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INTERNAL AND EXTERNAL DETERMINANTS OF HOUSING PRICE BOOMS IN HONG KONG, CHINA

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Abstract

Hong Kong, China's housing market witnessed dramatic appreciations recently, with the price index for private domestic housing units being 3 times higher than 10 years ago. This trend is supported by both internal and external factors, as illustrated in this paper. By providing a theoretical model and empirical analysis on the key variables influencing housing prices, we find that changes in housing price index reinforce price trends in the long term. Hong Kong, China's dollar quantitative easing, and the gross domestic product of the People's Republic of China (PRC) are positively related to housing prices and negatively to lending. The inability to increase supplies in response to rising demand since 2003 has also much to do with the skyrocketing prices. Moreover, mortgage-to-total loans value is shrinking due to the unaffordability of housing units at current prices. This trend has to be tackled in time, otherwise the PRC may incur severe consequences similar to Japan's experience in the 1990s.

Keywords: housing bubble, housing prices, housing market, quantitative easing (QE), monetary policy

JEL Classification: R31, E51, E31

Contents

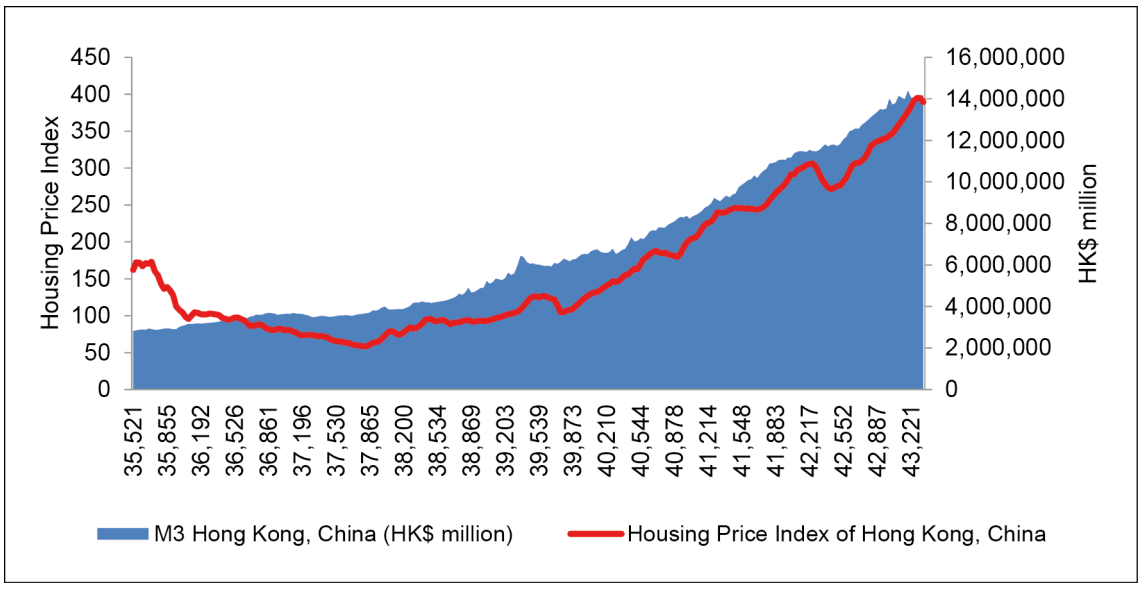
1. INTRODUCTION

This research aims to discover the driving factors behind Hong Kong, China's housing market prices during 1999–2018. In this period, the housing market first experienced a recession in 1997–2003, then a vibrant recovery and strong growth momentum until the present.

The price level has become increasingly unaffordable and is emerging as a prominent economic issue. Thanks to booming real estate prices, homeowners have enjoyed a "wealth effect," while those who do not own property have suffered, resulting in a staging wealth inequality. In addition, excess credit devoted to the real estate market can be detrimental to the economy in the long run, as evidenced from the case of Japan in the 1980s–1990s. To ease the situation of income inequality and potential hazards to economic growth, housing units have to be made affordable. Hence, this paper devotes itself to investigating the driving forces behind the housing price boom, in order to formulate better policies to tackle the price hike.

During this housing boom, the economy is flooded by huge stocks of new money supplies.

Figure 1: Housing Price Index and M3 in Hong Kong, China (Apr 1997–Sep 2018)



For data source please refer to Table 1.

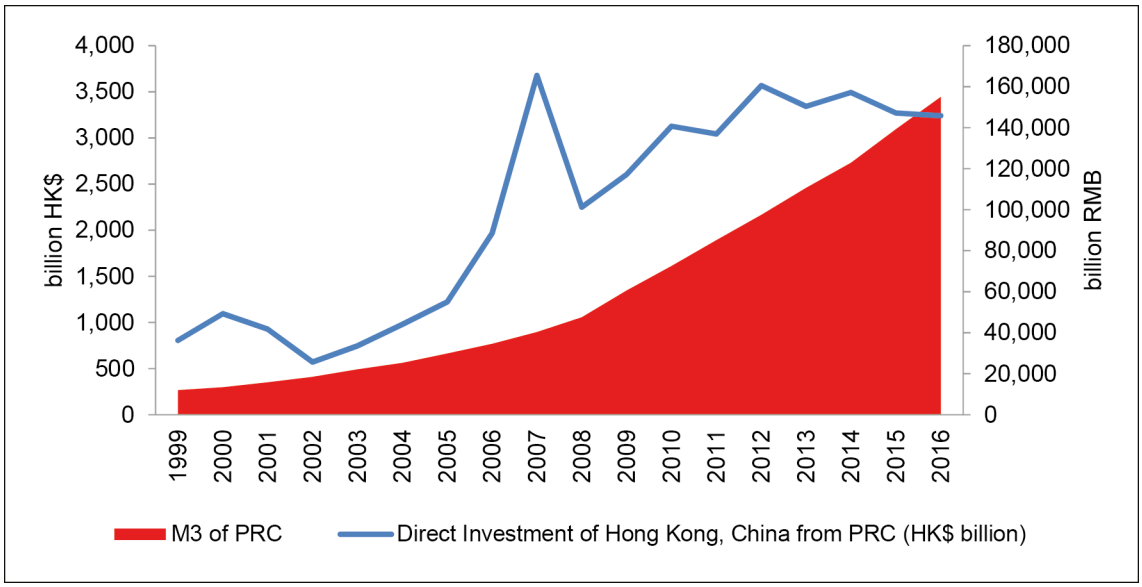
Source: Authors' own compilation.

In the years before 2003, the M3 of Hong Kong, China stagnated, while the housing price index declined. M3 began to rise massively after 2003, and retained extraordinary growth since 2008 as the US began conducting quantitative easing (QE) and implementing low interest rate policies following the subprime mortgage crisis and global financial crisis. This was in order to keep the long-run interest rates at low levels for boosting the private investment in the US. As Hong Kong, China's currency is pegged to the dollar at 7.8 HKD per USD, the interest rate in Hong Kong, China followed that of the US to almost zero. At the same time, the housing price index began climbing with great momentum, from slightly over 100 in 2008–2009, to close to 400 in late 2018. By comparing

developments of M3 supply and housing prices, it is clear that a significant association exists between the variables.

Indeed, it was also in this period that the PRC began flexing its economic muscle. Since 2002, Chinese direct investment has been growing enormously. The position of Chinese direct investment in Hong Kong, China rose from only 805 billion HKD to over 3200 billion in late 2018. Expansion of Chinese corporations abroad worked in hand with the monetary policy implemented by the People's Bank of China. As observed in Figure 2, the M3 of the PRC has risen significantly since the year 2008. In the same year, discount rate in the PRC dropped from 4.14% to only 2.70%. Monetary expansion has made Chinese acquisition of assets abroad easier and more intensive than before, resulting in higher demand for assets.

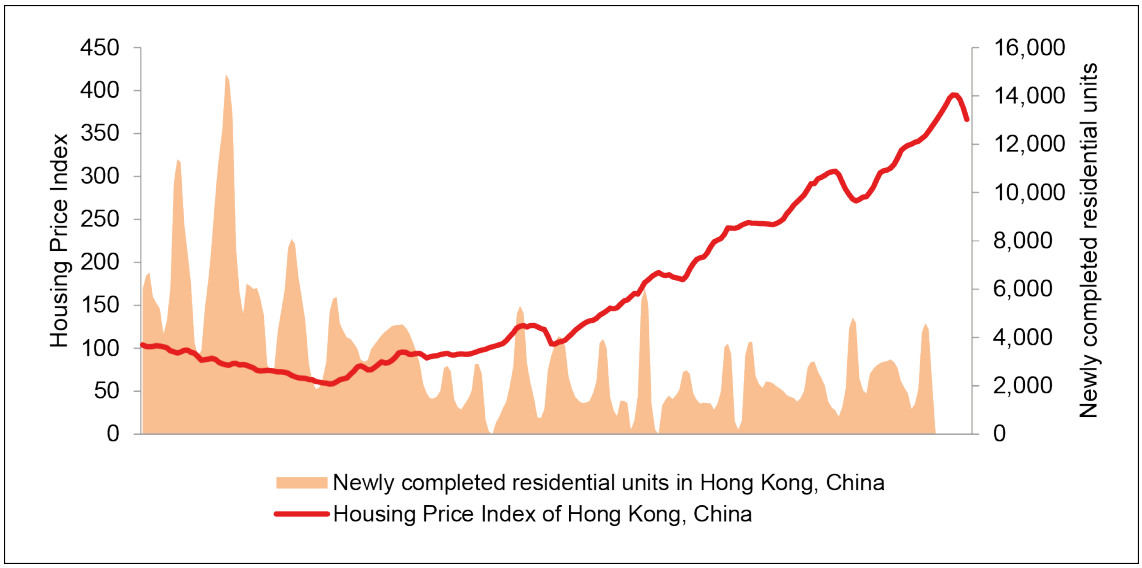
Figure 2: Position of Direct Investment of Hong Kong, China from the PRC (in HK$ billion) **and the M3 of the PRC** (in billion RMB) **1999–2016**



Source: Authors' own compilation using data of direct investment positions (Census and Statistics Department n.d.); and data of M3 of the PRC, refer to Table 1.

The issue of high housing prices also has an internal dimension. Supply of housing units has also been kept at a historic low since 2003, in comparison to the previous levels (Figure 3 and Figure 4). The government decided to reduce real estate supply in 2003, after the market was hit by the Asian Financial Crisis (1997) and Severe Acute Respiratory Syndrome (SARS) (2003) and began regressing. To revive the market and the economy, the government halted all new construction of home-ownership schemes (a type of public subsidized housing for sale) and adopted a much more passive land auction policy, the Land Application List System, which sharply decreased the supply of land into real estate market. Since then, despite price hikes, supplies have always been kept at below 6,000 per month.

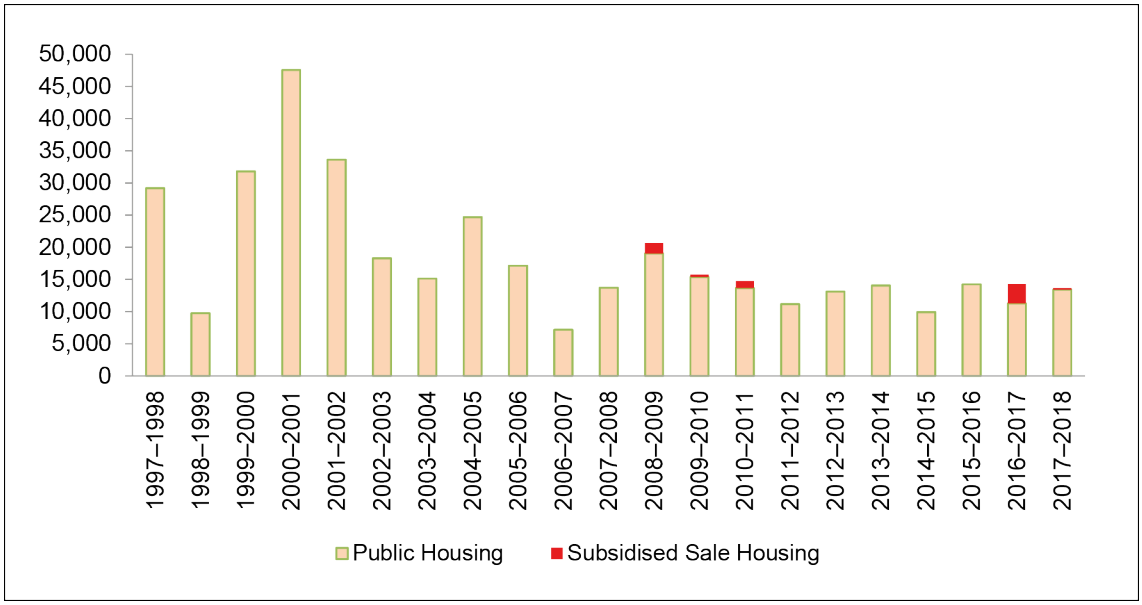
Figure 3: Newly Completed Private Residential Units and Housing Price Index in Hong Kong, China (1999–2018)



For sources of data, please refer to Table 1.

Source: Authors' own compilation in Excel.

Figure 4: Newly Completed Public Housing Units (1997–2018)

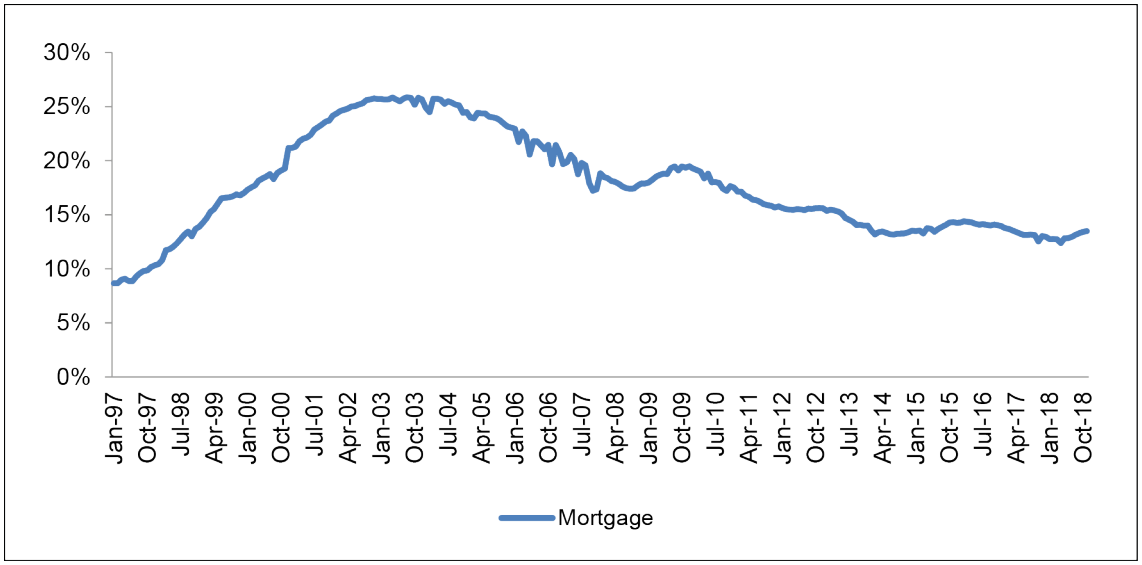


Source: Authors' own compilation using data from Census and Statistics Department Various volumes (2001–2018).

This paper adopts the measurement of mortgage-to-total loans as an indicator of a bubble in housing market. Yoshino, Nakamura and Sakai (2013), illustrate that in the 1980s–1990s, when loose monetary policy and excess liquidity produced the housing bubble in Japan, loans issued by banks leaned toward the real estate and construction sectors. After burst of the asset price, especially the housing price bubble in Japan in 1990, for more than 2 decades the Japanese economy went into a long-lasting recession (Yoshino and Taghizadeh-Hesary 2016; Yoshino and Taghizadeh-Hesary 2017).

In the case of Hong Kong, China, however, the mortgage-to-loan ratio operates in opposition to housing price hikes. In 1997–2003, the housing price index in Hong Kong, China declined, reaching as low as 58.4 in July 2003. In the same period, the mortgage-to-total-loan ratio grew, peaking at 25.74% in the same month. Since then, housing prices recovered, while mortgage-to-loan ratio began dropping.

Figure 5: Mortgage Loans to Total Bank Loans, Hong Kong, China (Jan 1997–Nov 2018)



For sources of data, please refer to Table 1.

Source: Authors' own compilation in Excel.

Besides monetary variables, housing prices, and housing supply, this paper also includes Gross Domestic Product (GDP) as well as Consumer Price Index (CPI) of Hong Kong, China and the PRC as independent variables to gage the effect of domestic and external economic development on housing prices. As for external factors, the study focuses more on the PRC, since the FDI and foreign trade of Hong Kong, China are predominantly related to the PRC.

This paper is organized as follows. Section 2 is dedicated to a literature review on the determinants of housing prices. As this paper is interested in investigating the effects of domestic and external causes of the price hike, the literature considered centers around topics of international capital flow and loose monetary policy, and their relationship with housing price changes. Previous papers investigating on the case of Hong Kong, China are also reviewed. Section 3 is dedicated to providing a theoretical model for this paper, followed by an empirical analysis of the results from regression in Section 4. Section 5 provides a conclusion and policy recommendations for tackling the issue.

2. LITERATURE REVIEW

The global economic recession in the aftermath of the 2008 financial crisis has propelled economies to address the economic downfall with loose monetary policies, for instance, quantitative easing, or negative interest rates. Loose monetary policies have led to global monetary abundance. Together with international capital flows, these are the factors believed to cause housing price appreciation.

2.1 International Capital Flows and Housing Price Appreciation

Capital inflow has long been elaborated as being positively related to higher housing prices. The former Chairman of Federal Reserve Bank, Ben Bernanke, has delivered a hypothesis in which he stressed that the US, as a country experiencing current account deficits, would be facing corresponding net capital inflows. International net capital flows are a trigger peg for house price growth. As homeowners' wealth increases with increased housing prices, this may lead to further growth in house prices, which again causes higher, more prominent wealth effects in a spiral-like manner (The Federal Reserve Board 2005).

Many economists agree that capital inflow is contributing significantly to the upsurge in property prices. For example, Yiu and Sahminan's (2017) work on the global liquidity and capital inflows and their impact on house prices in Association of Southeast Asian Nations (ASEAN) economies has attributed the upsurge in housing prices to the quantitative easing (QE) policy adopted by the advanced economies since 2009, which has led to an abundance in global liquidity. Concomitantly, the ASEAN-5 economies (Indonesia, Malaysia, the Philippines, Singapore and Thailand) have experienced strong capital inflows. Their paper argues that capital inflows have a positive effect on the residential house prices of the five countries; even after accounting for their own domestic demand (by using real GDP growth as a proxy), the capital inflows still have a positive impact in Indonesia and Singapore.

Other research that has also pointed toward the same conclusion includes Sa and Wieladek (2011), who compared the magnitude of effect of monetary policy and capital inflow shocks on the US housing market. Using the open economy vector autoregressive (VAR) model, they found that the monetary policy shocks have produced a limited effect on housing prices. In contrast, capital inflows have a more positive and long-lasting effect. For Australia, Fereidouni and Tajaddini (2016) found that direct foreign investment in the housing market has caused housing price appreciation in the long run. A similar conclusion is put forward by Guest and Rohde (2017), and their argument is echoed by a working paper from the Treasury of the Australian Government (Wokker and Swieringa 2016).

2.2 Monetary Policy and Housing Prices

Japan's experience with increased credit supply in the bubble period (1980s) and the accompanying housing boom are textbook examples of how the former results in the latter. In Yoshino, Nakamura and Sakai (2013), it is shown that excess liquidity and expansion of bank loans led to a higher mortgage-to-loan ratio, an indicator adopted in this paper. Japanese banks gave loans to an extent that was beyond profit maximization. In addition, as the market was flooded with new demands as a result of soaring capital and credit, the supply of new housing surged, leading to a rapid decline in housing prices in 1989. After the burst of the housing bubble, Japan entered the "lost decade," in which investment growth was minimal in spite of the low, and later

negative interest rate, as the investment–saving curve became vertical after the bust (Yoshino and Taghizadeh-Hesary 2016; Taghizadeh-Hesary and Yoshino 2016; Yoshino, Taghizadeh-Hesary, and Miyamoto 2017).

Justiniano, Primiceri and Tambalotti (2015) studied the effect of increasing credit supply on the housing boom that preceded the Great Recession. In their argument, looser lending constraints in the mortgage market was the major driver behind housing price appreciation. Interestingly, they invalidated the popular assertion that a lower collateral requirement was the driver for housing prices appreciation. Instead, they suggest that, at the peak of the housing market, the lowering of the collateral requirements caused a fall in housing prices.

Su, et al.'s (2019) study on the causality between housing prices and money supply in the PRC from January 1998 to December 2016 has found the existence of a time-varying, "bidirectional causal link" between housing prices and money supply in the PRC. In particular, Chi-Wei, et al. (2019) show that the bubble and bust cycle of housing prices can both positively and negatively affect money supply in the PRC in different sub-periods. Meanwhile, the money supply has a positive impact on housing prices as well.

In fact, the mechanism of how monetary policy can affect the macroeconomy and housing market is more complex than simply through changing the cost of capital. Taghizadeh-Hesary and Yoshino (2016) proved that the monetary policy of the US can impact on global commodities' prices, including crude oil prices, which are the key component of inflation. This link is especially prominent in emerging markets like the PRC, in comparison with developed countries. There are several other studies that have found a positive association between monetary policy and asset and commodities markets (Taghizadeh-Hesary and Yoshino 2014; Yoshino and Taghizadeh-Hesary 2014).

2.3 Housing Prices in Hong Kong, China

Cheung, Chow, and Yiu (2017) found capital inflows positively related to housing price changes. They regressed the return on the Hong Kong, China residential property price index as the dependent variable against the currency-based measure of capital inflow independent variable. To gage capital flows, they selected the sum of Hong Kong, China's monetary base and net spot foreign currency position's respective percentage to GDP. It is proven that capital inflow tends to be associated with upsurges in real estate property prices, even with the inclusion of dummy variables of US Quantitative Easing (QE). The robustness of US QE dummy variables is exceeded by that of capital flows. While it is controversial to take the US QE as a dummy variable instead of monetary supply in US dollars as a representation of the effects of QE in a time series, their study suggests that international capital inflow is a significant variable in explaining housing and stock market price developments.

Ho and Wong (2008) found that export and interest rates are statistically significant and responsible for long-term developments in housing market. Utilizing an autoregressive distributed lag (ARDL) model, they found that exports lead to domestic consumption and hence investments, while interest rates also have an impact on housing prices. In return, increased housing prices stimulate consumption as well.

Leung, Chow and Han (2008) found GDP per capita, real interest rate, land supply, and residential investment deflator to be significant variables in the long run, and equity price to be significant in the short run. By employing cointegration tests and reduced-form demand–supply equations, they argue that the causes of the appreciation are stronger economic fundamentals.

As the aforementioned research has not provided an overarching view that compares and contrasts the factors behind the phenomenon, but rather just focused on domestic causes, this study has been conducted with the inclusion of a wide range of variables and by considering both internal and external causes, as illustrated in the following sections.

3. THEORETICAL MODEL

This section shows mathematically which factors have an impact on the housing price boom. Based on the theoretical model that will be developed in this section, the empirical model will be developed in Section 4.

The housing demand is shown with downward sloping in Figure 6. Housing demand (H_t^d) is showed in Equation 1, which depends on constant demand for houses (d_0), housing prices (P_t^H), interest rate on housing loan (r_t), expected housing prices ($P_t^{H^e}$), households' income level (Y_t) and inflow of foreign capital (FDI_t).

When the economy is in boom, the income level increase so the price of housing goes up. In the short-run housing construction is very slow, so housing supply is fixed at $\overline{H}^s$ as showed in Figure 6 and in Equation 2.

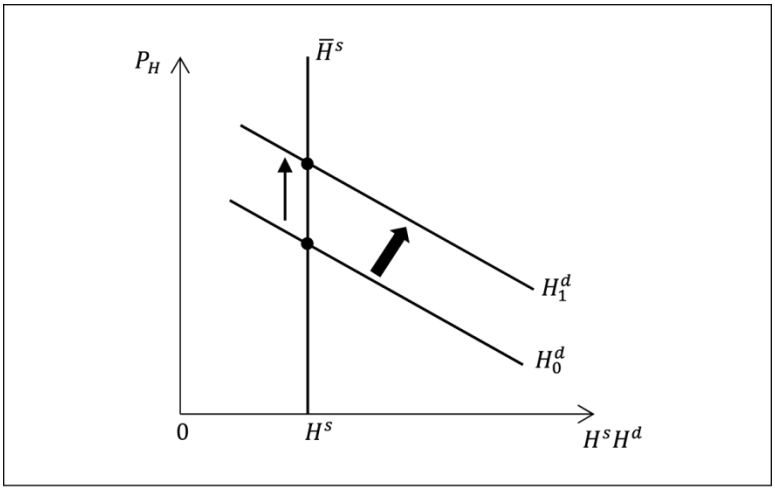
When the economy is in a down-turn, monetary policy becomes easier, and the interest rates will be lowered. Then the housing demand starts to rise because the interest rates on housing loan become lower. Then housing prices start to rise, as shown in Figure 6. Then people expect that housing price will increase further ($P_t^{H^e}$). Then the housing demand goes up further (Explanation 3).

$$H_t^d = d_0 - d_1 P_t^H - d_2 r_t + d_3 P_t^{H^e} + d_4 Y_t + d_5 FDI_t \quad (1)$$

$$H^s = \overline{H}^s \quad (2)$$

$$r \downarrow \Rightarrow H^d \uparrow \Rightarrow P^H \uparrow \Rightarrow P^{H^e} \uparrow \Rightarrow H^d \uparrow \quad (3)$$

Figure 6: Impact of Increasing Housing Demand on Prices (In Case of Constant Supply)



Source: Authors' compilation.

When the investors in the real estate market understand that demand is increasing in this market, they start to invest and construct new houses. With a few years' lag, the housing supply starts to increase, as the housing construction is matter of time ($H_t^d \uparrow \Rightarrow H_{t+1}^s \uparrow$). Then the supply of houses shifts to the right as in Figure 7 from $\bar{H}^s$ to H_{t+1}^s. This means that housing supply prices suddenly start to fall a little bit, as is shown in Figure 7.

$$\Delta H^s = \lambda\left(H_t^d - \bar{H}_t^s\right) \tag{4}$$

Equation 4 shows that the adjustment of housing supply is slow and there is a time lag for the housing construction, which is λ. Suppose it takes 3 years to fill the demand gap then λ is $1/3$. If the housing construction takes 1 year to be completed then λ is equal to 1.

$$H_{t+1}^s - \bar{H}_t^s = \lambda\left(H_t^d - \bar{H}_t^s\right) \tag{5}$$

Equation 5 shows that housing supply gradually adjusts to the demand for housing.

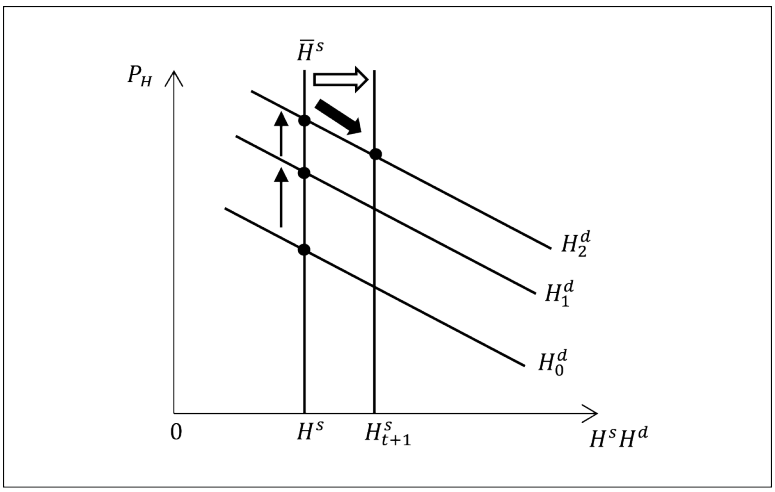
$$H_{t+1}^s = \lambda H_t^d + (1-\lambda)\bar{H}_t^s \tag{6}$$

Equation 6 is obtained by writing Equation 5 for H_{t+1}^s.

$$H_{t+1}^s = \lambda(d_0 - d_1 P_t^H - d_2 r_t + d_3 P_t^{H^e} + d_4 Y_t + d_5 FDI_t) + (1-\lambda)\bar{H}_t^s \tag{7}$$

Equation 7 shows the actual supply of housing in the following year. In Equation 7 if λ is equal to 1 then the demand is fulfilled in the following year. In reality λ is usually smaller than 1, meaning that housing construction usually takes more than 1 year.

Figure 7: Impact of Increasing Housing Demand on Prices (Case of Increasing Supply)



Source: Authors' compilation.

In Equation 8, demand for housing in the following year is shown, which is the function of the price of housing in the following year, interest rates of housing loans in the following year, expected price of housing in the next year, income level of households in the next year and the foreign direct investment (FDI) of the next year.

$$H_{t+1}^{d} = d_0 - d_1 P_{t+1}^{H} - d_2 r_{t+1} + d_3 P_{t+1}^{H^e} + d_4 Y_{t+1} + d_5 FDI_{t+1} \quad (8)$$

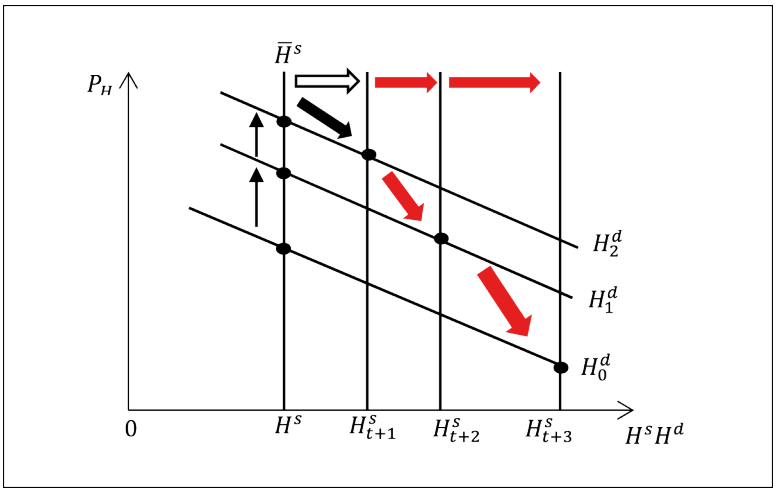
When the supply of housing increases, the prices start to fall, then the expected price of housing will also reduce, which will have a negative impact on the future demand for houses, as shown in Equation 9.

$$P^{H} \downarrow \Rightarrow P^{H^e} \downarrow \Rightarrow H_{t+1}^{d} \downarrow \quad (9)$$

This will shift down the demand from H_2^d to H_1^d as shown in Figure 8. Again, housing supply will keep on rising. That actual housing price will fall further because the expectation of housing price decreased again, and the continuous falling of the prices due to the increase of newly built houses (new supply) and decreased demand will burst the housing price bubble.

$$H_{t+2}^{s} - H_{t+1}^{s} = \lambda\left(H_{t+1}^{d} - H_{t+1}^{s}\right) \quad (10)$$

Figure 8: Falling Housing Prices Due to New Supply and Decreased Demand



Source: Authors' compilation.

Equation 10 shows the growth of housing supply in $t + 2$, which is adjusted by λ.

$$H_{t+2}^{d} = d_0 - d_1 P_{t+2}^{H} - d_2 r_{t+2} + d_3 P_{t+2}^{H^e} + d_4 Y_{t+2} + d_5 FDI_{t+2} \quad (11)$$

Equation 11 shows the housing demand in $t + 2$.

$$\lambda H_t^d + (1-\lambda)\bar{H}_t^s = \underbrace{d_0 - d_1 P_{t+1}^{H} - d_2 r_{t+1} + d_3 P_{t+1}^{H^e} + d_4 Y_{t+1} + d_5 FDI_{t+1}}_{H_{t+1}^{d}} \quad (12)$$

In Equation 12 the left-hand side comes from Equation 6 and the right-hand side comes from Equation 8.

$$P_{t+1}^{H} - \lambda P_{t}^{H} = \frac{1}{d_1}\begin{bmatrix} (1-\lambda)d_0 - d_2(r_{t+1} - \lambda r_t) \\ +d_3\left(P_{t+1}^{H^e} - \lambda P_{t}^{H^e}\right) + d_4(Y_{t+1} - \lambda Y_t) \\ -(1-\lambda)\bar{H}_t^S + d_5(FDI_{t+1} - \lambda FDI_t) \end{bmatrix} \quad (13)$$

By rewriting Equation 12 for price of housing, Equation 13 is obtained. It shows that the increase in the price of housing is a function of the adjusted constant demand, changes of the housing loan interest rate, changes in the expectation of housing price, changes in the income level of households, adjusted housing supply, and the changes of flow of foreign capital.

$$\frac{\partial P_{t+1}^{H}}{\partial P_{t+1}^{H^e}} = \frac{d_3}{d_1} >; \frac{\partial P_{t+1}^{H}}{\partial r_{t+1}} = -\frac{d_2}{d_1} < 0; \frac{\partial P_{t+1}^{H}}{\partial Y_{t+1}} = \frac{d_4}{d_1} > 0; \frac{\partial P_{t+1}^{H}}{\partial \bar{H}_t^S} < 0; \frac{\partial P_{t+1}^{H}}{\partial FDI_{t+1}} = \frac{d_5}{d_1} > 0 \quad (14)$$

Explanation 14 shows 5 inequalities that arise from the differences of housing price in Equation 14 with respect to different variables that here we interpret from left to right. The first inequality in the left shows that the future expectation is that if the housing price goes up, then the price of housing goes up. The second inequality shows that if the interest rate goes down, housing demand goes up, so the housing price goes up. The third inequality shows that when the economy is in a boom state and the income level of household goes up, the demand for housing increases and therefore the housing prices increase. The fourth inequality shows that when housing supply starts to increase, the housing prices go down. The last inequality, or the right-hand side one, shows that if the flow of foreign capital goes up, the demand for assets, including housing prices, increases due to increased demand by foreigners, as a result of housing price increases.

4. EMPIRICAL ANALYSIS

This section provides the empirical analysis in order to the find out the reasons behind the current housing price bubble in Hong Kong, China. Section 4.1 shows the data that we will use in the empirical analysis:

4.1 Data Analysis

4.1.1 Unit Root Test

In time series analysis, all variables need to be tested for the presence of unit root by stationarity tests. The series are evaluated for stationarity, in order to avoid spurious results in the analysis coming from the data series with a unit root. In order to check stationarity of each variable, Augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) tests were employed. The results are shown in Tables 2 and 3.

Table 1: Variables Used in Empirical Analysis

Variable and Definition	Symbol	Source
Private Domestic Housing Price Indices (Territory-wide) (Referred to as "housing price index")	I	Data of the Government of Hong Kong, China
M3 of Hong Kong, China (in logarithm form)	M3hk	Hong Kong Monetary Authority
M3 of the PRC (in logarithm form)	M3cn	Federal Reserve Bank of St. Louis
Housing lending interest rate in Hong Kong, China	Rhk	Hong Kong Monetary Authority
Housing lending interest rate in the PRC	Rcn	The World Bank
Percentage of newly approved housing mortgages in total newly issued loans to private sector in Hong Kong, China	M	Hong Kong Monetary Authority
Consumer Price Index (CPI) of Hong Kong, China	Chk	Data of the Government of Hong Kong, China
Consumer Price Index (CPI) of the PRC	Ccn	Federal Reserve Bank of St. Louis
Gross Domestic Product of Hong Kong, China	Yhk	Census and Statistics Department, Hong Kong, China
Gross Domestic Product of the PRC	Ycn	Federal Reserve Bank of St. Louis
Total newly completed housing units in Hong Kong, China	H	Census and Statistics Department, Hong Kong, China

Source: Authors' own compilation.

Table 2: Augmented Dicky–Fuller Test (ADF)

	Levels			First Difference			Second Difference		
Variable	t-statistic	Critical Vlue	Prob.	t-statistic	Critical Value	Prob.	t-statistic	Critical Value	Prob.
I	–1.91	–3.43	0.64	–2.87	–2.87	0**			
M3cn	12.6	–2.87	1	–3.71	–2.87	0**			
M3hk	–1.87	–2.87	0.35	–7.94	–2.87	0**			
Rcn	–1.93	–3.46	0.32	–14.8	–2.87	0**			
Rhk	–2.78	–2.87	0.06	–7.55	–2.87	0**			
M	–1.75	–2.87	0.41	–5.19	–2.87	0**			
Ycn	1.87	–2.87	1	–0.51	–2.87	0.89	–13.12	–2.87	0**
Yhk	0.56	–2.87	1	–2.55	–2.87	0.1	–9.71	–2.87	0**
Ccn	0.46	–2.87	1	–2.6	–2.87	0.1	–16	–2.87	0**
Chk	0.21	–2.87	0.97	–2.33	–2.87	0.16	–13.84	–2.87	0**
H	–1.87	–2.87	0.34	–6.1	–2.87	0**			

Notes: *denotes significance at 5% level; **denotes significance at 1% level.

Source: Authors' compilation using Eviews ver. 10.

For the ADF test, all variables contain unit root and are non-stationary in level. *I, M3cn, M3hk, Rcn, Rhk, M, and H* become stationary in the first difference. *Ycn, Yhk, Ccn, and Chk* become stationary in the second difference. For the PP test, *H* is stationary at levels. All other variables become stationary with the first difference.

Table 3: Phillips–Perron Test (PP)

	Levels			First Difference		
Variable	**t-statistic**	**Critical Value**	**Prob.**	**t-statistic**	**Critical Value**	**Prob.**
I	1.95	–2.87	1	–8.31	–2.87	0**
M3cn	9.61	–2.87	1	–11.85	–2.87	0**
M3hk	3.44	–2.87	1	–17.01	–2.87	0**
Rcn	–1.94	–2.87	0.31	–14.81	–2.87	0**
Rhk	–1.72	–2.87	0.42	–7.8	–2.87	0**
M	–1.77	–2.87	0.4	–18.58	–2.87	0**
Ycn	3.25	–2.87	1	–8.75	–2.87	0**
Yhk	–0.64	–2.87	0.86	–7.85	–2.87	0**
Ccn	1	–2.87	1	–12.69	–2.87	0**
Chk	1.63	–2.87	1	–16.1	–2.87	0**
H	–3.78	–2.87	0.004*			

Notes: *denotes significance at 5% level; **denotes significance at 1% level.

Source: Authors' compilation using Eviews ver. 10.

According to Granger (1981) and Engle and Granger (1987), cointegration analysis is not applicable when variables are integrated at different orders. In the case of this study, the variables are integrated at I(0), I(1) and I(2). Hence, according to Johansen and Juselius (1990), the Auto Regressive Distribution Lag (ARDL) method is applicable. The ARDL cointegration technique is used in the determination of the long-run relationship between data series with different orders of integration (Pesaran and Shin 1999; Pesaran, Shin, and Smith 2001). The result can provide information on the short-run dynamics and long-run relationship of the considered variables.

ARDL technique can be applied irrespective to order of integration the variables are integrated at, be it I(0) or I(1) or a mix of both. This helps to avoid the pretesting problems associated with standard cointegration analysis. In standard cointegration analysis, all variables are required to be classified into the same order, either I(0), I(1) or I(2).

4.1.2 Wald Test

In order to test for the presence of a long-run relationship, the Wald test is conducted. The null hypothesis of the non-existence of the long-run relationship is defined by:

H_0: $\alpha_1 = \alpha_2 = \cdots = 0$ (null hypothesis, i.e. absence of a long-run relationship)
H_1: $\alpha_1 \neq \alpha_2 \ldots \neq 0$ (existence of long-run relationship)

Table 4: Wald Test

Test Statistic	Value	Df	Probability
F-Statistic	27.429	(17, 204)	0.00**
Chi-Square	466.30	17	0.00**

Notes: **denotes significance at 1% level.

Source: Authors' compilation using Eviews ver. 10.

Table 4 shows results of the Wald test. The F-statistic is larger than the critical value. The probability for the null hypothesis, i.e. absence of long-term relationship between variables, is 0. Hence, the null hypothesis is rejected. A long-run relationship between variables exists.

4.2 Empirical Results

The empirical model that we used in this paper using the theoretical model that was developed in Section 3 is as bellow:

$$I_t = \alpha_0 + \alpha_1 I_{t-1} + \alpha_2 log(M3cn)_t + \alpha_3 log(M3hk)_t + \alpha_4 (Rcn)_t + \alpha_5 (Rhk)_t + \alpha_6 (M)_t + \alpha_7 (Ccn)_t + \alpha_8 (Chk)_t + \alpha_9 log(Ycn)_t + \alpha_{10} log(Yhk)_t + \alpha_{11} log(H)_t + \varepsilon_I \quad (15)$$

Equation 15 shows the empirical model that we used for estimation of the factors that have an impact on determination of the housing price index (I_t). Refer to Table 1 for the respective definitions of each symbol and their sources, ε_I is the error term.

The ARDL estimate shows the relationship between the variables. Using the option of automatic lag selection on EViews10, utilizing the Akaike Information Criterion (AIC), it was found that the optimal number of lags for our model is as follows:

Table 5: Number of Lags for Each Variable for ARDL Model

Variable	I	M3hk	M3cn	Rhk	Rcn	M	Chk	Ccn	Yhk	Ycn	H
Optimal Lag	1	3	1	0	3	1	0	0	0	1	0

Source: Authors' own estimation on EViews10.

With the number of optimal lags estimated, the ARDL regression was run and results are as follows:

Table 6: ARDL Regression Results

Variable	Coefficient	T-statistic	Probability
I	0.77	11.18**	0
M3HK	30.2	3.17**	0
M3CN	15.24	0.8	0.43
Rhk	–0.45	–0.46	0.64
Rcn	–2.02	–3.12**	0
M	37.33	0.81	0.42
Chk	0.28	1.31	0.19
Ccn	0.13	0.43	0.66
Yhk	–0.14	–0.02	0.98
Ycn	7.66	2.58**	0.01
H	0.1	0.31	0.74
Constant (intercept)	0.5	1.31	0.19
R-squared	0.76	Durbin-Watson stat	2.01

Notes: *denotes significance at 5% level; ** denotes significance at 1% level.
Source: Authors' compilation using Eviews 10.

From the ARDL model above, there are four variables found to be statistically significant in explaining the movements of the housing price index in Hong Kong, China. These variables are housing price index itself with one lag, M3 of Hong Kong, China with 3 lags (-3), Housing lending interest rates of the PRC with 3 lags (-3), and GDP of the PRC, with 1 lag (-1). I, M3HK, and Ycn have a positive association with the housing price index, while Rcn has a negative impact on housing price index. This means that monetary abundance in Hong Kong, China has a significant impact on increasing the housing price index in Hong Kong, China by increasing the demand. Improving the economic situation in the PRC and reducing the lending interest rate in the PRC will increase the flow of FDI to Hong Kong, China and increase the demand for housing, hence elevating the prices there. Hence, the housing price boom of Hong Kong, China has both internal and external dimensions.

We proceed to Conditional Error Correction Model Regression in the following.

Table 7: Number of Lags for Each Variable for the Conditional Error Correction Model Regression

Variable	I	M3hk	M3cn	Rhk	Rcn	M	Chk	Ccn	Yhk	Ycn	H
Optimal Lag	1	1	2	0	1	0	0	0	0	1	0

Source: Authors' own estimation on EViews10.

With the number of optimal lags estimated, the Conditional Error Correction Model Regression is as follows:

Table 8: Conditional Error Correction Model Regression

Variable	Coefficient	T-statistic	Probability
I	0.32	7.05	0.00**
M3HK	50.48	3.31	0.00**
M3CN	16.48	0.88	0.37
Rhk	–0.15	–0.16	0.86
Rcn	–3.68	–2.78	0.00**
M	49.5	1.07	0.28
Chk	0.13	0.62	0.53
Ccn	0.39	1.39	0.16
Yhk	–2.26	–0.37	0.7
ycn	12.61	3.8	0.00**
H	0.09	0.28	0.77
Constant	0.15	0.52	0.59

Notes: *denotes significance at 5% level; **denotes significance at 1% level.

The Error Correction Model (ECM) is derived from the ARDL model through a simple linear transformation, which incorporates short-run adjustments together with long-run equilibrium without losing the long-run information. As the sample size of this paper is relatively large (n>200), the ARDL conditional error correction model becomes less useful. It is kept here for readers' information.

Similarly, the same four variables are found to be statistically significant in explaining the movements of the housing price index in Hong Kong, China with some differences in their lag order. M3HK and Ycn have a positive relationship with the dependent variable I, while Rcn is negatively related to I. We proceed to the levels equation in the following.

Table 9: Number of Lags for Each Variable for the Levels Equation

Variable	i	M3hk	M3cn	Rhk	Rcn	M	Chk	Ccn	Yhk	Ycn	h
Optimal Lag	1	1	2	0	1	0	0	0	0	1	0

Source: Authors' own estimation on EViews10.

Table 10: ARDL Error Correction Model (Levels Equation)

Variable	Coefficient	T-statistic	Probability
I	153.42	2.73	0.00**
M3HK	50.09	0.71	0.47
M3CN	0.477	0.18	0.85
RHK	–11.41	2.68	0.00**
RCN	–15.45	–2.72	0.00**
M	0.39	0.66	0.5
CHK	1.18	1.45	0.14
CCN	–6.88	–0.46	0.64
YHK	38.35	3.2	0.00**
YCN	0.27	0.38	0.7
Constant	0.47	0.49	0.61

Note: all variables are in the first differences.

Source: Author's own estimation on EViews10.

The levels equation performs differently. The four variables found statistically significant are: Housing Price Index itself with one lag (-1), lending rates in Hong Kong, China without lags, housing lending interest rates in the PRC with 1 lag (-1), and GDP of Hong Kong, China without lags. M3HK and Ycn are no longer statistically significant, replaced by Rhk and Yhk. I and Yhk have a positive relationship with the dependent variable I, while Rcn and Rhk are negatively related to I.

For a robustness check of the interactions between variables in the short run, a Granger causality test and a correlation test were conducted by selecting 2 lags. Results are presented in Table 11 and 12 respectively:

Table 11: Granger Causality Test Results

Probability											
Variable	**I**	**M3hk**	**M3cn**	**Rhk**	**rcn**	**M**	**Chk**	**Ccn**	**Yhk**	**Ycn**	**H**
I		0.57	0.00**	0.61	0.17	0.01**	0.00**	0.07	0.00**	0.42	0.02*
M3HK	0.00**		0.00**	0.51	0.53	0.00**	0.00**	0.00**	0.00**	0.00**	0.00**
M3CN	0.03*	0.06		0.4	0.62	0.00**	0.00**	0.00**	0.00**	0.00**	0.00**
Rhk	0.57	0.00**	0.07		0.21	0.00**	0.37	0.59	0.41	0.69	0.06
Rcn	0.93	0.36	0.63	0.59		0.06	0.57	0.70	0.98	0.99	0.70
M	0.24	0.64	0.06	0.75	0.44		0.03*	0.81	0.00**	0.42	0.03*
Chk	0.18	0.46	0.00**	0.80	0.14	0.28		0.04*	0.03*	0.33	0.30
Ccn	0.04*	0.86	0.00**	0.63	0.25	0.00**	0.00**		0.00**	0.00**	0.00**
Yhk	0.04*	0.04*	0.03*	0.02*	0.44	0.00**	0.00**	0.00**		0.01**	0.01**
Ycn	0.00**	0.00**	0.49	0.61	0.7	0.00**	0.00**	0.00**	0.00**		0.00**
H	0.83	0.01**	0.71	0.32	0.12	0.00**	0.07	0.01**	0.06	0.65	

Notes: The dependent variables are on the x-axis while the independent variables are on the y-axis.

Null hypothesis: y-axis variable does not Granger cause the correspondent x-axis variable.

Source: Authors' own estimation on EViews10.

Table 12: Correlation Matrix

Coefficient											
Variable	**I**	**M3hk**	**M3cn**	**Rhk**	**rcn**	**M**	**Chk**	**Ccn**	**Yhk**	**Ycn**	**H**
I	1	0.95	0.90	–0.44	–0.40	–0.85	0.98	0.96	0.95	0.89	–0.32
M3HK	0.95	1	0.99	–0.54	–0.31	–0.81	0.90	1	0.98	0.98	–0.46
M3CN	0.90	0.99	1	–0.63	–0.31	–0.73	0.84	0.98	0.95	0.99	–0.51
Rhk	–0.45	–0.54	–0.63	1	0.31	0.12	–0.38	–0.56	–0.48	–0.60	0.30
Rcn	–0.40	–0.32	–0.31	–0.32	1	0.07	–0.41	–0.30	–0.32	–0.26	–0.05
M	–0.85	–0.81	–0.73	0.13	0.08	1	–0.87	–0.83	–0.83	–0.74	0.29
Chk	0.98	0.91	0.84	–0.38	–0.40	–0.87	1	0.92	0.91	0.81	–0.24
Ccn	0.96	0.99	0.98	–0.56	–0.29	–0.83	0.93	1	0.97	0.97	–0.44
Yhk	0.95	0.98	0.95	–0.48	–0.31	–0.83	0.91	0.97	1	0.94	–0.43
Ycn	0.89	0.98	0.99	–0.61	–0.26	–0.74	0.81	0.97	0.94	1	–0.55
H	–0.32	–0.46	–0.52	0.30	–0.04	0.29	–0.24	–0.44	–0.43	–0.55	1

Source: Authors' own estimation on EViews10.

To check if cointegration exists in the model, a bounds test is conducted. In Table 13, the F-statistic is beyond the correspondent I(1) values. Hence the existence of cointegration is rejected.

Table 13: F-Bound Test

F-bound Test	Value	Level of Significance	I(0)	I(1)
F-statistic	7.64	10%	2.08	3
K	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15

Source: Authors' estimation on EViews10.

4.3 Empirical Results Analysis

4.34.1 Causal Relationship Between Interest Rate, M3, and Housing Prices

Money supply reduces the interest rate, increases the demand for credit, and eventually increases demand for assets and housing. Empirical results show that lending interest rate has a negative impact on housing prices in the long run. However, in the short term, it is money supply (M3) that matters. In the long-run levels equation, Rhk replaces M3HK as the statistically significant monetary supply variable for explaining developments in housing price index.

In the ARDL equation, M3 of Hong Kong, China can trigger housing price appreciation. In the ARDL model (difference), RHK is not significant, while M3HK is significant and found to be positively related to housing prices. However, in the long-run levels equation, RHK becomes significant, and M3HK becomes insignificant.

This leads to the point that while M3 has an immediate impact on housing prices, in long-run determinant of monetary supply, the interest rate, is responsible for surging housing prices. It takes time for low interest rates to be transformed into increased money supply. In the Granger causality test, we find that Rhk Granger causes M3HK and the relationship is negative. Results from the Granger causality test and correlation matrix confirm this argument. In the Granger causality test, Rhk Granger causes M3HK, while M3HK does not Granger cause RHK. The relationship is positive.

In turn, increased money supply causes higher housing prices, and increased housing prices can also contribute to more money supply. M3HK is found to be Granger causing I positively. Meanwhile, I also Granger causes M3HK, with the probability for null hypothesis at 0 as well. The bidirectional link between money supply and housing prices was in conformity with Su, et al. (2019).

Nonetheless, it is important to note that RHK is, to a certain extent, an indicator of global monetary supply. Under the Linked Exchange Rate Mechanism, the Hong Kong, China dollar is pegged to the US dollar. The value of HKD swings in the margin of 7.75–7.85 HKD per USD. The difference between the Hong Kong Inter-bank Offered Rate (HIBOR) and the Federal Reserve Bank's target rate can trigger significant capital inflow/outflows and destabilize the currency value. HKD interest rate tends to follow the footsteps of the US in the long run. Hence RHK and M3HK indicators should be taken as both domestic and international monetary supply indicators.

4.3.2 Housing Prices and Mortgages in Hong Kong, China

Mortgages do not cause housing price developments in Hong Kong, China. Instead, housing prices *negatively* impact on the Mortgage/loan ratio. Throughout the ARDL model, M (mortgage/ total loans ratio) has never been a statistically significant variable in explaining housing price index. In the Granger causality, M is statistically insignificant in explaining housing price index. However, the reverse relationship, is verified in the test. In the correlation matrix, I-M relationship is negative, at –0.85. While mortgages are not a cause of higher housing prices, housing prices per se can affect mortgage amount significantly, in a negative manner. The price hike deters many households and individuals from buying houses, as current housing prices make it an impossibility for the average person to buy a house, even with the aid of a mortgage. The higher the housing prices, the fewer the number of people who can buy houses and the lower the M/L ratio.

4.3.3 The External Role

Influence from the PRC has been a key factor. In the short run, ARDL, which regresses at differences, the PRC GDP is statistically significant, with a coefficient of 7.66. In the Granger causality test, Ycn is found to Granger cause I as well. Meanwhile, the Chinese lending rate (Rcn) is statistically significant in the levels equation. Its magnitude of influence, the coefficient (–15.45), pales that of even Hong Kong, China's (–11.41).

The PRC government's bid to loosen credit and leverage requirements to confront decelerating economic growth in recent years has made Chinese investments overseas more prominent than before, irrespective of the level of economic growth in the PRC. Increased investments would also boost Hong Kong, China's GDP in the long run, an explanation for why Yhk becomes significant in a prolonged period. It echoes with Cheung, Chow and Yiu (2017), who concluded that the close economic ties between the PRC and Hong Kong, China has made Hong Kong, China's stock and real estate market very dependent on the PRC's economy.

4.3.4 Continuous Skyrocketing Prices Due to Past Inflation in the Real-Estate Market

Housing price index (I) per se has been significant throughout different models. The coefficient is positive, indicating that price growth at any given time leads to more growth in future.

The reason for this "self-fulfilling prophecy" of appreciation in real estate prices could be the workings of increased wealth effect in housing asset appreciations. As housing prices grow, it becomes more profitable to invest in housing market, in relation to other financial assets. Hence, the housing market attracts more capital and investments. Meanwhile, investors' borrowing capacity also grows as a result of increased wealth through housing asset appreciation (Muellbauer 2007). The Interlink between housing asset appreciation and perpetuation of the condition of monetary abundance is also explored empirically by other authors (Chi-Wei et al. 2019; Goodhart and Hofman 2008). To prevent even further speculation in the housing market in the future, timely interventions to restore equilibrium are necessary.

4.3.5 Housing Supply and Housing Prices in Hong Kong, China

Throughout the regression and subsequent tests, housing supply has never been statistically significant; housing supply is not responsible for or affected by, or does it respond to price changes. In fact, with reference to Figure 3 and 4, production of housing units in both public and private sectors have been kept at low levels since 2003.

This disequilibrium of supply-demand is a result of government policies. As the falling housing prices before 2003 hit the local economy badly, government finance and political stability were compromised (HKMA 2000). Subsequently, Hong Kong, China entered an era of low provisions of new housing units. Newly completed housing units have, since then, never been above 6000 per month, with some recorded months be as low as less than a hundred. Following the Asian Crisis of 1999 and SARS 2003, the government has paused construction of home-ownership schemes, a type of subsidized, government-run public housing for sale, and has opted for a Land Application List System, in which the government no longer put available lands for sale on a regular basis; instead developers now choose land from a list of land for sale offered by the government and provide a quote, followed by an open auction.

The Land Application List System was finally reversed in 2014. Since then, the government has been more active in encouraging the construction of new residential units. The Long Term Housing Strategy Steering Committee published a strategy for supplying new housing units in 2013, stipulating a goal of supplying the market with 440,000–500,000 housing units in the years of 2013–2023, a figure that significantly exceeds current supply. Nonetheless, as development projects often take years to complete, whether this wave of increased supply will deter appreciations of real estate prices is yet to be observed.

4.3.6 Irrelevance of Inflation

Inflation per se is irrelevant in explaining the housing market development in Hong Kong, China. CHK and CCN have never been statistically significant throughout the model. Only CCN is found significant for explaining I in the Granger causality test. This leads to the argument that Hong Kong, China's housing prices development is irrespective of domestic inflation in Hong Kong, China. Short term changes in the PRC's inflation rate might be influential; however, over a longer time scale, is irrelevant.

Instead, it is more likely that inflation is a by-product of the workings of increased housing prices and money supply. In the Granger causality test, CHK is affected by the variables of I, M3HK, M3CN, CCN, YHK and YCN. This finding verifies the earlier assertion made by Aoki, Proudman and Vlieghe (2004), who asserted that increased household wealth in housing market leads to an increase in household consumption.

5. CONCLUSION AND POLICY IMPLICATIONS

In this paper, we find that Hong Kong, China's housing price development in 1999–2018 resulted from changes in money supply (M3 in HKD), low interest rates in Hong Kong, China and the PRC, GDP growth in the PRC, as well as previous growth in housing prices. Though supply of new housing units is found to statistically insignificant, we establish that its insignificance is a proof of disequilibrium of supply and demand in Hong Kong, China's housing market. Besides, current house prices are proven to be beyond general public's affordability, hence a decreasing mortgage/ total loans ratio with housing asset appreciations. After Cheung, Chow and Yiu (2017), the importance of the PRC's economic growth on developments of housing market in Hong Kong, China is verified again. With the continual growth of the PRC's economy, demand for immovable assets in Hong Kong, China from the PRC would grow, as houses in Hong Kong, China are not only a decent consumable, but also a profit-making asset.

Nonetheless, housing prices in Hong Kong, China are beyond the general public's affordability. As the younger generation and grassroots population find it more difficult than before to accommodate their own housing needs, people are propelled to live in undesired settlements or sub-divided units. The phenomenon not only constitutes a dire economic condition of the people, but also distrust and disapproval of the government and its political system. Hence, it is of prime importance for the government to restore the equilibrium of supply and demand in the housing market in Hong Kong, China.

This paper suggests, as inferred from aforementioned results, that the government should increase supplies of housing units in both public and private sectors in order to restore equilibrium. In addition, this paper advises against using the tool of mortgage-to-value (or loan-to-value) ratio as a leverage to limit growth in mortgages and purchases of housing units. As current housing prices are above the level of affordability, lowering the mortgage-to-value ratio would even deter first-time buyers from buying a flat, while those investors with abundant capital would be un-impacted. The government should also consider increasing the stamp duty fee for transactions of housing units held by/ bought by those with more than one unit. Halting growth in the housing market is of prime importance–as we observe in the case of Japan in 1980s and 1990s, a bust of real estate bubble can cause severe damage to the banking sector. Besides, allocating too much capital into real estate can also damage growth of small-to-medium-enterprises (SMEs), the backbone of the economy, as banks allocate more credit to the construction and purchases of real estate rather than SMEs (Yoshino, Nakamura, and Sakai 2013).

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