Availability, Affordability and Volatility: the case of Hong Kong Housing Market

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Abstract

Housing prices in Hong Kong have gained international attention. This study suggests that the housing supply may be insufficient. Consistent with previous studies, we confirm that merely increasing the land supply may not increase the housing supply. We also find preliminary evidence for widening income inequality, which, when combined with unavailability, can lead to unaffordability in the housing market. Given the current housing supply elasticity with respect to price, Hong Kong is not more volatile than major cities in the United States. Thus, improving housing availability and thereby increasing housing supply elasticity, could effectively decrease housing price volatility.

Keywords: Land policies, housing availability, housing affordability, housing volatility, Granger causality

JEL Classification: E30, R21, R31, R52

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1. Introduction

Despite its small size, less than 10% of New York City in area, Hong Kong has attracted international attention for its economic activities. Friedman’s (1997) praise of Hong Kong’s “free market practice” is one example. More recently, as housing prices in Hong Kong have reached new heights, the Chief Executive, Mr. C. Y. Leung proposed several measures to “stabilize the housing market.” As the Wall Street Journal (2013) reported,

“Free market policies transformed Hong Kong from a city of refugees to a prosperous regional hub in the space of a generation. Now Chief Executive Leung Chun-ying thinks he knows better than the market... The most serious example concerns the property market, which was a focus of this week’s speech. Mr. Leung is bowing to populist pressure to label fast-rising house prices a market failure and do something about it...

In Mr. Leung’s view, the market is failing to correctly match supply of apartments to the demand, which also incorrectly pricing apartments that are on the market. So he proposes an expansion in public-housing units (building 100,000 units for the five years starting 2018), the creation of massive development areas near the border with China, and reclamation projects that would create new islands on which to build apartment towers...

In fact, the Hong Kong government may have some empirical grounds for its worries. Here we present some intuitive graphs and delay more formal analysis to later sections. Figure 1a demonstrates that Hong Kong house prices reached a new height in 2013Q3, even after

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Friedman (1997) claims that “...Economists and social scientists complain that we are at a disadvantage compared with physical and biological scientists because we cannot conduct controlled experiments. However, the experiments that nature throws up can be every bit as instructive as deliberately contrived experiments. Take the fifty-year experiment in economic policy provided by Hong Kong between the end of World War II and this past July, when Hong Kong reverted to China.... In this experiment, Hong Kong represents the experimental treatment; Britain, Israel, and the United States serve as controls. Immediately after World War II, Hong Kong had a population of about 600,000. A colony of Britain, it did not receive its freedom after the war as most other colonies did.... After the Communists took control of mainland China, a flood of refugees came to Hong Kong. Over the next fifty years, the population exploded. Today it is more than six million.... I take Britain as one control because Britain, a benevolent dictator, imposed different policies on Hong Kong from the ones it pursued at home.... Nonetheless, there are some statistics, and in 1960, the earliest date for which I have been able to get them, the average per capita income in Hong Kong was 28 percent of that in Great Britain; by 1996, it had risen to 137 percent of that in Britain. In short, from 1960 to 1996, Hong Kong’s per capita income rose from about one-quarter of Britain’s to more than a third larger than Britain’s. It’s easy to state these figures. It is more difficult to realize their significance. Compare Britain—the birthplace of the Industrial Revolution, the nineteenth-century economic superpower on whose empire the sun never set—with Hong Kong, a spit of land, overcrowded, with no resources except for a great harbor. Yet within four decades the residents of this spit of overcrowded land had achieved a level of income one-third higher than that enjoyed by the residents of its former mother country.... I believe that the only plausible explanation for the different rates of growth is socialism in Britain, free enterprise and free markets in Hong Kong. Has anybody got a better explanation? I’d be grateful for any suggestions.”
correcting for inflation. Figure 1b shows that the house-price-to-wage ratio has increased rapidly since 2004. In comparison, the US market is much more stable.\(^2\) As the house price-to-wage ratio is often used as a measure of affordability, Figure 1b might suggest that housing affordability is an issue that needs to be considered in Hong Kong. Clearly, it is dangerous to draw any conclusion with one data plot. We will re-examine the affordability issue in more details in some later section. It suffices to say that based on our econometric analysis, un-affordability is indeed an issue. And the un-affordability, along with other stylized facts in the Hong Kong housing market, will be shown to connect to the fact of limited housing supply.

[Housing policy discussions in the context of Hong Kong are interesting for several reasons. First, as housing supply is related to the land market, and land ownership in Hong Kong is public, any “housing supply deficiency” or “land shortage” is apparently the responsibility of the Hong Kong government. Thus, it is reasonable for the Hong Kong government to consider policy options to “correct” problems in the housing market. Second, Hong Kong’s boundary is fixed by the Basic Law of Hong Kong, and in that sense the supply constraint is potentially a very binding constraint.\(^3\) More generally, Hong Kong, like many growing cities, is confronted with the following set of questions. Does the housing market function effectively? Will house prices become “too high”? Should the government intervene in the housing market? If so, what kind of interventions should the government take? Thus, the lessons drawn from Hong Kong might also be relevant to other cities, especially other Asian cities.

Clearly, we are not able to address all of these questions in one paper. Here, we clarify some “stylized facts” regarding the Hong Kong housing market, and hopefully separate the “facts” from the “myths” that are present in the media.\(^4\) For instance, as we mentioned earlier, due to the Basic Law of Hong Kong, Hong Kong cannot expand her boundary like other cities. Some people therefore assert that the resulting limited supply of land drives the high house prices. Interestingly, Figure 1c shows that only 5% of the land in Hong Kong is currently used for residential purposes, whereas more than 60% is categorized as “woodland/wetland.”\(^5\) As land is a major input of housing construction, severe land use restrictions could be translated into high

\(^2\) However, the Hong Kong government is not alone. Roubini (2013) claims that “In emerging markets, bubbles are appearing in Hong Kong, Singapore, China...” Even Dr. Chang-Yong Rhee, IMF’s director of the Asia and Pacific Department, asserted in a press conference held in Hong Kong that “Some adjustments are necessary,” for the Hong Kong housing market (The Standard, 2014b). More discussion on this point is provided in later sections.


\(^4\) It is common in economics to clarify “stylized facts.” Among others, see Ambler et al. (2004), and Jones and Romer (2010).

\(^5\) Among others, refer to Turner et al. (forthcoming) for a discussion of land use regulation and welfare.
land prices, and hence high house prices. This paper addresses that point by examining the land supply issues in Hong Kong. As explained below, simply developing more land for residential and commercial purposes may not be sufficient to immediately “cool down” the property market.

Another popular explanation for the high house prices in Hong Kong focuses on the composition of the new housing supply. Figure 1d shows that the supply of small units (class A) as a share of new housing units has dropped significantly over the years. More generally, there is a tendency for developers to allocate more weight to larger and more luxurious housing units, whereas the “need for smaller units” may be under-served, and hence overall house prices increase. Below, we discuss why profit-maximizing developers may not supply “enough” small units to the market even if the demand is there.

[Figures 1c and 1d about here]

The last explanation is related to Hong Kong’s unique position as a regional financial center. As the Hong Kong dollar is pegged to the U.S. dollar, the very low nominal interest rate imposed by the U.S. translates into a low nominal interest rate in Hong Kong. In contrast, inflation in Hong Kong is often imported, such as the effect of the continuous appreciation of the renminbi, as many goods sold in Hong Kong are imported from China. This leads to a very low, even negative, real interest rate environment that encourages home purchasing. In addition, more funds from China are speculating in the Hong Kong real estate markets. As a whole, these factors create an expectation that house prices will go up [Clayton (1996)]. We will return to this point in a later section.

Overall, the new housing supply is jointly determined by the government and developers. Government plays a key role in redevelopment projects, scheduling land sales, and the conversion of land usage. Developers can determine the date of completion and primary selling prices. In the following section, we discuss each party in turn, and address the following questions.7

(1) Housing availability: Are housing units now under-supplied? Can and will the government increase the housing supply?

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6 See Leung and Tang (forthcoming) and Dieci and Westerhoff (2012) for details.
7 Notice that our sequence is to discuss availability issue first, followed by affordability and volatility. The idea is that housing units must be somehow “insufficiently” supplied (availability issue) first. Then the market price can become “too high” (affordability issue) when economic agents try to purchase units from the constrained market. Volatility, the third issue, is also related to price, and hence placed naturally after the discussion on affordability. This sequence is also consistent with the tradition in microeconomics that the allocation goods is first considered, and then the market price is interpreted as a “mechanism” to “implement” that (constrained) optimal allocation. Among others, see Mas-Colell et al (1995), McKenzie (2002), for more discussion.
(2) Housing affordability: Can and will the government and developers make private housing “more affordable” by lowering the house price-to-wage ratio?

(3) Housing volatility: Can and will the government reduce the volatility of the housing market?

Among others, Malpezi (2012) highlights several common issues in the housing market policy considerations. We hope that some lessons drawn from this paper, which focuses on Hong Kong, will be applied to other Asian cities, especially fast-growing cities in China.

2. Housing Availability

Following the tradition of Economics to discuss the quantity allocation before the price determination, this section discusses the availability of housing in Hong Kong. The availability and volatility issues are related to house price and hence will be discussed in later sections. As shown in Figure 2, on average, each household has more than one housing unit (public or private). Thus, if housing units were evenly distributed, many issues would be resolved. Unfortunately, housing units are not evenly distributed. Some households have multiple units for investment or other purposes. Hence, the demand for both public and private housing is still un-fulfilled. The following paragraphs briefly describe the institutions and the current situation of public rental housing, subsidized housing, and private housing in Hong Kong.

First, we focus on the public rental market. In 2012, there were 727,800 households, 30.7% of the total households in Hong Kong, living in public rental housing [Figure 3]. To be eligible for public rental housing, a household’s income and assets cannot exceed a certain limit. A 1999/2000 survey by the Hong Kong Housing Authority collected information on 108,300 applicants in that period. If the Authority commits to keep the average waiting time for general applicants at around three years, it has to build at least 36,100 units a year. For various reasons, the Hong Kong government is unable to meet this target, and hence there is a prolonged average waiting time for applicants [Table 1]. More importantly, this figure does

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8 Clearly, this points to the distribution of home ownership, or more generally, the income or wealth distribution issue. This is further discussed in later sections.
9 The income and asset limits are subject to renewal regularly. For the latest information, please visit http://www.housingauthority.gov.hk/en/flat-application/income-and-asset-limits/index.html
10 Mr. C. W. Tung, the first Chief Executive after Hong Kong was handed over to China, made such a promise. Among others, see Lau (2002) for more details.
11 According to Goodstadt (2013), such delays are interpreted as beneficial by some government officials because a shortened waiting time could encourage even more people to join the queue, making the “excess demand” of public housing units even more unmanageable. Among others, see Wong (1998) for a related discussion.
not take into account people who are rehoused because of redevelopment. It may be fair to say that there is strong evidence that the Hong Kong government has not fully accommodated the public’s need of housing.

[Figures 2 and 3 and Table 1 about here]

One might argue that very few governments can meet the housing needs of their citizens in any case. Although this statement may be true, it is still important to note the magnitude of the “supply shortage” in Hong Kong. For example, in the year 2012/2013, the Housing Authority received 40,000 new applications, and the accumulated applications reached 229,000. However, the annual new supply of public rental housing was only 13,114 units. It has been estimated that an applicant has to wait 17 years for a public housing unit. This is consistent with the conventional wisdom in economics that when a private good is provided at a subsidized rate, it will be over-subscribed and will result in rationing. Even though the government’s policy address in 2013/14 stated that the new public housing supply will further increase to about 20,000 units a year, the annual number of new applications is twice that of the new supply, and hence the average waiting time may not be shortened for at least the next few years.

In addition to public rental housing, the Hong Kong government has tried to promote home-ownership. For instance, the Home Ownership Scheme (HOS) attempts to provide subsidized home ownership to families that cannot afford a private unit. Usually, the subsidized units are sold at about 70% of market value. If the homeowner sells the subsidized unit in the secondary market, they have to pay the “premium” back to the government. The availability of subsidized housing is controlled by the government. In November 2002, the government attempted to stabilize the housing market by ending the HOS. In 2011, it launched an enhanced program to subsidize home ownership called the “My Home Purchase Plan”. Under the current housing target, the government plans to build 8,000 HOS units per year.

In an economy based on an \textit{laissez faire} philosophy, the private housing market plays an important role in the whole sector. As Figure 3 shows, the proportion of households living in private housing has remained steady at around 50% since 1993. Since 2005, the number of new private housing unit has been below 20,000 units a year [Figure 4]. The government believes

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12 In 1999/2000 there were 14,601 houses allocated to this category.
13 Among others, see Banerjee (1997), Friedman (2002), and Wong (1998) for more discussion on this point. See also Leung, Sarpa, and Yilmaz (2012) for a discussion of how the introduction of public housing could affect the rent gradient, the population composition across communities, labor supply, and social welfare.
14 The calculation of premium is as follows:
\[
\text{Premium} = \frac{\text{market value at selling time} \times (\text{market value at purchasing time} - \text{actual purchasing price})}{\text{market value at purchasing time}}
\]
15 In the 2012/2013 policy address, the government did not pledge to undertake any projects for the My Home Purchase Scheme. The land originally earmarked for the scheme was set aside for new HOS development instead.
the “housing shortage” is mainly due to wrangles over land use, and it plans to increase the supply of land, in both the short and long term, to satisfy housing and other needs.

For the government policy to be effective, an increase in the land supply must lead to an increase in the new housing supply. Statistically, this statement can be tested by running a Granger causality test for the effects of an increase in the area of land sold on the new supply of private housing units. Clearly, the causality could run the other way: because the government and the market anticipate a high demand for housing, the amount of land area sold by the government to the private developers would increase. In that case, the causality would be from the new supply of housing to the area of land sold. Again, this is a statement that we can test statistically. The results reported in Table 2a\(^{16}\) show that the total area of land sales, which is designated for residential purposes only, does not Granger-cause the number of new completions of private housing units, and the new completions of private housing does not Granger-cause the land sale area.\(^{17}\) In other words, simply increasing the land supply, either through auctions or tender [Figure 5], does not guarantee that there will be more private housing available in the market. This observation is further confirmed by the results reported in Table 2b that no strong lead-lag relationship exists between the two variables over ±20 quarters.\(^{18}\) The main “missing piece” is the profit-maximization strategies of real estate developers\(^{19}\) [Lai and Wang (1999)]. In Hong Kong, the new supply of housing is dominated by a few developers. They are large corporations listed on the Hong Kong Stock Exchange. As their policies are to maximize shareholders’ wealth,\(^{20}\) their strategies may not maximize the supply of private housing. Although in the 2010/11 budget speech, the Financial Secretary announced that the government was prepared to specify conditions for land sales, including the minimum number of flats to be constructed and their size restrictions, the developers’ still choose the time in which to complete and sell the units.

[Figures 4 and 5 and Tables 2a and 2b about here]

The agricultural land policy in Hong Kong illustrates how developers may influence the new housing supply. To fully understand the agricultural land policy in Hong Kong, some discussion of the Hong Kong land ownership system may be very helpful. We present a few key points below, and interested readers can refer to the Appendix for further details.

\(^{16}\) In fact, Lai and Wang (1999) have done some related analysis. The results presented here can be interpreted as an update and extension of their research.

\(^{17}\) Among others, see the Local Research Community (2013) for a related analysis.

\(^{18}\) The authors are grateful for an anonymous referee’s suggestion to use Johansen’s cointegration test to study the long-term relationship between LSA and CNPH. However, LSA is a I(0) series and CNPH is a I(1) series. Therefore, this test may not be applicable in this case.

\(^{19}\) For the list of developers in Hong Kong, please refer to Appendix 2.

\(^{20}\) For the behavior and price strategy of developers, refer to Henderson and Thisse (1999), Gillen and Fisher (2002) and Ching and Fu (2003).
After a battle in 1898, the British government, which had already occupied and developed Hong Kong Island for decades, took a 99-year lease on the New Territories. At that time, the New Territories area in sharp contrast with Hong Kong Island.

When the British took over the New Territories, they attempted to understand the land ownership structure and raise taxes. They found a land-ownership system significantly different from their expectations. For instance, as Hase (2006, p. 31) observes, “Besides the fact that there were no accurate survey records and that the district land registers were out of date, it was of even greater concern that much of the tax revenue was in the hands of intermediaries, who collected their rents from those farming the land and forwarded what was due to the authorities.”

Before the British takeover, the New Territories unfortunately experienced hardship due to population growth and “inter-village wars” that led to many casualties, which might have made the native residents more distrustful.

The British takeover was not warmly welcomed, and misunderstandings and fears abounded. Taxes and the Sanitary Board were two important concerns. Some local landlords who had clear vested interests might have encouraged the spread of misunderstandings.

This situation eventually led to the disastrous Six-Day War. Several thousand poorly equipped Chinese villagers surrounded and attacked the well-equipped British Army. Apparently, several hundred Chinese villagers were killed in that war.

To maintain the security of Hong Kong with limited forces, Sir Henry Blake, the British Governor of Hong Kong at that time, adopted a “Forgive and Forget” policy. Blake even established district councils and invited the leaders of the villages to join the councils. Blake’s policy had a long-term effect on Hong Kong.

As a result, although land ownership is technically public in Hong Kong, the government faces several constraints when developing “agricultural land,” which is “effectively owned” by the native people. To develop those lands, the government can directly trade with the locals, obtain the agricultural land, and then ask the Town Planning Board, whose members are appointed by the Hong Kong government, to “convert” agricultural land to commercial and residential land. Alternatively, developers who purchase agricultural land from locals could submit a similar land-use conversion request. Usually, to obtain permission to convert land use, developers need to pay a “land premium” (LP). The exact amount of the LP is decided on a case-by-case basis, and is typically determined in confidential negotiations between the government and the involved developers.
In light of this process, it is relatively easy to understand why although the contribution of agricultural activities to Hong Kong’s GDP has been less than 0.1% since 2000, the share of agricultural land stays above 6% [Figure 6a], with most of the land abandoned [Figure 6b]. The conversion of agricultural land to residential land could potentially increase the housing supply, but a substantial amount of the agricultural land is held by developers. From 2002 to 2011, the agricultural land bank of the four major developers increased from 79.6 million square feet to 101.2 million square feet [Figure 6c]. In this period, about 25% of the abandoned agricultural land was in the hands of developers. Clearly, developers are not interested in agricultural production. They simply wait for the “right market” and then apply for government permission to convert their agricultural land to residential or commercial land. Thus, although the government needs the developers to purchase land and develop new commercial and residential areas, the developers need the government to approve their land use conversion requests, at a “reasonable” LP so that the whole development project remains profitable. The relationship between the government and the major developers may thus be similar to a “bilateral monopoly” economic model. Some time-consuming bargaining is inevitable. Unfortunately, economic science may not be able to provide much useful guidance for that.

Even if both the government and developers agree to increase the new housing supply, there may be additional constraints. As Hong Kong is open to international trade, those constraints come from “non-tradable sectors” of the economy. The first constraint is the supply of land. Severe land use regulations imposed in Hong Kong. In particular, as we have discussed, a substantial amount of land in Hong Kong is classified as “agricultural land” and most of it is held by “native people,” who are given special privileges, including the “New Territories Small House Policy” (SHP). The original idea was to ensure that the descendants of the native people would be given land and the right to build small houses for themselves if the Hong Kong government takes the land for development. However, it has been repeatedly reported that these rights have been abused in different ways, leading to many controversies. According to the results of a survey conducted by Lao (2013), issues surrounding the SHP are still un-resolved. At the same time, both the Hong Kong government and developers need to have a certain level of

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21 The study of bilateral monopolies has a long history in the economics literature. Among others, see Morgan (1949).
22 Clearly, this is an application of the Balassa-Samuelson effect. Among others, see Bardhan et al. (2004) and the reference therein for a discussion.
23 It is well known that land use regulations can lead to severe distortions in the housing market. Among others, Bertaud and Malpezzi (2001) study the case of Malaysia. Leung and Teo (2011) present a multi-region, dynamic, stochastic general equilibrium (DSGE) model to study the general equilibrium impacts of related distortions.
agreement with the native people if they intend to develop more “agricultural land” for residential and commercial purposes. Thus, reaching an agreement with the native people may be an additional issue in the further development of Hong Kong.

The second constraint comes from the labor supply. Clearly, an increase in the housing supply implies an increase in the demand for trained and licensed construction workers. According to the latest consultation document of the Public Engagement Exercise on Population Policy, the number of job vacancies in construction sites rose by 74.3% in June 2013. The document recommends importing workers to complement the existing workforce, but it has received a range of feedback. Although the Labor Advisory Board took action in April 2014 to speed up the importation of workers through the Supplementary Labor Scheme that covers 26 categories of jobs in the construction sector, this may not significantly increase the new housing supply within the next several years. Hence, the increase in new housing supply may be moderate.

3. Housing Affordability

It is not surprising that when the public housing supply cannot meet the demand, the demand will be channeled to the private market. Hence, the “affordability” of private housing becomes a crucial issue [Mukhija (2004); Tiley and Hil (2010); Wang and Murie (2011); Gurran and Whitehead (2011)]. We follow Malpezzi (1999) to provide a benchmark for house prices. Malpezzi’s model relates the changes in house price-to-income ratio to the house price dynamics with several merits. It is simple and easy to implement as it requires only income and house price data. It recognizes that as the house price-to-income ratio deviates from the long-term value, house prices will adjust and the system will eventually return to the long-term value. More specifically, we use the Hong Kong data for the 1980Q2-2009Q1 period as our starting sample. Moving the terminal date one quarter at a time, we then repeatedly re-estimate both the recursive regression model and the rolling regression model, so that the parameters and model-implied real housing prices are estimated. Then, by comparing the actual value with

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26 Leung (2014) shows that Malpezzi’s model can be approximated as the reduced form dynamics derived from a dynamic stochastic general equilibrium model. For the details of the formula, see Appendix 3.

27 According to Clark and McCracken (2009), combining recursive regression (with a sampling period that increases over time) with a rolling regression (with a constant sampling period), can significantly improve forecasting accuracy when the data generation process is (potentially) subject to a structural break. As the Hong Kong housing market may be subject to a “structural break” during the sampling period, we consider it appropriate to use both a recursive and rolling regression.

28 Notice that since model parameters are being updated in each quarter. Thus, relative to the original model of Malpezzi (1999), our econometric model is more “flexible” in at least two dimensions. First, our model allows the house price-to-income ratio to be time-varying. Second, it allows the house price change to be increasingly (or decreasingly) sensitive to the change of house price-to-income ratio. Yet, in spite of these relaxations, our model’s
the implied value in each quarter, we can produce the time plot of the following quantity (in percentage terms):

\[
\frac{\text{Actual real housing price}}{\text{Malpezi's implied real housing price}} - 1
\]

Clearly, a negative (positive) value of this quantity means that the actual house price is smaller (higher) than its model-implied counterpart. Figure 7 illustrates several points clearly. First, our result is robust in the sense that the recursive and rolling regressions achieve the same patterns in the implied quantities. Second, since March 2009, there have been many more quarters with positive values than quarters with negative values, meaning that house prices tend to be higher than those implied by the market fundamentals, even when we allow the coefficients to be time-varying. In fact, the deviations seem to be significant. There are several quarters in which the percentage deviations are more than 6%: 2009Q3, 2010Q3, and 2012Q3. This is consistent with the results of Shiller (2007) that the market fundamentals may not fully explain the movements in housing prices. In fact, Leung and Tang (forthcoming) provide evidence that market sentiment or “animal spirit” is a driving force in the Hong Kong housing market. Again, we are not trying to provide an explanation for this phenomenon. We only intend to establish the “over-pricing of Hong Kong housing” as a stylized fact.

When we perform the Johansen cointegration test for the U.S. real housing price index and real weekly earnings (both are I(1) variables, from Table 3a), the results show a cointegrating relationship (Table 3b). This means that the long-term ratio between the U.S. housing prices and weekly earnings is constant. In the case of Hong Kong, although the variables are also I(1) (Table 3c), the Johansen cointegration test reports that both the Trace statistic and Max-eigen statistic do not exceed the 5% critical values (Table 3d). In other words, the test statistics suggest that there is no constant long-term ratio between the real housing price and real earnings in Hong Kong. This is somewhat at odds with existing economic models, which typically predict the existence of a steady state or some constant long-term value. Thus, there may be significant mispricing in the Hong Kong housing market. To further investigate this mispricing issue, we adopt a few measures to examine whether “housing affordability” in Hong Kong has deteriorated or improved.29

29 Clearly, there are other measures of affordability, for example purchase affordability and repayment affordability, such as Gan and Hill (2009). Unfortunately, to repeat the analysis of Gan and Hill (2009) in the context of Hong Kong would demand detailed information of the income distribution of Hong Kong, which is not accessible to the
According to the cross-country data provided by the CIA, Hong Kong has the second highest population density in the world [Figure 8], and the related problem of the low affordability of housing has been highlighted recently.\footnote{According to Bertaud (2014), comparing with cities in Australia, Canada, Ireland, Japan, New Zealand, the United Kingdom, U.S.A., Hong Kong housing was the least affordable in the year 2013.} As Figure 9a shows, in 2012, an average person in Hong Kong could only purchase 22 square feet of housing with his or her annual income, which is in sharp contrast with the situation in Japan (103 square feet). If we further classify workers according to the nature of their job, it is clear that the problem of unaffordable housing is not restricted to people with low incomes. Figure 9b demonstrates that the annual income of people working at the supervisory level is worth at most 30 square feet of a typical-sized (Classes A, B, and C) flat, or less than 20 square feet of a luxurious (Classes D and E) flat. Not surprisingly, housing affordability is even lower for employees with lower income levels [Figure 9c].

Some commentators have attributed the “unaffordability” of housing to the so-called “high land price policy” (HLPP).\footnote{Although the Hong Kong government has never admitted the existence of such a policy, there are clues that it has at least attempted to maintain land prices above a certain level. For instance, the Policy Address 2008/2009 (Paragraph 34) explicitly states that land will never be sold below market value.} According to this explanation, the government deliberately sells land at a high price. In fact, the proceeds from land sales\footnote{For the share of land revenue under different disposal types, please refer to Appendix 4.} are one of the major sources of government revenue. In the fiscal year 2012/2013, the \textit{Lp}\footnote{The premiums from land transactions are credited to the Capital Works Reserve Fund. The Fund can only be used in land acquisition, public works programs, capital subventions, and major systems, equipment, and computerization. For details, please refer to the link: \url{www.budget.gov.hk/2012/eng/pdf/cwrf_mem.pdf}} shares were 15.7\% of the total government revenue, followed by profits taxes [Figure 10a]. As a result, high land prices could be translated into the high selling price of private units.

Although this explanation may sound intuitive, and it is popular among certain groups, it may not be the complete economic explanation. There are several issues to be addressed. First, as shown in Table 4, land sales do not Granger-cause real housing prices.\footnote{See Tse (1988) for a similar finding.} Thus, even if the Hong Kong government does practice a HLPP, it is not clear whether high land prices are translated into high house prices. Second, as the Hong Kong government has limited land reserves, selling the land at a slow rate (and hence a high price) may not be a bad policy. The situation is
analogous to an oil oligopoly that has limited oil reserves and thus attempts to maximize the present value of the profit. The optimal strategy could indeed be selling a small amount of oil in each period of time, letting the demand drive up the price, and thus maximizing profit (Loury, 1986). Moreover, Figure 10b shows that one of the major public expenditures is housing, in the form of below-market-rate public rental housing and subsidized ownership. If real estate constitutes a large fraction of most people’s life-time wealth, then more people will demand public housing and subsidized ownership, which in turn increases the government’s burden. As the Hong Kong government is constrained by the Basic Law to maintain a balanced budget, the incentive for a rational government to maintain an “excessively high land price” could be over-estimated.

[Figures 10a and 10b about here]

We consider two alternative explanations for the “unaffordability” of housing in Hong Kong. First, we conjecture that the developers may be responsible for the high house price in Hong Kong. We follow Glaeser and Gyourko (2008) in using the price-to-cost ratio as a measure of the profit margin of developers. We find that the annual growth rate of price-to-cost ratio over time is always positive [Figure 11a], except for the periods after the Asian financial crisis and the global financial crisis (GFC). This suggests that for every dollar of building cost, developers are charging increasing housing prices.

To shed further light on this issue, we attempt to study the relationship between developers’ stock prices and housing prices. As the real stock prices of the four major developers are positively correlated [Table 5], we use principal component analysis to extract the “common factor” in the different developers’ stock prices. Clearly, PC1 explains most of the variation [Table 6], and it is positively and significantly related to stock prices [Table 7]. The Granger causality results in Table 8 show that PC1 is Granger-caused by real housing prices. There is also a feedback effect such that PC1 Granger-causes real housing prices. As a robustness check, the analysis is repeated for the other six developers, and the same conclusion is reached. In summary, the stock performances of the major developers’ stocks are tied closely to real housing prices. High house prices benefit the stock prices. In light of this, it is unlikely that the profit-maximizing developers would have much incentive to build affordable housing units.

35 This is consistent with Shih’s theory of Hong Kong’s housing policy. According to Shih (2014), the British government did not devote many resources to the development of Hong Kong. It thus needed to establish the colony as a low income tax and virtually free-trade port. Hence, to finance any public expenditures, the government now needs to sell land at a high price.

36 Clearly, whether the Hong Kong government is “rational” in the sense of economics is beyond the scope of this study. We thank some anonymous friends for this qualification.

37 Following Leung and Tang (2012), we designate the periods for the Asian financial crisis and global financial crisis as December 1997 and September 2008, respectively.
Our second conjecture is related to income inequality. Glaeser and Gyourko (2008, p. 16) argue that "combining income and housing costs in a single affordability metric is a bad idea because it confuses issues of income inequality with problems in the housing market". According to their calculations, people earning minimum wage would not have much after paying rent and basic consumption. Thus, part of the “observed housing unaffordability” problem may be due to the fact that the income of certain groups in the society cannot keep pace with the aggregate output trend. This conjecture is consistent with the recent literature in macroeconomics. Among others, Krusell et al. (2000) argue that capital goods are complementary to skilled labor and as the relative price of capital goods (including computers) continues to drop, the “college premium” increases and the income gap between those who are college educated and those who are not widens. Duffy et al. (2004) confirm this hypothesis with panel data from more than 70 countries.38

Unfortunately, the official data for the study of income inequality is limited in Hong Kong.39 Here we adopt the ratio between the official wage index and the per capita GDP. The idea is that if wages can somehow keep pace with the aggregate GDP trend, that ratio would remain more or less constant. Formally, we can in fact prove the following proposition. (The proof can be found in Appendix 5.)

**Proposition 1:**40

If the aggregate production of an economy is characterized by an aggregate Cobb-Douglas function as in much of the macroeconomics literature, \( Y = A \left( K \right)^\alpha \left( N \right)^{1-\alpha} \), where \( Y \) is the aggregate output, \( A \) is the productivity, \( K \) is the aggregate capital, \( N \) is the aggregate labor inputs, and the factor markets are perfectly competitive, then the ratio of the wage rate to per capita real GDP, \( w / \left( Y / N \right) \), is a constant.

Notice that this result holds whether the productivity is a constant or a random variable. With this theoretical benchmark, we plot the empirical counterpart of this ratio in Figure 11b.

According to the graph, the ratio drops from unity (baseline value at 1982) to less than half. It seems reasonable to conclude that income inequality in Hong Kong is indeed widening.41 Some

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38 Among others, see Acemoglu (2002) and Hornstein et al. (2007) for related analyses.

39 Among others, see Lui (2011) for a related analysis.

40 Since the Nobel-winning work of Kydland and Prescott (1982), the aggregate production function is typically assumed to be Cobb-Douglas for a variety of reasons. Among others, see Cooley (1995), Davis (2009), King and Rebelo (1999), and Ljungqvist and Sargent (2000, 2007) for more discussion.
research questions remain open: (1) how does this affect the housing market? and (2) what should the corresponding optimal policy be? We are unable to address these questions here, and can only suggest they be examined in future research.

4. Housing Price Volatility

The third issue we consider is housing market volatility, which has received much attention recently. For example, Leung and Teo (2011) note that differences in supply elasticities can be used to explain the differences in house price volatility. In particular, they find that supply elasticity is negatively and significantly related to housing volatility in major U.S. cities. The idea is very simple. If housing supply elasticity is low when prices are low, then most of the adjustments in housing markets would occur when the market are affected by shocks. Therefore, when we compare the volatility of housing prices across cities, we should consider the potential differences in supply elasticities.

Unfortunately, for most Asian economies, comparable time series of house prices are not publicly available. Perhaps more importantly, we need to a statistical relationship between supply elasticity and the volatility of the housing price among cities comparable to Hong Kong, so that we can determine whether the housing price volatility in Hong Kong is “too high” given her supply elasticity. Hence, comparing Hong Kong with another Asian city would not be suitable for our purposes. We thus use the relationship that has been identified in major U.S. cities. Although Hong Kong is clearly not an American city, there are some similarities. For example, like many American cities, Hong Kong has high levels of maturity and transparency, and a large listed real estate market. Interestingly, Hong Kong fits reasonably well in the statistical relationship identified by Leung and Teo (2011). We thus use the monthly real estate data from 1993 to 2011 and calculate the supply elasticity of the Hong Kong housing market as 0.76 and its house price volatility as 8.37%. Based on Leung and Teo’s (2011) estimation, an American city with a supply elasticity of 0.76 would be associated with a volatility is 7.90%, which is close to the actual house price volatility of Hong Kong. Figure 12 shows that if Hong

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41. Thus, our result is also consistent with the findings of Karabarounis and Neiman (2013) regarding major economies.
42. For instance, see Leung, Cheung, and Tang (2013) for the decomposition of volatility in the Hong Kong housing market and the references therein.
43. See Glaeser et al. (2005), Green et al. (2005), Saiz (2010), and Davidoff (2013) for discussions of supply elasticities and housing price movements.
44. Clearly, there are other studies that compare Hong Kong with U.S. cities. See, for instance, Chang et al. (2013) for an analysis on how shocks in the U.S. affect the GDP and asset markets in Hong Kong.
45. Among others, see Newell et al. (2004) for details.
46. Please refer to Appendix 6 for computations.
Kong were an American city, it would fit well in the regression line given in Leung and Teo. The result is even better if we remove Atlanta from the regression.\(^47\) Thus, the housing market of Hong Kong is not suffering from excessive volatility, despite the comments in the media.\(^48\)

5. Conclusions

This paper has examined three aspects of the Hong Kong housing market: availability, affordability, and volatility. Examining availability is relatively straightforward. Section 2 presents evidence suggesting that there is a “housing shortage” in both the public and private housing markets. The number of outstanding applications for public rental houses has reached 229,000 cases, whereas the expected number of new completed units remains 20,000 a year. The waiting time is clearly much longer than the official target. The number of new private units

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\(^{47}\) Details will be provided upon request.

\(^{48}\) Historically, the Hong Kong government has attempted to stabilize housing prices. In 2002, housing was in a trough. The government launched nine measures aimed at providing public rental houses to those in need, reducing direct participation in the private housing market, and improving transparency in the market. Together with the Individual Travel Scheme in 2003, the housing market started to recover. In fact, similar stabilizing measures have also been implemented in Hong Kong. For details, please refer to the document (Chinese only): [www.legco.gov.hk/yr03-04/chinese/sec/library/0304fs01c.pdf](http://www.legco.gov.hk/yr03-04/chinese/sec/library/0304fs01c.pdf). According to Stephens (2012a and 2012b), the U.K. government has also attempted to identify the root causes of volatility, create a sustainable housing market, and protect homeowners from high volatility.

\(^{49}\) See Yiu, Yu, and Jin (2013) for the identification of bubbles in the Hong Kong property market.

\(^{50}\) The rates of the Special Stamp Duty are available at: [http://www.ird.gov.hk/eng/faq/ssd.htm](http://www.ird.gov.hk/eng/faq/ssd.htm). For a formal analysis of how the Stamp Duty affects the housing market, see Leung, Leung, and Tsang (forthcoming), among others.
has recently been below 20,000 units annually, suggesting that there may be an “excess demand.”

As the land ownership in Hong Kong is public, it is tempting to conclude that if the government increases the land supply, the housing supply issue (i.e., availability) will be solved. Unfortunately, our econometric findings suggest that even if the government increases land sales, the new housing supply may not be increased, because building more housing units and making them more affordable may not be consistent with the profit-maximizing objective of the real estate developers.

How then can the Hong Kong government increase the availability of housing units? Several strategies have been proposed. Wong (1998, 2013) suggests that current practices, such as the lack of means testing, could create a mismatch between public housing units and tenants. Therefore, Wong suggests privatizing the public housing units to improve their market efficiency and even the wealth of the residents.51 Alternatively, to modify the “hold and wait” behavior of developers, some commentators suggest specifying in the land sale documents a maximum period of time during which private developers must build a specific number of units.52 The government may also need to provide incentives for more labor in the construction sector, so that the official target of completing 470,000 housing units in ten years can be met.

Clearly, the lack of housing tends to drive up house prices, and if income distribution is uneven, unaffordability can become an issue. We argue that a high land price policy is not the crucial factor that makes private housing unaffordable. There are other agents in the housing market. For instance, as suggested by Ortalo-Magné and Prat (2014), among others, homeowners may have incentives to keep housing units unaffordable to outsiders. Our study provides evidence that the unaffordability of housing units may come from developers’ strategies. The objective of developers is to maximize shareholders’ profit, and hence the developers may lack incentives to sell housing units at “affordable prices.” The fact that the average wage does not keep pace with the aggregate GDP may also suggest a widening of income inequality, which causes housing units to be unaffordable to a growing proportion of the population. Although the government might develop policies that encourage developers to provide private units at affordable prices, it is much harder for the government of a small open economy to resist the global trend of increasing income inequality.

Finally, if the limited housing supply is persistent, it can magnify the volatility issue. Hong Kong has a small open economy and hence is subject to different kinds of international shocks. For

51 Based on Ortalo-Magne and Rady (2006), Ho and Wong (2006) discuss the potentially negative side of the privatization of public housing in Hong Kong.
52 It is well known that developers may wait to develop when facing stochastic prices. Among others, see Wang and Zhou (2006) for a formal analysis.
instance, a sudden and significant inflow of capital can drive up the housing demand and as housing is non-tradable, house prices can only increase to clear the market. If the housing supply elasticity is low, the extent to which house prices need to increase is even higher. In fact, the Hong Kong housing market has experienced peaks and troughs in the past two decades. To minimize the swings in the housing market, the government has implemented countercyclical measures to stabilize the market. Given the supply elasticity of the Hong Kong housing market, we find that the actual housing price volatility in Hong Kong is comparable to that in American cities. In that sense, the Hong Kong housing market is functioning well. Thus, if the Hong Kong government intends to lower housing price volatility, attention should be shifted to policy measures that can increase the elasticity of the supply of housing. Whether this is worth pursuing, and if so, how it can be achieved, is a question for future research.

Obviously, several issues are left unexplored in this study. For instance, given that small and medium size enterprises constitute a large number of firms in Hong Kong, and many of these entrepreneurs use their personal homes as collateral, how the macroeconomy might be distorted? what is the optimal housing and land use policy? Furthermore, will the housing policy need to be adjusted if the global trend of increasing income inequality persists? We believe that future research would provide more guidance to these issues.

Acknowledgement:
We are grateful to the comments and suggestions from an anonymous referee, Paul Anglin, Shaum Bond, Wing Hong Chan, Nan-Kuang Chen, Yan Dong, John Glascock, Yifan Gong, Richard Green, Daisy Huang, Rose Lai, Hongyu Liu, Lok Sang Ho, Vikas Kakkar, Steve Malpezzi, Tim Riddiough, Isabel Yan, Zan Yang, Abdullah Yavas, Matthew Yiu, seminar participants of HKSAR Government Bureau of Education Seminar on Housing Market (2012), Hong Kong Economic Association Forum 2012, Christian Economists Roundtable 2013, Southwest University of Finance and Economics (Cheng Du, China), 2013 Tsinghua workshop on Real Estate and Consumption, City University students in the EF4490, EF4491 class, and the financial support of City University of Hong Kong. The usual disclaimer applies.

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53 Among others, see Jin and Zeng (2007) and Chen and Leung (2008) for more analysis.
54 Among others, see Leung (2204) for a non-technical discussion of the early macro-housing literature.
Figures and Tables

Figure 1a Real Housing Price Index (Dec 1979 = 100)

Sources: Rating and Valuation Department and Census and Statistics Department, Hong Kong SAR government.
Figure 1b Time plot of housing price index relative to wage index

Sources: Rating and Valuation Department and Census and Statistics Department, Hong Kong SAR government; International Monetary Fund; Federal Housing Finance Agency.
Figure 1c Land Utilization in Hong Kong

Source: Planning Department, Hong Kong SAR government.
Figure 1d Composition of New Housing Units

Key: Class A – Flats with a saleable area smaller than 400 square feet; Class B – Flats with a saleable area from 400 to 699 square feet; Class C – Flats with a saleable area from 700 to 999 square feet; Class D – Flats with a saleable area from 1000 to 1599 square feet; Class E – Flats with a saleable area larger than 1600 square feet.

Source: Rating and Valuation Department, Hong Kong SAR government.
Figure 2: Housing Units Relative to Number of Households

Source: Census and Statistics Department, Hong Kong SAR government.
Figure 3 Domestic Households by Type of Housing

*Source: Census and Statistics Department, Hong Kong SAR government.*
Figure 4 Completions of Private Housing Units

Source: Rating and Valuation Department, Hong Kong SAR government.
Figure 5 Land Sale by Area

Key: SA – Scheduled Auction; ALA – Application List Auction; TEN – Tender; AB – Letter A/B

Source: Lands Department, Hong Kong SAR government.

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55 See Appendix 1 for details.
Figure 6a Share of Agricultural Land and Value of Agricultural and Fishing Industry (As a Share of GDP)

Sources: Census and Statistics Department and Planning Department, Hong Kong SAR government.
Figure 6b Agricultural land Utilization

Source: Agriculture, Fisheries and Conservation Department, Hong Kong SAR government.
Figure 6c Agricultural Land Holding

Year 2002 (79,674,300 sq. ft.)
- 28.33%
- 28.62%
- 28.66%

Year 2011 (101,230,020 sq. ft.)
- 19.63%
- 41.39%
- 26.97%
- 12.32%

Source: Hong Kong Exchanges and Clearing Limited
Figure 7 Percentage deviation of the actual real house price relative to the model-implied real house price

Source: Authors’ calculations
Figure 8 Population Densities across Countries (People per Square Kilometers of Land)

<table>
<thead>
<tr>
<th>Country</th>
<th>Population Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Singapore</td>
<td>7,000</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>7,000</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>6,000</td>
</tr>
<tr>
<td>Taiwan</td>
<td>4,000</td>
</tr>
<tr>
<td>South Korea</td>
<td>3,000</td>
</tr>
<tr>
<td>West Bank</td>
<td>2,000</td>
</tr>
<tr>
<td>Rwanda</td>
<td>2,000</td>
</tr>
<tr>
<td>Netherlands</td>
<td>2,000</td>
</tr>
<tr>
<td>Lebanon</td>
<td>2,000</td>
</tr>
<tr>
<td>Burundi</td>
<td>2,000</td>
</tr>
<tr>
<td>India</td>
<td>2,000</td>
</tr>
<tr>
<td>Israel</td>
<td>2,000</td>
</tr>
<tr>
<td>Haiti</td>
<td>2,000</td>
</tr>
<tr>
<td>Philippines</td>
<td>2,000</td>
</tr>
<tr>
<td>Belgium</td>
<td>2,000</td>
</tr>
<tr>
<td>Japan</td>
<td>2,000</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>2,000</td>
</tr>
<tr>
<td>Puerto Rico</td>
<td>2,000</td>
</tr>
<tr>
<td>El Salvador</td>
<td>2,000</td>
</tr>
<tr>
<td>Vietnam</td>
<td>2,000</td>
</tr>
</tbody>
</table>

Source: CIA World Factbook (2012)
Figure 9a The Purchasing Power of Annual Income (in terms of square feet of flat)

Sources: CEIC
Figure 9b The Purchasing Power of Annual Income (for workers in supervisory level)

(in terms of square feet of flat)

Key: Class A – Flats with a saleable area smaller than 400 square feet; Class B – Flats with a saleable area from 400 to 699 square feet; Class C – Flats with a saleable area from 700 to 999 square feet; Class D – Flats with a saleable area from 1000 to 1599 square feet; Class E – Flats with a saleable area larger than 1600 square feet

Sources: Census and Statistics Department; Rating and Valuation Department, Hong Kong SAR government.
Figure 9c The Purchasing Power of Annual Income (for low level of workers)

(in terms of square feet of flat)

Key: Class A – Flats with a saleable area smaller than 400 square feet; Class B – Flats with a saleable area from 400 to 699 square feet; Class C – Flats with a saleable area from 700 to 999 square feet; Class D – Flats with a saleable area from 1000 to 1599 square feet; Class E – Flats with a saleable area larger than 1600 square feet

Sources: Census and Statistics Department; Rating and Valuation Department, Hong Kong SAR government.
Figure 10a Components of Government Revenue

Source: Census and Statistics Department, Hong Kong SAR government.
Figure 10b Public Expenditure by Policy Area Group

Source: Census and Statistics Department, Hong Kong SAR government.
Figure 11a Annual Growth Rate of Price-to-Cost Ratio

Sources: Civil Engineering and Development Department; Census and Statistics Department, Hong Kong SAR government.
Figure 11b Ratio of the official wage index relative to the per capita GDP (Rebased as unity at the year 1982)

Sources: Census and Statistics Department, Rating and Valuation Department, Hong Kong SAR government.
Figure 12 Scatter Plot of Housing Volatility and Supply Elasticity
### Table 1 Number of Applications for Public Rental Housing

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Public Rental Housing Applications</th>
<th>New Public Rental Housing Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000/2001</td>
<td>108,400</td>
<td>46,756</td>
</tr>
<tr>
<td>2001/2002</td>
<td>86,400</td>
<td>29,817</td>
</tr>
<tr>
<td>2002/2003</td>
<td>91,900</td>
<td>20,390</td>
</tr>
<tr>
<td>2003/2004</td>
<td>91,000</td>
<td>15,148</td>
</tr>
<tr>
<td>2004/2005</td>
<td>91,400</td>
<td>24,682</td>
</tr>
<tr>
<td>2005/2006</td>
<td>97,400</td>
<td>17,153</td>
</tr>
<tr>
<td>2006/2007</td>
<td>107,300</td>
<td>7,192</td>
</tr>
<tr>
<td>2007/2008</td>
<td>111,600</td>
<td>13,726</td>
</tr>
<tr>
<td>2008/2009</td>
<td>114,400</td>
<td>19,050</td>
</tr>
<tr>
<td>2009/2010</td>
<td>129,100</td>
<td>15,389</td>
</tr>
<tr>
<td>2010/2011</td>
<td>152,400</td>
<td>13,672</td>
</tr>
<tr>
<td>2011/2012</td>
<td>189,000</td>
<td>11,186</td>
</tr>
<tr>
<td>2012/2013</td>
<td>229,000</td>
<td>13,114</td>
</tr>
</tbody>
</table>

*Source: Hong Kong Housing Authority, Hong Kong SAR government.*
Table 2a Granger Causality between Land Sale Area (LSA) and Completions of New Private Housing (CNPH) (F-statistics)

(Sampling period: 1980Q4 – 2013Q1)

<table>
<thead>
<tr>
<th>Lag</th>
<th>LSA does not granger cause CNPH</th>
<th>CNPH does not granger cause LSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.016</td>
<td>1.773</td>
</tr>
<tr>
<td>2</td>
<td>0.843</td>
<td>1.949</td>
</tr>
<tr>
<td>3</td>
<td>0.796</td>
<td>1.434</td>
</tr>
<tr>
<td>4</td>
<td>0.975</td>
<td>0.939</td>
</tr>
<tr>
<td>8</td>
<td>0.877</td>
<td>0.962</td>
</tr>
<tr>
<td>12</td>
<td>0.809</td>
<td>0.964</td>
</tr>
</tbody>
</table>

Note: The cyclical components are used. ***, ** and * denote 1%, 5% and 10% significance respectively.

Table 2b Lead lag-table between Land Sale Area (LSA) and Completions of New Private Housing (CNPH)

(Sampling period: 1980Q4 – 2013Q1)

<table>
<thead>
<tr>
<th></th>
<th>CNPH(-20)</th>
<th>CNPH(-16)</th>
<th>CNPH(-12)</th>
<th>CNPH(-8)</th>
<th>CNPH(-4)</th>
<th>CNPH(-3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LSA</td>
<td>-0.130</td>
<td>-0.055</td>
<td>-0.025</td>
<td>0.145</td>
<td>0.101</td>
<td>-0.097</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>CNPH(-2)</th>
<th>CNPH(-1)</th>
<th>CNPH</th>
<th>CNPH(+1)</th>
<th>CNPH(+2)</th>
<th>CNPH(+3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LSA</td>
<td>0.059</td>
<td>0.102</td>
<td>0.168</td>
<td>-0.026</td>
<td>-0.109</td>
<td>0.027</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>CNPH(+4)</th>
<th>CNPH(+8)</th>
<th>CNPH(+12)</th>
<th>CNPH(+16)</th>
<th>CNPH(+20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LSA</td>
<td>-0.007</td>
<td>0.131</td>
<td>0.202</td>
<td>0.160</td>
<td>0.140</td>
</tr>
</tbody>
</table>

Note: The cyclical components are used.
Table 3a Unit root test of real housing price index and real weekly earnings for the United States

(Sampling period: 1979Q1 – 2013Q4)

<table>
<thead>
<tr>
<th></th>
<th>Level (trend and intercept)</th>
<th>1st difference (trend)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real housing price</td>
<td>-3.344</td>
<td>-2.892 **</td>
</tr>
<tr>
<td>(seasonally adjusted)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Real weekly earnings</td>
<td>-3.314</td>
<td>-13.56 ***</td>
</tr>
<tr>
<td>(seasonally adjusted)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The optimum lag is determined by AIC criteria at a maximum lag of 4 quarters.

*** significant at 1% level; ** significant at 5% level

Table 3b Johansen cointegration test between real housing price index and real weekly earnings for the United States

(Sampling period: 1970Q1 – 2013Q4)

(i) Unrestricted cointegration rank test (Trace)

<table>
<thead>
<tr>
<th>Hypothesized number of cointegrating equation</th>
<th>Trace statistic</th>
<th>5% critical value</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>20.85</td>
<td>15.49</td>
</tr>
<tr>
<td>At most 1</td>
<td>1.72</td>
<td>3.84</td>
</tr>
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</table>

(ii) Unrestricted cointegration rank test (Maximum Eigenvalue)

<table>
<thead>
<tr>
<th>Hypothesized number of cointegrating equation</th>
<th>Max-eigen statistic</th>
<th>5% critical value</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>19.13</td>
<td>14.26</td>
</tr>
<tr>
<td>At most 1</td>
<td>1.72</td>
<td>3.84</td>
</tr>
</tbody>
</table>
Table 3c Unit root test of real housing price index and real wage index for Hong Kong
(Sampling period: 1982Q1 – 2013Q4)

<table>
<thead>
<tr>
<th></th>
<th>Level (trend and intercept)</th>
<th>1st difference (trend)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real housing price index</td>
<td>-1.884</td>
<td>-5.941***</td>
</tr>
<tr>
<td>(not seasonally adjusted)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Real wage index</td>
<td>-1.764</td>
<td>-3.658***</td>
</tr>
<tr>
<td>(not seasonally adjusted)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The optimum lag is determined by AIC criteria at a maximum lag of 4 quarters.

*** significant at 1% level; ** significant at 5% level

Table 3d Johansen cointegration test between real housing price index and real wage index for Hong Kong
(Sampling period: 1979Q4 – 2013Q4)

(i) Unrestricted cointegration rank test (Trace)

<table>
<thead>
<tr>
<th>Hypothesized number of cointegrating equation</th>
<th>Trace statistic</th>
<th>5% critical value</th>
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</thead>
<tbody>
<tr>
<td>None</td>
<td>3.403</td>
<td>15.49</td>
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</table>

(ii) Unrestricted cointegration rank test (Maximum Eigenvalue)

<table>
<thead>
<tr>
<th>Hypothesized number of cointegrating equation</th>
<th>Max-eigen statistic</th>
<th>5% critical value</th>
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<tbody>
<tr>
<td>None</td>
<td>3.347</td>
<td>14.26</td>
</tr>
</tbody>
</table>
Table 4 Granger Causality between Land Sale Area (LSA) and Real Housing Price (RHP) (F-statistics)
(Sampling period: 1980Q4 – 2013Q1)

<table>
<thead>
<tr>
<th>Lag</th>
<th>LSA does not granger cause RHP</th>
<th>RHP does not granger cause LSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.319</td>
<td>3.079 *</td>
</tr>
<tr>
<td>2</td>
<td>0.299</td>
<td>2.355 *</td>
</tr>
<tr>
<td>3</td>
<td>0.290</td>
<td>1.686</td>
</tr>
<tr>
<td>4</td>
<td>0.521</td>
<td>1.565</td>
</tr>
<tr>
<td>8</td>
<td>0.463</td>
<td>1.180</td>
</tr>
<tr>
<td>12</td>
<td>0.360</td>
<td>1.239</td>
</tr>
</tbody>
</table>

Note: The cyclical components are used. ***, ** and * denote 1%, 5% and 10% significance respectively.
Table 5 Correlations among developers’ stock

(1983Q1 – 2013Q1)

Panel A: 4 main developers

<table>
<thead>
<tr>
<th></th>
<th>CH</th>
<th>HEN</th>
<th>NWD</th>
<th>SHK</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HEN</td>
<td>0.761***</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NWD</td>
<td>0.622***</td>
<td>0.841***</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>SHK</td>
<td>0.870***</td>
<td>0.916***</td>
<td>0.768***</td>
<td>1</td>
</tr>
</tbody>
</table>

Key: CKH = Cheung Kong (Holdings) Limited; HEN = Henderson Land Development Company Limited; SHK = Sun Hung Kai Properties Limited; NWD = New World Development

Panel B: Other 6 developers

<table>
<thead>
<tr>
<th></th>
<th>HL</th>
<th>HOPE</th>
<th>HUT</th>
<th>HYS</th>
<th>SINO</th>
<th>WH</th>
</tr>
</thead>
<tbody>
<tr>
<td>HL</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HOPE</td>
<td>0.533***</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HUT</td>
<td>0.434***</td>
<td>0.387***</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HYS</td>
<td>0.542***</td>
<td>0.624***</td>
<td>0.584***</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SINO</td>
<td>0.782***</td>
<td>0.632***</td>
<td>0.557***</td>
<td>0.625***</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>WH</td>
<td>0.707***</td>
<td>0.629***</td>
<td>0.563***</td>
<td>0.845***</td>
<td>0.670***</td>
<td>1</td>
</tr>
</tbody>
</table>

Key: HL = Hang Lung Properties Limited; HOPE = Hopewell Holdings Limited; HUT = Hutchison Whampoa Property; HYS = Hysan Development Company Limited; SINO = Sino Land; WH = Wharf Holdings Limited

Note: The cyclical components are used. ***, ** and * denote 1%, 5% and 10% significance respectively.
### Table 6 Explanatory Power of Principal Components

Panel A: 4 main developers

<table>
<thead>
<tr>
<th></th>
<th>Proportion explained</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC1-A</td>
<td>84.90%</td>
</tr>
<tr>
<td>PC2-A</td>
<td>10.09%</td>
</tr>
<tr>
<td>PC3-A</td>
<td>3.63%</td>
</tr>
<tr>
<td>PC4-A</td>
<td>1.39%</td>
</tr>
</tbody>
</table>

Panel B: Other 6 developers

<table>
<thead>
<tr>
<th></th>
<th>Proportion explained</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC1-B</td>
<td>67.71%</td>
</tr>
<tr>
<td>PC2-B</td>
<td>10.90%</td>
</tr>
<tr>
<td>PC3-B</td>
<td>9.25%</td>
</tr>
<tr>
<td>PC4-B</td>
<td>6.90%</td>
</tr>
<tr>
<td>PC5-B</td>
<td>3.43%</td>
</tr>
<tr>
<td>PC6-B</td>
<td>1.81%</td>
</tr>
</tbody>
</table>

### Table 7 Principal Components

Panel A: 4 main developers

<table>
<thead>
<tr>
<th></th>
<th>PC 1-A</th>
<th>PC 2-A</th>
<th>PC 3-A</th>
<th>PC 4-A</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH</td>
<td>0.479</td>
<td>-0.724</td>
<td>0.491</td>
<td>0.280</td>
</tr>
<tr>
<td>HEN</td>
<td>0.519</td>
<td>0.188</td>
<td>-0.587</td>
<td>0.592</td>
</tr>
<tr>
<td>NWD</td>
<td>0.475</td>
<td>0.689</td>
<td>0.538</td>
<td>-0.102</td>
</tr>
<tr>
<td>SHK</td>
<td>0.525</td>
<td>-0.197</td>
<td>-0.354</td>
<td>-0.749</td>
</tr>
</tbody>
</table>

Panel B: Other 6 developers

<table>
<thead>
<tr>
<th></th>
<th>PC 1-B</th>
<th>PC 2-B</th>
<th>PC 3-B</th>
<th>PC 4-B</th>
<th>PC 5-B</th>
<th>PC 6-B</th>
</tr>
</thead>
<tbody>
<tr>
<td>HL</td>
<td>0.405</td>
<td>-0.415</td>
<td>0.510</td>
<td>-0.236</td>
<td>0.415</td>
<td>0.420</td>
</tr>
<tr>
<td>HOPE</td>
<td>0.382</td>
<td>-0.336</td>
<td>-0.533</td>
<td>0.622</td>
<td>0.262</td>
<td>0.037</td>
</tr>
<tr>
<td>HUT</td>
<td>0.348</td>
<td>0.775</td>
<td>0.301</td>
<td>0.361</td>
<td>0.238</td>
<td>0.032</td>
</tr>
<tr>
<td>HYS</td>
<td>0.427</td>
<td>0.243</td>
<td>-0.427</td>
<td>-0.362</td>
<td>-0.398</td>
<td>0.536</td>
</tr>
<tr>
<td>SINO</td>
<td>0.431</td>
<td>-0.231</td>
<td>0.380</td>
<td>0.244</td>
<td>-0.691</td>
<td>-0.285</td>
</tr>
<tr>
<td>WH</td>
<td>0.448</td>
<td>0.050</td>
<td>-0.197</td>
<td>-0.487</td>
<td>0.260</td>
<td>-0.673</td>
</tr>
</tbody>
</table>
Table 8 Granger Causality between PC1 and Real Housing Price (F-statistics)

Panel A: 4 main developers

<table>
<thead>
<tr>
<th>Lag</th>
<th>PC1-A does not granger cause Real Housing Price</th>
<th>Real Housing Price does not granger cause PC1-A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>25.96 ***</td>
<td>9.287 ***</td>
</tr>
<tr>
<td>2</td>
<td>5.972 ***</td>
<td>5.864 ***</td>
</tr>
<tr>
<td>3</td>
<td>3.639 **</td>
<td>5.527 ***</td>
</tr>
<tr>
<td>4</td>
<td>2.718 **</td>
<td>4.174 ***</td>
</tr>
<tr>
<td>8</td>
<td>4.748 ***</td>
<td>3.033 ***</td>
</tr>
<tr>
<td>12</td>
<td>3.859 ***</td>
<td>1.782 *</td>
</tr>
</tbody>
</table>

Panel B: Other 6 developers

<table>
<thead>
<tr>
<th>Lag</th>
<th>PC1-B does not granger cause Real Housing Price</th>
<th>Real Housing Price does not granger cause PC1-B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>14.61 ***</td>
<td>5.172 **</td>
</tr>
<tr>
<td>2</td>
<td>5.568 ***</td>
<td>3.416 **</td>
</tr>
<tr>
<td>3</td>
<td>3.698 **</td>
<td>3.559 **</td>
</tr>
<tr>
<td>4</td>
<td>2.667 **</td>
<td>2.851 **</td>
</tr>
<tr>
<td>8</td>
<td>3.318 ***</td>
<td>2.392 **</td>
</tr>
<tr>
<td>12</td>
<td>2.730 ***</td>
<td>1.534</td>
</tr>
</tbody>
</table>

Note: *** , ** and * denote 1%, 5% and 10% significance respectively.
References


Appendix

The appendix consists of several parts.

- Appendix 1 provides a detailed description about the letter A/B in land exchange.
- Appendix 2 provides the major listed developers in Hong Kong. Their stock codes and market capitalization (as at 6 June 2013) are also shown.
- Appendix 3 expands the formula of Malpezzi (1999) model.
- Appendix 4 shows the time plot of revenues from different land disposal types.
- Appendix 5 provides the proof of Proposition 1.
- Appendix 6 shows the calculation method of supply elasticity.
Appendix 1 Description of Letter A/B

Letter A/B actually is a kind of land exchange. These Letters A/B were first issued by the government as an alternative to cash compensation when private land was to be resumed in the New Town Development Areas of the New Territories. It aimed at speeding up acquisition of private land for public purposes by avoiding lengthy arguments over the level of compensation and cash payments and large outflow of cash. However, the system has not solved the ultimate problem because of shortage of land in Hong Kong. Therefore, this system was stopped (no letter A/B was offered any longer) on 8 March 1983. This system was first used to form part of the Tsuen Wan New Town.

In the old days, with the increase in population and expansion of urban area, much of the land is urgently required for public purpose such as for road widening, community buildings or public housing schemes. However, a considerable amount of land being selected for the new town development was in private ownership. A novel system of land exchange was evolved which enabled the local inhabitants and landowners to retain an interest in the development of new town.

'Letter A' was issued by the government when private land was urgently required needed for public purposes and the land owners voluntarily surrender the land with vacant possession without going through the statutory resumption.

'Letter B' was offered to the land owners already affected by a Gazette Notice of resumption under Cap. 124 a choice of either cash payment or an entitlement to future grant of land.

Both 'Letter A' and 'Letter B' can be exchanged for building land, residential or industrial, at any time when suitable land becomes available by payment of a premium based upon the difference in value of the agricultural land surrendered and the building land selected. 2 sq. feet of building land can be exchanged for every 5 sq. feet of agricultural land that is surrendered. For building land, the ratio is one to one.
The bidder that submitted, in aggregate terms, the oldest Letter A/B calculated backwards from the date of closing the tender to the operative date of the Letter A/B surrendered would be awarded with the tender site.

In mid 1947 there was an outstanding land entitlement of between 420000 and 470000 sq. metres of building land in the form of 'letter B'. Because of the huge amount of land area accumulated from 'Letter A/B', the government should take some actions to speed up the clearance of the commitments for 'Letter A/B'. In 1984, it was announced that a number of New Territories related land transactions e.g. the payment of modification premia, building covenants extensions, and short-term-tenancy rent can be paid for by the surrender of 'Letter A/B' in lieu of cash.

Later in June 1997, the government enacted the New Territories Land Exchange Entitlements (Resumption) Ordinance to provide for the payment of redemption money in respect of land exchange entitlements to the Letter A/B owners, and for the extinguishment of their rights against the government under such documents to a future land exchange. Nowadays, there is no more Letter A/B.

Source: Department of Real Estate and Construction, University of Hong Kong (http://rec.hku.hk/hkbuilt/1-3-1-4.htm)
### Appendix 2 Listed Property Developers

<table>
<thead>
<tr>
<th>Property Developers</th>
<th>Stock Code</th>
<th>Market Capitalization (HKD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sun Hung Kai Properties Limited *</td>
<td>0016</td>
<td>367,629,050,221</td>
</tr>
<tr>
<td>Hutchison Whampoa Property ^</td>
<td>0013</td>
<td>347,251,550,031</td>
</tr>
<tr>
<td>Cheung Kong (Holdings) Limited *</td>
<td>0001</td>
<td>245,050,186,960</td>
</tr>
<tr>
<td>Wharf Holdings Limited ^</td>
<td>0004</td>
<td>212,686,858,355</td>
</tr>
<tr>
<td>China Overseas Land and Investment Ltd.</td>
<td>0688</td>
<td>186,744,279,530</td>
</tr>
<tr>
<td>Henderson Land Development Company Limited *</td>
<td>0012</td>
<td>127,503,688,224</td>
</tr>
<tr>
<td>Hang Lung Properties Limited ^</td>
<td>0101</td>
<td>122,925,410,885</td>
</tr>
<tr>
<td>Swire Pacific A</td>
<td>0019</td>
<td>84,988,542,225</td>
</tr>
<tr>
<td>New World Development *</td>
<td>0017</td>
<td>75,612,975,128</td>
</tr>
<tr>
<td>Sino Land ^</td>
<td>0083</td>
<td>68,518,936,800</td>
</tr>
<tr>
<td>China Resources</td>
<td>0291</td>
<td>61,265,206,560</td>
</tr>
<tr>
<td>Kerry Properties Limited</td>
<td>0683</td>
<td>44,348,403,422</td>
</tr>
<tr>
<td>Hysan Development Company Limited ^</td>
<td>0014</td>
<td>35,790,915,397</td>
</tr>
<tr>
<td>Chinese Estates Holdings Limited</td>
<td>0127</td>
<td>25,562,095,659</td>
</tr>
<tr>
<td>New World China Land Limited</td>
<td>0917</td>
<td>24,950,598,742</td>
</tr>
<tr>
<td>Hopewell Holdings Limited ^</td>
<td>0054</td>
<td>23,366,038,311</td>
</tr>
<tr>
<td>Shun Tak Holdings Limited</td>
<td>0242</td>
<td>12,407,086,177</td>
</tr>
<tr>
<td>K. Wah International</td>
<td>0173</td>
<td>10,344,401,121</td>
</tr>
<tr>
<td>Emperor International</td>
<td>0163</td>
<td>8,690,256,575</td>
</tr>
<tr>
<td>Lai Sun Development</td>
<td>0488</td>
<td>4,694,717,029</td>
</tr>
<tr>
<td>Tai Cheung Holdings Limited</td>
<td>0088</td>
<td>3,865,745,721</td>
</tr>
<tr>
<td>SEA Holdings</td>
<td>0251</td>
<td>3,171,706,547</td>
</tr>
<tr>
<td>Y. T. Realty</td>
<td>0075</td>
<td>1,958,915,667</td>
</tr>
<tr>
<td>Chuang’s Consortium International Ltd.</td>
<td>0367</td>
<td>1,781,383,563</td>
</tr>
<tr>
<td>Asia Standard International</td>
<td>0129</td>
<td>1,781,068,108</td>
</tr>
<tr>
<td>Tai Sang Land Development</td>
<td>0089</td>
<td>1,035,610,834</td>
</tr>
</tbody>
</table>

Note: The developers marked with * and ^ are referred as “Top 4 developers” and “Other 6 developers” respectively.

---

56 The values are obtained from Hong Kong Exchanges and Clearing Limited, as at 6 June 2013.


**Appendix 3 Malpezzi (1999) model**

The model asserts that

\[
dP_t = \beta_0 + \beta_1 \left( \frac{P_{t-1}}{Y_{t-1}} - k \right) + \cdots + \beta_n \left( \frac{P_{t-n}}{Y_{t-n}} - k \right) + \gamma_1 \left( \frac{P_{t-1}}{Y_{t-1}} - k \right)^3 + \cdots + \gamma_n \left( \frac{P_{t-n}}{Y_{t-n}} - k \right)^3 + \beta X + \epsilon_t
\]

where \( P_t \) = Real housing price at time \( t \), \( Y_t \) is the real income at time \( t \), \( k \) is the long-run house price-to-income ratio, \( X \) is a vector of control variables, and \( \epsilon_t \) is the error term.

In our paper, it considers \( n = 2 \) and the model can be simplified as:

\[
dP_t = \beta_0 + \beta_1 \left( \frac{P_{t-1}}{Y_{t-1}} - k \right) + \beta_2 \left( \frac{P_{t-2}}{Y_{t-2}} - k \right) + \gamma_1 \left( \frac{P_{t-1}}{Y_{t-1}} - k \right)^3 + \gamma_2 \left( \frac{P_{t-2}}{Y_{t-2}} - k \right)^3 + \epsilon_t
\]

\[
P_t - P_{t-1} = \beta_0 + \beta_1 \frac{P_{t-1}}{Y_{t-1}} - k + \beta_2 \frac{P_{t-2}}{Y_{t-2}} - k + \gamma_1 \left( \frac{P_{t-1}}{Y_{t-1}} - k \right)^3 - 3k \left( \frac{P_{t-1}}{Y_{t-1}} \right)^2 + 3k^2 \left( \frac{P_{t-1}}{Y_{t-1}} \right) - k^3
\]

\[
+ \gamma_2 \left( \frac{P_{t-2}}{Y_{t-2}} - k \right)^3 - 3k \left( \frac{P_{t-2}}{Y_{t-2}} \right)^2 + 3k^2 \left( \frac{P_{t-2}}{Y_{t-2}} \right) - k^3 + \epsilon_t
\]

\[
P_t - P_{t-1} = \left[ \beta_0 - k(\beta_1 + \beta_2) - k^3(\gamma_1 + \gamma_2) \right] + \left[ (\beta_1 + 3k^2\gamma_1) \frac{P_{t-1}}{Y_{t-1}} + (\beta_2 + 3k^2\gamma_2) \frac{P_{t-2}}{Y_{t-2}} \right]
\]

\[
- 3k \left[ \gamma_1 \left( \frac{P_{t-1}}{Y_{t-1}} \right)^2 + \gamma_2 \left( \frac{P_{t-2}}{Y_{t-2}} \right)^2 \right] + \gamma_1 \left( \frac{P_{t-1}}{Y_{t-1}} \right)^3 + \gamma_2 \left( \frac{P_{t-2}}{Y_{t-2}} \right)^3 + \epsilon_t
\]

Hence, we have

\[
P_t = \hat{P}_{t-1} + \hat{\alpha}_0 + \hat{\alpha}_{11} \frac{P_{t-1}}{Y_{t-1}} + \hat{\alpha}_{12} \frac{P_{t-2}}{Y_{t-2}} + \hat{\alpha}_{21} \left( \frac{P_{t-1}}{Y_{t-1}} \right)^2 + \hat{\alpha}_{22} \left( \frac{P_{t-2}}{Y_{t-2}} \right)^2 + \hat{\alpha}_{31} \left( \frac{P_{t-1}}{Y_{t-1}} \right)^3 + \hat{\alpha}_{32} \left( \frac{P_{t-2}}{Y_{t-2}} \right)^3
\]
Appendix 4 Revenues from Land Disposal Types

Key: SA – Scheduled Auction; ALA – Application List Auction; TEN – Tender; AB – Letter A/B

Source: Lands Department
Appendix 5 Proof of Proposition 1

**Proposition 1:** If the aggregate production of an economy is characterized by a Cobb-Douglas function,  
\[ Y = A(K)^\alpha (N)^{1-\alpha}, \]
where \( Y \) is the aggregate output, \( A \) is the productivity, \( K \) is the aggregate capital, \( N \) is the aggregate labor inputs, and the factor markets are perfectly competitive, then the ratio of the wage rate to per capita real GDP \( \frac{w}{Y/N} \) is a constant.

**Proof:**

Wage \( w \) = Marginal Product of Labor \( \frac{\partial Y}{\partial L} \)

\[ = (1-\alpha)AK^\alpha N^{-\alpha} \]

\[ = (1-\alpha)\frac{V}{N} \]

Rearranging gives \( w(Y/N) = 1 - \alpha = constant \)

**Remark:**

In microeconomics, we assume that the economy always achieves full employment. And hence “GDP per worker” and “GDP per capita” are identical. In reality, the two are not. The labor market participation rate changes over time. To correct for that, we need to define \( N \) to be the aggregate labor force and \( N^p \) is the total population. And hence \( w/(Y/N) \) is a constant, but \( \frac{w}{Y/N} = \frac{w}{N/N^p} \)

may not be a constant, since the labor market participation rate \( \frac{N}{N^p} \) may change over time. Empirically, the labor market participation rate does not change much and displays no clear trend. Thus, our result is essentially unchanged even after the correction.
Appendix 6 Calculation of Supply Elasticity

To calculate supply elasticity, we first obtain the housing data from CEIC, covering the period from January 1993 to December 2011. While the monthly series of housing price, consumer price index and materials cost index are available, the data of private housing stock is only updated once a year. Hence, we use interpolation to turn this yearly series into monthly series. Also, since the data for the relevant instruments proposed by Saiz (2010) is not available, we can only assume the error term is uncorrelated with housing price and housing stock in our analysis. The estimation result is as follows (with the t-statistics inside the parentheses):

\[
\log(\text{Housing Price}) = -16.38 + 0.63 \times \log(\text{materials cost}) + 1.32 \times \log(\text{housing stock}) \\
\quad \quad \quad \quad \quad \quad \quad (-1.86) \quad (3.44) \quad (2.25)
\]

The estimates suggest a relatively inelastic housing supply on average, with a value of 0.76 (=1/1.32). In the previous literature, it is shown that areas with lower supply elasticities tend to have high volatility of real house prices. To calculate the volatility of Hong Kong housing prices, the cyclical component of the log of real housing price is used. It is found that the standard deviation of real housing price is 8.37% over the sampling period.

In Leung and Teo (2011), they estimate the relationship between supply elasticity and house price volatility. They found that

\[
\text{Standard deviation (in %)} = 10.63 - 3.60 \times \text{Supply Elasticity} \\
\quad \quad \quad \quad \quad \quad \quad (6.34) \quad (-3.10)
\]

If we treat Hong Kong as one of the American cities, then using the above equation we could find that the standard deviation is about 7.90%.

---

57 Same assumption has been made in Saks (2008).