area continuum (NT→HK→KWN) and a class continuum (A→B) do emerge. Astoundingly, that area continuum exactly follows the population density sequence in ascending order[10]. Regarding the impacts brought by *NCOMP*, both models show that HK is more responsive than KWN. For instance, under Model 3, HK price would fall by 0.482% per 100-unit *NCOMP*, which is slightly higher than the 0.458% for KWN. This concurs with our population density elucidation as well. For NT, it is unusual to obtain a positive coefficient. Also, HK- and larger-sized (C and DE) units do exhibit higher elasticity of *RGDP*. A plausible explanation is that those units, to a larger extent, serve the investment (speculation) rather than dwelling purpose, so their prices are more sensitive to the overall

9 Nonetheless, when *L_RPI* is regressed on *L_RGDP_HLD* versus *L_RGDP_C* alone, the former does outperform the latter in terms of higher R2 attained and statistical significance, except for DE submarket (not shown here). Hence the issue remains ambiguous.

10 Population density (number of persons per sq. km) of NT, HK and KWN are 3870, 15924 and 44917, respectively. Source: Table 35, 2011 Population Census Summary Results, CSD.

Hong Kong economic conditions (i.e., GDP). So they are more volatile too (Table 2). Lastly, Model 4 indicates that C and DE are exempt from the SARS infection and 2008 GFC, which looks bizarre.

Model 5 is an even more parsimonious model, enclosing *RBLR* and *NCOMP* as the only independent variables, after knocking out the *RGDP* factor. In essence, as reported in Table 8, the inferences are more or less the same as previously on *RBLR*, except that it now exhibits another area continuum (HK→NT→KWN). The insulation of C and DE units still persists. As regards *NCOMP*, there are some minor improvements in that the expected coefficient sign for NT has turned negative (though it is statistically insignificant) and for A, B and C the signs have become significant. Nevertheless, a very undesirable outcome is the abrupt decay in explanatory power; in particular, for HK, C and DE, because the *RGDP* factor has been washed out.

Table 6: Model 3 regression results

Regressors	Interarea				Interclass				
	ALL	HK	KWN	NT	ALL	A	B	C	DE
Constant	−3.4842	−9.1662*	−3.0711	−8.5456	−7.7168	−11.8501	−6.3090	−17.3220**	−25.3836***
	(−0.4154)	(−1.9522)	(−0.6502)	(−1.2873)	(−0.7535)	(−1.3376)	(−0.6220)	(−2.7612)	(−4.3847)
L_RGDP_C	0.7225	1.2223***	0.6847	1.1176*	1.1156	1.4559*	0.9973	1.9407***	2.6430***
	(1.0151)	(3.0328)	(1.6799)	(1.9711)	(1.2858)	(1.9212)	(1.1583)	(3.6482)	(5.3784)
RBLR	−0.0326***	−0.0388***	−0.0294***	−0.0396***	−0.0243*	−0.0344**	−0.0218*	−0.0179	−0.0032
	(−3.0195)	(−3.7822)	(−3.0124)	(−4.1396)	(−1.9457)	(−2.3037)	(−1.9128)	(−1.4615)	(−0.2779)
NCOMP	-7.65×10^{-6}	-4.82×10^{-5}***	-4.58×10^{-5}***	1.52×10^{-5}*	-7.65×10^{-6}	-4.69×10^{-6}	-1.26×10^{-5}	-3.00×10^{-6}	-6.53×10^{-5}
	(−0.9284)	(−3.7568)	(−4.0308)	(1.8717)	(−0.7908)	(−0.2224)	(−0.9422)	(−0.0762)	(−0.7552)
D2003	−0.3551***	−0.3628***	−0.0854	−0.3125***	−0.3428***	−0.3611***	−0.3221***	−0.3432**	−0.3111***
	(−3.8185)	(−4.7563)	(−1.2260)	(−3.8261)	(−3.4836)	(−2.9659)	(−3.0126)	(−2.6278)	(−3.2686)
D2008	−0.2621**	−0.2231***	−0.2405**	−0.2457**	−0.2799**	−0.3027**	−0.2734***	−0.1682**	−0.1164*
	(−2.7591)	(−3.0157)	(−2.8597)	(−2.7626)	(−2.6842)	(−2.4565)	(−2.9192)	(−2.4189)	(−2.0537)
Adjusted R^2	0.6119	0.7684	0.7370	0.5214	0.5559	0.5162	0.5175	0.6249	0.7499

*.**.***Indicate significance at 10%, 5%, 1% level respectively. t-statistics are reported in parentheses. RGDP: Real gross domestic product, RBLR: Real best lending rate

Table 7: Model 4 regression results

Regressors	Interarea				Interclass				
	ALL	HK	KWN	NT	ALL	A	B	C	DE
Constant	−11.1098	−24.9673**	−10.9264	−17.6048	−17.9791	−26.6379	−15.1405	−43.7355**	−63.0046***
	(−0.7570)	(−2.1374)	(−0.8703)	(−1.2009)	(−0.9245)	(−1.4281)	(−0.7126)	(−2.3848)	(−3.2981)
L_RGDP_HLD	1.2520	2.3418**	1.2330	1.7247	1.8163	2.4762	1.5966	3.8192**	5.3223***
	(1.0973)	(2.5709)	(1.2591)	(1.5103)	(1.2028)	(1.7035)	(0.9683)	(2.6832)	(3.5913)
RBLR	−0.0261**	−0.0291**	−0.0238**	−0.0304***	−0.0145	−0.0246	−0.0132	0.0018	0.0191
	(−2.3842)	(−2.8118)	(−2.3850)	(−2.9304)	(−1.1594)	(−1.5376)	(−1.0611)	(0.1359)	(1.2595)
NCOMP	-9.55×10^{-6}*	-5.81×10^{-5}***	-4.62×10^{-5}***	9.75×10^{-6}	-1.13×10^{-5}	-2.01×10^{-5}	-1.75×10^{-5}	-1.23×10^{-5}	-1.44×10^{-5}
	(−1.7590)	(−5.7218)	(−4.2351)	(1.4225)	(−1.7078)	(−1.2346)	(−1.6827)	(−0.3060)	(−0.1513)
D2003	−0.3181***	−0.2991***	−0.0533	−0.2913***	−0.2881**	−0.2726*	−0.2661**	−0.2595	−0.1527
	(−3.2654)	(−3.8085)	(−0.7483)	(−3.2109)	(−2.5827)	(−1.9517)	(−2.3827)	(−1.5725)	(−1.1020)
D2008	−0.2616**	−0.2222**	−0.2237**	−0.2444**	−0.2784**	−0.2987**	−0.2684**	−0.1430	−0.0640
	(−2.5828)	(−2.6370)	(−2.5068)	(−2.3715)	(−2.4360)	(−2.1679)	(−2.6841)	(−1.4927)	(−0.7248)
Adjusted R^2	0.6111	0.7773	0.7197	0.4928	0.5443	0.4940	0.5052	0.5732	0.6517

*.**.***Indicate significance at 10%, 5%, 1% level respectively. t-statistics are reported in parentheses. RGDP: Real gross domestic product, RBLR: Real best lending rate

Table 8: Model 5 regression results

Regressors	Interarea				Interclass				
	ALL	HK	KWN	NT	ALL	A	B	C	DE
Constant	5.0760***	5.2065***	4.9477***	4.6749***	5.5031***	5.2501***	5.5024***	5.4482***	5.5239***
	(35.8347)	(50.0808)	(53.5708)	(31.9775)	(34.2841)	(34.0012)	(39.9853)	(36.8654)	(30.6400)
RBLR	−0.0313***	−0.0474***	−0.0291***	−0.0378***	−0.0210*	−0.0415**	−0.0189*	−0.0108	−0.0030
	(−3.0847)	(−4.1853)	(−3.6415)	(−3.6635)	(−1.7368)	(−2.3747)	(−1.7539)	(−0.6121)	(−0.1144)
NCOMP	-1.52×10^{-5}**	-8.65×10^{-5}***	-5.77×10^{-5}***	-3.37×10^{-7}	-1.98×10^{-5}**	-4.60×10^{-5}*	-3.00×10^{-5}***	-6.37×10^{-5}**	−0.0001
	(−2.6189)	(−4.3848)	(−4.3756)	(−0.0401)	(−2.7555)	(−1.7484)	(−2.9833)	(−2.1906)	(−1.4443)
D2003	−0.3545***	−0.4007***	−0.0379	−0.3992***	−0.3383***	−0.3370**	−0.2860***	−0.5302***	−0.4569***
	(−4.4358)	(−7.1257)	(−0.4671)	(−5.2414)	(−4.1588)	(−2.8004)	(−3.1073)	(−8.4768)	(−5.6154)
D2008	−0.2569**	−0.1677*	−0.1679**	−0.2333**	−0.2709**	−0.2336	−0.2642**	0.0159	0.2059
	(−2.5573)	(−1.9019)	(−2.5449)	(−2.1181)	(−2.3794)	(−1.6964)	(−2.6491)	(0.1269)	(1.2655)
Adjusted R^2	0.6057	0.6755	0.6924	0.4487	0.5157	0.3839	0.4951	0.1448	−0.0035

*.**.***Indicate significance at 10%, 5%, 1% level respectively. t-statistics are reported in parentheses. RBLR: Real best lending rate

Comparing between Model 3 and 5 for parameter stability, both the RR and CUSUMSQ tests are implemented. Model 3 passes the tests whereas Model 5 fails the RR test for some submarkets (not shown here). As demonstrated, it is prohibitively difficult to search for one "best" model applicable to all markets, since each has its uniqueness. This is analogous to formulating a universal econometric model for all currencies. As a final check, we examine the co-integrating relationships among the variables under Model 3 and 5 using the Johansen approach. We miss out all technical details of the method here. It is suffice to briefly mention that there are two rank test statistics – trace test and maximum eigenvalue test – under the approach to ascertain the number of co-integrating relationships. Because the approach is only applicable to I(1) variables, we exclude those segments with I(0) *NCOMP*s. Assuming that the data series display linear trends and the co-integrating equations have intercepts with trends, the tests are undertaken at 5% significance levels. Table 9 summarizes our results, indicating that the variables are co-integrated under Model 3 but not Model 5. Theoretically, Model 3 appears to be a better model as it holds in the long-term.

5. CONCLUSIONS AND POLICY IMPLICATIONS

There are several limitations with our study. First and foremost is data constraint because *NCOMP* figures are at best released annually. The HAC method used to correct the standard errors in the regressions is, strictly speaking, valid for large samples and may be inappropriate in our small samples (Gujarati and Porter, 2009. p. 448). Second, to keep our tasks manageable, we have not taken into account of those tentative macro prudential measures enforced by the Government since 2009 for combating speculations in the property market.[11] Yet this should not be very problematic because they should largely be incorporated in the mortgage rate or loan size (He, 2014). And those cooling-down effects are found to be short-lived (Craig and Hua, 2011). Third, our models might be prone to some kinds of specification errors (e.g. non-normality) due to small samples. Fourth, even though stock market performance is perceived as a crucial factor affecting housing demand, Lin and Lin (2011) find no causality between them for Hong Kong. Leung and Tang (2015b) have stepped forward by uncovering two-way causality between the initial public offerings (IPOs) from Chinese firms and Hong Kong house prices, because IPOs reflect market sentiment and signal economic prospects. Nevertheless, quantifying all these would further deplete our degrees of freedom. Hence, we decide not to consider all equity-related factors. Finally, the way that we derive our area indices might be inappropriate and contaminate the data quality[5].

11 The Annex of He (2014) provides an excellent summary on these.

Table 9: Number of co-integrating relationships under Johansen approach

Rank Test	Model 3				Model 5			
	RPI	KWN	RPI2	B	RPI	KWN	RPI2	B
Trace	1	1	1	1	0	0	0	0
Max-eigenvalue	0	0	1	1	0	0	0	0

RPI: Real price indices

To solve the problem of housing unaffordability, solely increasing land supply is inadequate. The government can alleviate income inequality by subsidizing low-income groups in taking shelters with public housing, remove obsolete land-use restrictions and better urban planning policies (Abelson, 2009; Caldera and Johansson, 2013; Leung and Tang, 2015a). Last but not least, we need to be cautious about the potential threats in 2015, which are likely to pose downward pressure on prices in near term. Locally, there are symptoms manifesting that Hong Kong economic conditions are deteriorating, including the recent drop in number of overnight visitor arrivals and the Nikkei Hong Kong Purchasing Managers' Index™ (PMI®)[12]. Externally, the unexpected devaluation of renminbi during August 11-13 has trembled the stock markets[13]. The predicted economic growth of China is slowing[14]. Furthermore, mortgage rate in Hong Kong is deemed to follow suit with the impending FFR hike. According to our Model 3, weakening economic growth and concomitantly rising mortgage rate would dampen prices in virtually all segments. Increased net new completions could possibly act as the catalyst for the adjustments.

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12 Refer to Nikkei Hong Kong PMI® release on September 4, 2015. Available from: http://www.markiteconomics.com/Survey//PressRelease.mvc/d39bfbffe11b4e83be89f2a54aeb148f.

13 Within 2 weeks (August 11-21), S&P 500, FTSE 100, Nikkei 225, DAX, Shanghai Stock Exchange Composite Index (SSE) and Hang Seng Index (HSI) have plunged by around 6.33%, 8.14%, 6.60%, 12.76%, 10.71% and 8.61%, respectively.

14 See Asian Development Outlook 2015 Update, Asian Development Bank.

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Appendix 1: Data sources

Variables with denotations	Descriptions	Sample periods	Source
New completions (COMP) and demolitions (DEM) of units	Can be prefixed by ALL_ or A_ etc., referring to territorywide or specific (sub)markets	1989-2014	RVD
Net new unit completions (*NCOMP*)	= COMP−DEM		
PI	RPI, defined as PI deflated by CPI		
HK_PI, KWN_PI and NT_PI; ALL_PI	Specific PI for an area or the whole territory	1991-2014	Versitech Limited, The University of Hong Kong
A_PI, B_PI, C_PI, and DE_PI; ALL_PI2	Specific PI for a class or the whole territory	1989-2014	RVD
BLR in percentage; RML in billion HKD	*RBLR*; *RRML*, respectively defined as BLR and RML deflated by CPI	1989-2014	Hong Kong Monetary Authority
Gross GDP per capita (*GDP_C*) and per household (*GDP_HLD*) in HKD	*RGDP*, defined as GDP deflated by CPI	1989-2014	CSD
Hong Kong population (POP) and number of households (HLD); average household size (*HLD_SIZE*)	In terms of thousands ('000); no. of persons	1989-2014	CSD

PI: Price index, RPI: Real price indices, RML: Residential mortgage lending, RRML: Real residential mortgage lending, RBLR: Real best lending rate, GDP: Gross domestic product, CPI: Consumer price index, CSD: Census and Statistics Department, RGDP: Real gross domestic product

Appendix 2: Correlation matrix of explanatory variables

	L_RGDP_C	L_RGDP_HLD	L_RRML	RBLR	ALL_NCOMP	HK_NCOMP	KWN_NCOMP	NT_NCOMP	A_NCOMP	B_NCOMP	C_NCOMP	DE_NCOMP
L_RGDP_C	1	0.893847	0.749202	−0.1216	−0.82864	−0.624036	−0.422089	−0.765971	−0.66318	−0.848576	−0.36228	−0.20231
L_RGDP_HLD	0.893847	1	0.392785	−0.46763	−0.774772	−0.382915	−0.585989	−0.689561	−0.435249	−0.819193	−0.454358	−0.401371
L_RRML	0.749202	0.392785	1	0.454382	−0.53411	−0.692049	−0.05092	−0.510945	−0.712667	−0.528165	0.021492	0.154003
RBLR	−0.1216	−0.467633	0.454382	1	0.274435	−0.202853	0.413815	0.253166	−0.104335	0.274502	0.499125	0.437374
ALL_NCOMP	−0.82864	−0.774772	−0.53411	0.274435	1	0.675156	0.583816	0.895927	0.788865	0.960361	0.611271	0.250878
HK_NCOMP	−0.624036	−0.382915	−0.69205	−0.20285	0.675156	1	0.345522	0.45289	0.78447	0.626633	0.214048	0.012823
KWN_NCOMP	−0.422089	−0.585989	−0.05092	0.413815	0.583816	0.345522	1	0.225514	0.235886	0.651211	0.283416	0.523926
NT_NCOMP	−0.765971	−0.689561	−0.51095	0.253166	0.895927	0.45289	0.225514	1	0.737014	0.836536	0.623154	0.089104
A_NCOMP	−0.66318	−0.435249	−0.71267	−0.10434	0.788865	0.78447	0.235886	0.737014	1	0.684186	0.255327	−0.073648
B_NCOMP	−0.848576	−0.819193	−0.52817	0.274502	0.960361	0.626633	0.651211	0.836536	0.684186	1	0.476676	0.222659
C_NCOMP	−0.36228	−0.454358	0.021492	0.499125	0.611271	0.214048	0.283416	0.623154	0.255327	0.476676	1	0.305744
DE_NCOMP	−0.20231	−0.401371	0.154003	0.437374	0.250878	0.012823	0.523926	0.089104	−0.073648	0.222659	0.305744	1