Effects of Government's Land Supply and Public Housing on Hong Kong's Residential Market: A Dynamic Model Of New Housing Supply

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Abstract

The property market plays an important role in the overall economic performance of Hong Kong. Housing is the most important form of savings for many households. The extremely volatile property market will create many social and financial problems. Thus the healthy and stable development of property market has been one of the goals of the Hong Kong Government. The housing price increases sharply in the past few years and it creates much negative tension in the society. The Hong Kong Government pledges to increase land supply and public housing to ease the property market.

This thesis attempts to explore the impact of land supply and public housing program on housing price in Hong Kong. An aggregate housing model with three components is designed in which the land supply and public housing are incorporated. The results show that the public housing program has a negative impact on the housing price. The land supply will impact the housing price through increasing the future housing supply.

Key words: Land Supply, Public Housing, Housing Supply, Housing Price, Hong Kong.
Declaration

I declare that this thesis represents my own work, except where due acknowledgement is made, and that is has not been previously included in a thesis, dissertation or report submitted to this University or to any other institution for a degree, diploma or other qualification.

Signed __________________
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Chapter One: Introduction

Hong Kong has an area of 1,104 square kilometers as at mid-2009. With a total population of 7 million, Hong Kong becomes one of the most densely populated areas. At the same time, the high rate of natural increase and the continued influx of migrants from China further increase the population. The combination of limited land area and high population pose increasing pressure on the property market. The property price in Hong Kong has been one of the most highest in the world. The average residential housing price increased 30% in 2009 and 24% in 2010. The overall price index in February 2011 just surpassed the peak in 1997. The high housing price makes it difficult for many families to purchase a flat. When price goes up, many people without permanent dwelling become very anxious, especially the younger people who felt locked out of the property market. The high housing price may cause many social problems. For example, high housing price is one reason that induces around 200,000 people to take part in the anti-Government demonstrations on July 1 of 2011. The rocketing housing price also increases the concern of a real estate bubble. The bursting of the property bubble may help to trigger a financial crisis, which may lower the economic growth rate or even lead to an economic recession. Andrea and Claudio (2010) pointed out that the U.S. is an important source of global fluctuations; the subprime crisis triggered the global financial turmoil. Due to the significance of the property market, the housing price behavior should be closely watched. At a certain point, it is necessary for the Government to take measures to maintain a healthy and stable property market.

1.1 Overview of the Hong Kong property market

The following chart shows the total number of the household in Hong Kong from 1982 to 2010. It can be observed that the number of household almost doubles in the last thirty years. The increase of household comes from different resources. Firstly, young children tend to leave their parents and have their own families. Secondly, in
order to maintain its competitiveness, the Hong Kong Government also designs different policies to attract high net value investors and highly skilled worker immigration. The growing number of households indicates the underlying demand for the new housing unit is still large. But the high housing price will put much pressure on those potential home buyers as well.

**Chart-1: The growing number of households**

![Chart 1: The growing number of households](image1)

At the same time, the private residential property price has been extremely volatile in the last thirty years. Due to the data limitation, Chart-2 plots the real residential property price index in the period of 1981:1-2010:3, which is the longest data set on housing price available publicly.

**Chart-2: The trend of real residential property price**

![Chart 2: The trend of real residential property price](image2)

The graph shows that the price dropped sharply from 1981 to 1984, and grew gradually to reach the peak in later 1997 before Asian financial crisis seriously hit the property market. The price continued to drop thereafter until 2003; then the trend was reverted and real price doubled in the past 7 years. It can be found that there were many short term up and down trends in the past 30 years.
Another variable closely related to housing price is the total agreement of purchase and sale for residential housing. When the housing price continues to climb, it may induce more short term of speculation activities. The following chart shows that there appears to be more intense trading activity (i.e. transaction volume) in rising markets than in falling markets. The total agreements dropped significantly after the Asia Financial Crisis and it continues to drop until the housing price trend reverted in 2003. From 2008 to 2010, the obvious positive relationship between them was observed again.

**Chart-3 Comparison of Housing price and Agreements of purchase and sale**

The following chart shows the completion of the new private residential housing measured in usable floor area. The quarterly new housing supply has been quite volatile with the average of 258,000 m$^2$. The new housing supply stayed well below the average value in the past 6 years. The housing price is also incorporated in the chart and there seems to be a negative relationship between these two variables.

**Chart-4 New Private Residential Supply**
1.2 Introduction of the Government policies

The sharp increase and the volatile housing price arouse the attentions of the Hong Kong Government who has been playing a significant role in the property market. In response to the rapid increase in housing price, two main public policies of the Hong Kong Government are an increase in land supply and public housing program. Below I provide a brief background of the two policies.

Land supply

Hong Kong is a land restricted area and the Government is the largest land lord. The Government decides when and how much land can be put to the market for private developers and public housing construction departments.\(^1\) Prior to the hand-over, the Sino-British Joint Declaration (1985) established new policies to treat the land leases issue. The policy states that “the total amount of new land to be granted shall be limited to 50 hectares a year (excluding land to be granted to the Hong Kong Housing Authority for public rental housing) until 30 June 1997”.\(^2\) As the Asia financial crisis seriously hit the property market of Hong Kong in 1997, the housing price continued to drop and the Hong Kong Government decided to reduce the land supply to support the housing price. The constraint on land supply is commonly seen as a main factor constraining housing supply. As the land supply of Hong Kong is easily measured, it offers us a unique experiment to study the impact of land supply restriction on the property market. Chart-5 shows the land disposal for the private residential construction in the last thirty years. The graph shows that in the first twenty years, the land disposal by the Government has been highly volatile. It reached as high as more than 200,000 m\(^2\), but in some other quarters, there were no land supplies at all. Starting around year 2000, the quantity of land supply dropped significantly.

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1 Main two Departments are Hong Kong Housing Authority and the Hong Kong Housing Society.
2 Sino-British Joint Declaration: Annex III
Chart-5: Land Disposal for Private Residential

Public housing

Hong Kong has the second largest public housing sector in terms of percentage in the capitalist world, just after Singapore. The Hong Kong Government first became involved in social housing provision in 1954, when many families were affected by Christmas fire broke out in 1953. Since then, the Government has been playing a more and more important role in the property market by providing public housing. There are several stages of government’s provision of public housing. From 1954 to 1960; public housing was for those people who need shelter urgently. In 1980’s, the Government’s policy changed to provide Quality Housing. Starting from 2000, Government has been trying to induce the demand for private housing. Currently, there are around 50% of Hong Kong population living in the public permanent housing which includes rental flats and subsidized sale flats. Chart-6 shows the number of new completed public housing in the past thirty years. It can be seen that the supply of public housing highly fluctuated around 10,000 units before 2002, but like the land disposal, the supply of public housing dropped significantly in the past 8 years.

Chart-6: New public housing completed in Units
Chart-5 and Chart-6 show that the public housing and land supply were volatile before 2002 and it can also be clearly observed that they dropped sharply in the past 8 years. At the same time, Chart-2 shows the housing price continue to increase in the past 7 years. This suggests that there could be a certain relationship between land supply, public housing supply and housing price.

The Government believes that providing more public housing and land supply would help to put the pressure on the housing price and prevent it from reaching a risky level. That is why in different events, the Government officials of Hong Kong reiterated that the Government will take these measures to help maintain a stable and healthy property market. The public housing serves as a substitute for the private housing, so increasing supply of public housing would reduce the demand for the private housing. The increase of land supply for the private housing should result more housing supply because more projects can be launched by the developers on the new lands. So the increase of public housing and land supply are expected to negatively impact the housing price.

1.3 Purpose and Hypothesis

A healthy and stable property market plays an important role in Hong Kong’s overall economy. But many social problems and future economic downturn risk are likely to increase as housing price which already reached at a historical high level continues to climb. The Hong Kong Government has the resources to intervene in the property market by executing different policies. This motivates the question of whether Government policies, including land and public housing supply, will be effective or not in affecting the property market. There have been a few number of studies trying to discover the relationships among them. But the results of the existing literatures are still inconclusive.

This paper will mainly study the housing price, land supply, housing supply and
public housing in a new perspective, trying to better understand the relationship among them. I am going to focus on testing the following hypothesis derived from supply and demand theory.

1. Increasing of public housing will negatively affect the private housing price.
2. Increasing of land supply will lead to more private housing supply.
3. Increasing of land supply will negatively affect the private housing price.

In order to test the above hypothesis, I build a dynamic econometric model with three components. To my knowledge, there are no studies examining the effects of public housing on the private residential market of Hong Kong. Thus this paper can be considered as the first attempt on this front. In addition, it is counter-intuitive that most existing empirical works, for example, Peng and William (1994), find that there is no significant relationship between land supply and housing supply. An innovation of this thesis is to add a new variable named “Consent to Commence Work” that has never been used in earlier studies. I find this variable helps to capture the dynamic effect of land supply on housing supply and housing price.

The outline of the rest thesis is as follows. Chapter 2 is a review of the literature regarding the residential property market in general and influence of land supply and public housing on the housing price particular in Hong Kong. Chapter 3 describes the econometric model in my study, and the data is discussed in the Chapter 4. The empirical results are presented in Chapter 5, and concluding remarks are given in the last chapter.
Chapter Two: Literature Review

Hong Kong is one of places where the new land supply is heavily controlled by the government, so the Hong Kong Government plays a special role in influencing the characteristics of property market compared to other countries. In the first part of this chapter I will review the literatures related to my studies in general. Then I will discuss the studies focusing on exploring the effect of land supply specifically to the Hong Kong property market.

2.1 General literature review

The commonly used approach to study the behavior of housing price is deriving a reduced form equation where price is a function of supply and demand variables. Many of these works are interested in estimating the price elasticity of supply. Muth (1960) is one of the earliest works trying to study the housing supply elasticity in the U.S. market. He constructs the demand and supply equations for the housing and gets the reduced form under the assumption that the housing price clears the housing market. Then he regresses the housing price on output and other supply and demand variables; he finds no statistical relationship between price and output. Later, Follain (1979) applies the same model as Muth but using a new data set; his finding is consistent with Muth results. Both of them conclude that housing supply curve is perfectly elastic. Stover (1986) points out that their regression results can be interpreted as an evidence of perfectly inelastic supply. He uses a translog cost function and his estimates are consistent with infinite supply elasticity. Malpezzi and Maclennan (1996) modified their model and tried to compare the price elasticity of United States and United Kingdom. The advantage of building structural equations model is that it is able to estimate the effects of different variables, so I am going to apply their basic model in this study.

A few scholars try to study the relationship between housing price and
transaction volume. In Stein (1995), he runs a regression of transaction volume on the previous year’s percentage change in prices for single-family homes between 1968 and 1992 in United States. The regression produces a highly statistically significant coefficient on the trading volume and it supports that there is a positive relationship between housing price and transaction volume. He uses the down payment effects to explain that the rise in the housing price will increases the wealth of existing homeowners. Therefore, they are able to meet the requirement of down payment for new housing. In Leung etc.(2002), they applies the disaggregated data of the Hong Kong property market to explore the relationship between the housing price and trading volume and the contemporaneous relationship of the two was found as well. Tse (1999) further points out the transaction volume could be treated as a proxy for the speculation demand of housing.

Some studies try to explore which is the leading factor, the collapse of property market first, or the deterioration of economic fundamentals. Quigley (2001) tries to study how the changes in property markets affect the subsequent economic performance of the economy. He applies the data that comes from private sources and financial observers; the results suggest that the speculation activities in the property market play a significant role in triggering the Asian financial crisis beginning in 1997. Andrea and Claudio (2010) also shed some light on how the subprime mortgage crisis is responsible for triggering the U.S. financial crisis. Kim,K-H (2000) argues that the fall in real estate prices could not have been a major cause of the economic crisis after studying the financial crisis in Korea. But he points out that housing represents a large percentage of a nation’s wealth, and the property market is closely linked to the financial intermediaries. No matter which one is a leading factor, the collapse of the real estate sector would no doubt seriously influence the overall economy by affecting the aggregate expenditure and profitability of the financial institutions.

A significant amount of other papers try to study the effects of various factors on the housing price. Harris (1989) finds that the real rate of interest is the mechanism
for affecting the housing price level. Reichert (1990), studies the impact of interest rates, income and employment upon regional housing prices of U.S. The results show that different regions respond differently to certain variable. Baffoe-Bonnie (1998) found out that the housing market is very sensitive to the shocks of the employment growth and mortgage rate.

2.2 Studies related to the Hong Kong property market

The structured model used in some previous literatures is widely applied in the local studies. But the local studies add some unique factors only applied to Hong Kong market, for examples, restricted land supply and public housing program.

Peng and Wheaton (1994) examine whether a sudden drop in land supply would influence the housing price. And if so, what is the underline mechanism? They assume that the total households are fully allocated to the public housing and private housing. Based on this assumption, they build up a model that housing price was determined by land supply, income etc. Their result shows that the one-, two-, or three-year lagged of land supply have a negative impact on the housing price and the coefficients are all statistically significant. To examine the underlying mechanism, they construct another housing supply model where housing supply is regressed on the land supply. Their result shows that all the coefficients of lag terms of land supply are statistically insignificant. So the authors conclude that the land supply does have an impact on the housing price, but the underlying mechanism is not through its effect on housing production.

Lai and Wang (1999), ask whether an increase of land supply will be a solution to the perceived shortage of housing supply in Hong Kong. Different from Peng and Wheaton (1994), the data they use is the usable floor area rather than housing unit. They regress the percentage changes of housing supply on the different lags of
percentage changes of land supply, but find that all the coefficients are statistically insignificant. So they conclude that land supply does not necessarily increase the housing supply. Tse (1998), points out that “this is because the land available may not be developed immediately, but simply added to the stock of the developers’ land bank” Their studies also indicate that the developers tend to increase the housing supply when the stock market was performing well in the previous year. So they conclude that “the developers’ supply decisions on new housing projects are more related to market timing rather than to the supply level of the land.

Tse (1998), applies the Granger causality test to explore the relationship between land supply and private housing price. The causality is rejected in the first difference and the level regression. He concludes that the land supply doesn’t influence the housing price. This is contradicted to the findings in Peng & Wheaton (1994).

In Tse(1999), he develops a reduced-form equilibrium model to explain changes of housing prices in Hong Kong by examining the role of the population growth, transaction volume, inflation and interest rate. An interesting finding in this paper is that the transaction volume, which serving as a proxy of speculation demand for housing, has a significant impact on the housing price.

Hui and Ho (2003), also attempts to explore the impact of land supply on housing prices in Hong Kong. By constructing the structural housing demand and supply functions and re-arranging the equations to get the reduced from, they get a model where factors affecting housing price can be identified. Their empirical results show that the coefficient of three-year time lag of land supply is not significant statistically, which is consistent with the findings of Tse (1998)

2.3 Summary of previous studies

The previous studies show that the property market and national economy is closely
related. Different variables have been tested whether they have significant impacts on the housing price. For the studies focused on exploring the effects of land supply specifically in Hong Kong, even though the methods applied in these studies are very similar, their findings of how land supply affects the housing price are contradicted. Peng and Wheaton (1994) show that land supply negatively impacts the housing price, but Tse (1998), Hui and Ho (2003) find there is no significant relationship between them. Besides, some existing literatures, Lai and Wang (1999), Peng and William (1994), do not support the assumption that increase of land supply is going to increase the housing supply in the future.

Surprisingly, Hong Kong has the second largest public housing program in the capitalist world; almost half of population is living in the public housing. Yet, to my knowledge none tries to study the effect of public housing supply on the Hong Kong private housing market.

The relationship between land supply, public housing, housing supply and housing price will determine the effectiveness of the Government policy. So it motivates me to modify the previous models to study the relationship between them. And I will present my model in the next chapter.
Chapter Three: Methodology

3.1 Overview of the model

The model in this study has three components. Following Peng and Weaton (1994), the first component is to study the housing market under the assumption that the housing price clears the market. It is able to measure the effect of public housing and new housing supply on housing price. This part is similar to the previous studies; where two structural equations are built first and the reduced form is derived to study the effects of some certain factors on the housing price. The difference is the measure of public housing is added in order to estimate the effect of public housing program. The second component is able to estimate the effect of land supply on the potential future private housing supply, which depends on the decisions made by the real estate developers. This part will take the land hoarding behavior of developers into account. Unlike existing literatures which study the relationship between land supply and housing supply directly, I use a new variable that will allow the model to better capture the developer’s decision making process when government supply more land for the housing market. The third component is to study the lagged dynamic of housing supply. Specifically, this component helps to understand how the approved amount of housing construction is going to influence the future housing supply. Combining with the second component, the relationship between land supply and real future housing supply will be derived. The details of three components are presented next.

3.1.1 First component of the model

The previous literatures have applied the assumption that the equilibrium of housing market is determined by the interaction of both demand and supply factors. Following these studies, I select some demand and supply factors that are commonly used and some unique factors only used in this study, specifically public housing supply. Two
Effects of Government's Land Supply and Public Housing on Hong Kong's Residential Market:
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structural equations of demand and supply of private housing have the following specification.

Quantity demand equation:

\[ Q_d^t = \alpha_0 + \alpha_1 P + \alpha_2 P_{ub} + \alpha_3 P_{ub}^2 + \alpha_4 P_{ub}^3 + \alpha_5 Puragree_{t-1} + \alpha_6 HSI + \alpha_7 UnemRate_{t} + \xi \]  

(1)

Quantity supply equation:

\[ Q_s^t = \beta_0 + \beta_1 P + \beta_2 Q_{t}^{new} + \omega_t \]  

(2)

The detail of each factor in the first equation is as follows.

- **P** stands for Price indices of private residential housing. According to the law of demand, the demand of housing is expected to increase if the housing price drops.

- **Pub** stands for the new completed units of public housing (public rental flats and subsidized sale flats). Public housing are either rented or sold at a significant lower price than the private housing. It substitutes for the private housing. Thus the new completion of public housing is expected to have negative impact on the demand of the private housing. Different lag terms of public housing are added to explore their effects.

- **Puragree** stands for the total number of Agreements of purchase and sale of residential units. As Tse(1999) suggested, agreements for sale and purchase can serve as a proxy for the speculation demand of private housing. I adopt his assumption and incorporate this factor in the study to explore the effect of purchase agreement on housing market. Basing on this assumption, it is expected that the increase of purchase agreements would increase the speculation demand of housing.

- **HSI** stands for the Hang Seng Index. It is one of the main indicators of overall market performance of Hong Kong. An increase in HSI would generally increase the wealth of overall investors. Besides, the confidence of investor and consumer will also be enhanced by the overall performance of the stock market. So I am
expecting that the continuing rising of stock market would be a factor stimulating the housing demand.

- **Unem** stands for the unemployment rate. The high unemployment rate means many people are out of job and not making money. It will undoubtedly weaken the purchasing power of consumer. High unemployment rate may also indicate a region might be experiencing a recession, so it is expected that high unemployment rate will decrease the housing demand, and as a result, influence the housing price.

Equation (2) shows the total supply of the private residential housing. I only incorporate variables of housing price and new housing completed. This equation assumes that housing supply mainly comes from the secondary housing market and the primary housing market.

In the secondary housing market, a housing owner may hold several housing for the investment purpose. As the housing price goes up, they may decide to sell some units of housing to gain the profit. So it is expected that the second-hand housing supply will response to the housing price. In the mean time, many new flats are completed every year and sold in the primary market, so it should constitute a proportion of total housing supply as well. As the presale of housing is very common in the property market, it is likely that only a certain amount of new housing can be on sale in the primary market. So a coefficient is attached to the quantity of housing new completed to exclude the presale amount of housing. If it equals to 1, there is no presale market or all the presale housing are put back to the market once the housing project is completed.

Each equation above has a ceteris paribus, causal interpretation. And it is a typical example of Simultaneous Equations Models where the explanatory variables are jointly determined with the dependent variable, typically through an equilibrium
mechanism. But the reduced form will be estimated by assuming that the current price clears the housing market. That is:

\[ Q^d_t = Q^s_t \]

We can get the reduced form by re-arranging the equations:

\[ P_t = (\beta_1 - \alpha_2)/(\alpha_1 - \beta_1) + \beta_2/(\alpha_1 - \beta_1) Q^{new}_{t-1} + \alpha_3/(\beta_1 - \alpha_1) Public_{t-1} + \alpha_4/(\beta_1 - \alpha_1) Public_{t-2} + \alpha_5/(\beta_1 - \alpha_1) Public_{t-3} + \alpha_6/(\beta_1 - \alpha_1) Public_{t-4} + \alpha_7/(\beta_1 - \alpha_1) Public_{t-5} + \alpha_8/(\beta_1 - \alpha_1) UnemRate_{t-1} + (\alpha_9 - \alpha_1)/(\beta_1 - \alpha_1) \]

The simplified reduced form of equation can be derived by substitute the coefficients.

\[ P_t = \chi_0 + \chi_1 Q^{new}_{t-1} + \chi_2 Public_{t-1} + \chi_3 Public_{t-2} + \chi_4 Public_{t-3} + \chi_5 Public_{t-4} + \chi_6 Public_{t-5} + \chi_7 UnemRate_{t-1} + \psi_t \]  \( (3) \)

### 3.1.2 Second component of the model

When exploring the relationship between land supply and housing supply, the method used by existing studies is to regress one variable on the other. Lai and Wang (1999), Wheaton (1994) also add time lags of land supply since it will take time to finish the housing project. They assume that the developers will start constructing the housing projects once the land is purchased from the Government. Then in two to three years, the housing projects will be completed and put to the primary market. But as Tse (1998) pointed out, the developer usually have land absorbing behavior, which means that it is not necessary for them to start the projects immediately when they get the land. This component will take the land hoarding behavior into account and it will help to better understand the decision making process of real estate developers.

To fix the idea, let’s see how the land supply is converted to the housing supply. After developers purchase the land from the Government, they can either choose to hold it or develop it. If they decide to start the housing project on the new land, they have to apply for the “Consents” from the Building Department first.\(^3\) If they decide

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\(^3\) Hong Kong monthly Statistical digest: “Consents to commence work” are issued by the Building Department for the Hong Kong Housing Society buildings or private buildings.
to hold the lands waiting for a better timing to launch the projects, then the application will be postponed. Another point need to be highlighted is that different housing projects can be launched at around the same time, but they may be finished in the different time periods depending on the housing project scale. The following flow chart shows how the land supply is finally transformed to the new housing supply.

**Chart-7 Decision making process of developers**

<table>
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<td>Developers (Decide when and how many flats to be built)</td>
</tr>
<tr>
<td>Consent to Commence work (Approved by the Government)</td>
</tr>
<tr>
<td>New Housing Supply (Projects finish in different years)</td>
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</tbody>
</table>

To explore the relationship between land supply and housing supply, previous studies mainly focus on testing whether the lag term of land supply has an impact on the current “New Housing Supply”. Their results show that there is no statistically significant relationship between them, which is contradictory to our intuition.

Two factors may influence the previous studies. Firstly, scholars point out that developers may make the development decision basing on the market performance. It is likely that they will choose to absorb the land for future development if they think time is not right. If that is true, then it will takes more than 2 or 3 years for land supply converting to the new housing supply. Secondly, different projects starting at the same time may be finished in the different years. Then testing the relationship between the land supply and a specific year’s new housing supply may not derive a significant result.

In this thesis, I will explore the relationship between land supply and housing supply in a new perspective. Since developers need to get the approval from the
Government before starting the housing project, the total usable floor area approved should be near to the sum of the future housing completed. So the current amount of “Consent” is like the sum of the future housing supply. If the significant relationship between land supply and amount of “Consent” can be found, it will support the assumption that land supply has a positive impact on the future housing supply. So the second component of the model can be written as flowing.

\[
Q_{t}^{\text{Consent}} = \alpha_0 + \alpha_1 (\log P_{t-1} - \log P_{t-2}) + \alpha_2 \text{Land}_{t-1} + \alpha_3 \text{Land}_{t-2} + \alpha_4 \text{Land}_{t-3} + \\
\alpha_5 \text{Land}_{t-4} + \alpha_6 \text{Land}_{t-5} + \alpha_7 \text{Land}_{t-6} + \alpha_8 \text{Land}_{t-7} + \alpha_9 \text{Puragree}_{t-3} + \epsilon_t
\]  

(4)

In this equation, the dependable variable is that total usable floor areas approved by the Government. Three explanatory variables are incorporated in this specification. The first variable is the first difference of housing price in the form of logarithm, which approximately represents the percentage change in housing price from one period to the next. The supply and demand theory states that as the price of a good or service increases, the quantity of goods or services offered by suppliers would increase and vice versa. So the real estate developers are expected to respond positively to the movement of housing price. Therefore, \( \alpha_1 \) measures how the developers respond to the growth rate of housing price in the last quarter. The second variable is the land supply. I add seven quarters of lag land supply to identify its effects on the potential future housing supply, which takes the land hoarding behavior into account. The third variable is the total amount of agreement for purchase and sale. Since this indicator of housing market activity is closely watched by real estate developers, I assume it will positively affect their decision of how many housing program to apply as well.

### 3.1.3 Third component of the model

Here I construct the third component to connect the previous two by studying the relationship between the potential housing supply and the real future housing supply.
It has the following specification.

\[ Q_{t}^{\text{new}} = \eta_{1}Q_{t-9}^{\text{Consent}} + \eta_{2}Q_{t-10}^{\text{Consent}} + \eta_{3}Q_{t-11}^{\text{Consent}} + \eta_{4}Q_{t-12}^{\text{Consent}} + \eta_{5}Q_{t-13}^{\text{Consent}} + \nu_{t} \] (5)

Many related literatures assume it will take two or three years to finish the housing projects. I follow their studies by incorporating 9th to 13th quarter lag of “Consent” to estimate their effects on the “new housing completed”.

In addition, it is intuitive that the total floor area of “New Housing Completed” should equal or at least close to the amount of approved area. Therefore, I am interested in testing whether the sum of \( \eta_{1} \) to \( \eta_{5} \) equals to one. Both the unrestricted and restricted specification will be tested.

### 3.2 Summary of the model

In this Chapter, I construct a dynamic model of housing market composed of three components. The first component is to test the hypothesis that the increase of public housing will negatively affect the housing price. The impact of housing supply on housing price is studied as well. The second one is to test the hypothesis that an increase of land supply will lead to an increase of housing supply, the underlying assumption is that the amount of “Consent” would fully covert to housing supply in the future. Combining with the results of the first two components, the third one is able to test the hypothesis that an increase of land supply will influence the housing price by influencing the future housing supply. Some other variables widely used in the existing literatures are also incorporated in this model.

As will be shown in Chapter 4, housing price, unemployment rate and Hang Seng index are all non-stationary time series, specifically I(1). In order to avoid the possible spurious regression resulted from the non-stationary variables, the first difference of the equation (3) will be estimated. Both unrestricted and restricted forms of equation (5) will both be tested.
Chapter Four: Data

4.1 Data description

The data are extracted from various issues of Hong Kong Property Review and Hong Kong Monthly Digest of Statistics, issued by the Rating and Valuation (R&V) Department and Census and Statistics (C&S) Department, respectively. The longest quarterly data obtained is from 1981 Q1 to 2010 Q3 which consists of 119 observations. Next I will explain relevant variables in detail.

Housing price (P)

The private residential housing price is measured by the price indices. According to R&V department, the price index is derived from all the transactions incurred in a given period and it is able to measure the value changes by reference to the factor of rent or price divided by rateable value of the subject properties. Some previous studies, for example Hui and Ho (2003), use the average price. But the average price may change from one period to another not only because of its changes in value but also because of variation in quality. The advantage of applying the price indices is that it is designed to measure price changes while keeping the quality constant. This paper adopts the quarterly price indices of the private residential. Private residential housing does not include the public housing built by the Housing Authority Department. It includes five classes ranging from A to E by reference to saleable floor area, specially less than 40, 40-69.9, 70-99.9, 100-159.9m$^2$ and area of 160 m$^2$ or above, respectively. As the price index includes all the classes of private residential housing across the whole territory of Hong Kong, it would serve as a proxy of the aggregate private housing price level. In order to adjust the effect of inflation, the price indices are deflated by the GDP deflator.

---

4 Rateable value is an estimate of the annual rental value of the property at a designated valuation reference date, assuming that the property was then vacant and to let.
**New Housing Completed ($Q_{t}^{new}$)**

In Hong Kong, a building is considered to be “completed” upon the issuance of an Occupation Permit by the Buildings Department. The data adopted in the model for the private new housing completed is the usable floor area measured in thousand square meters. The usable floor area is defined as the aggregate area of the floors in a building excluding any staircases, lift landings, kitchens and any space occupied by machinery for any lift, air-conditioning system or similar service provided for the building. So it will be significantly lower than the registered floor area. As the data does not include the public rental flats and subsidized sale flats, it can serve as a proxy of the new private housing supply.

**Consent to commence work ($Q_{t}^{Consent}$)**

Before developers start constructing the housing project, they need to get permit from the Building Department in the form of “Consent to commence work”. The quarterly data applied in this paper is the same to the measure of New Housing Completed so that they are comparable. The data are extracted from various issues of Hong Kong Monthly Digest of Statistics.

**Public housing supply (Pub)**

Public housing mainly includes public rental flats and subsidized sale flats. Both of them are divided into two types basing on its floor areas, which are less than 40 m$^2$ and 40-69.9 m$^2$, respectively. The data applied in this paper is the newly completed of public rental and subsidized sale flats. The quarterly data are extracted from Hong Kong Monthly Digest of Statistics.

**Unemployment Rate & Hang Seng Index (Unem & HSI)**

Seasonally adjusted unemployment rate figures are collected from the Hong Kong Monthly Digest of Statistics and it includes all sex and age groups. Hang Seng Index is the closing price of the each quarter’s last trading day. It is also deflated by
the GDP deflator to adjust the inflation.\textsuperscript{5}

Agreements of purchase and sale (Puragree)

The agreement for purchase and sales of building units is for residential purpose. They generally relate to transactions executed up to four weeks prior to their submission for registration. And it refers to sale and purchase agreements with payment of stamp duty. The monthly transactions were obtained from the Hong Kong Monthly Digest of Statistics, and then the quarterly transaction volume is calculated by summing up all of the monthly transactions within that quarter.

Land Supply (Land)

The Hong Kong Government has several methods to dispose the land, including public auction, public tender, private treaty grants and letter A/B. This paper excludes the private treaty grants because most of the land disposed by this method is given to Housing Authority and Housing Society for the public housing program. The quarterly data of land supply for housing are collected from Hong Kong Monthly Digest of Statistics, including “pure residential use” and “composite residential/commercial use”. The amount of “composite residential and commercial use” roughly constitutes 15% of the total amount. So I use the summation of these two variables to represent the land supply for private residential building. The descriptive statistics for the data are put forth in table 1.

<table>
<thead>
<tr>
<th>Table 1: Descriptive Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>$P$</td>
</tr>
<tr>
<td>$\text{UnemRate}$</td>
</tr>
<tr>
<td>$\text{HSI}$</td>
</tr>
<tr>
<td>Puragree</td>
</tr>
<tr>
<td>$\text{Land(m}^2\text{)}$</td>
</tr>
<tr>
<td>$\text{Public(unit)}$</td>
</tr>
<tr>
<td>$Q(\text{New } \text{`000m}^2\text{)}$</td>
</tr>
<tr>
<td>$Q(\text{Consent } \text{`000m}^2\text{)}$</td>
</tr>
</tbody>
</table>

\textsuperscript{5} The full dataset can be found on the financial website http://finance.yahoo.com/
4.2 Stationary test

The analysis of time series data poses several challenges to the econometric study. One of which is the stationarity requirement. The OLS method is based on the assumption that the means and variances of variables being tested are constant over the time. The formal definition of stationary stochastic process is as following.

The stochastic process \{x_t : t = 1, 2, \ldots\} is stationary if for every collection of time indices \(1 \leq t_1 < t_2 < \ldots < t_m\), the joint distribution of \((x_{t_1}, x_{t_2}, \ldots, x_{t_m})\) is the same as the joint distribution of \((x_{t_1+k}, x_{t_2+k}, \ldots, x_{t_m+k})\) for all integers \(k \geq 1\).

If their means and variances change over time, then they are known as non-stationary or unit root variables. The spurious relationship may be found if the variables are non-stationary time series. The commonly used methods to test the presence of unit roots are the Augmented Dickey-Fuller test (Dickey and Fuller, 1979 and 1981). The simplest approach to test a unit root begins with an AR(1) model,

\[
Y_t = \alpha + \rho Y_{t-1} + u_t, t = 1, 2, \ldots, \\
H_0 : \rho = 1
\]

If we cannot reject the null hypothesis, than the dependable variable has a unit root. A convenient equation for carrying out the unit root test is to subtract \(Y_{t-1}\) from the both sides and to define \(\delta = \rho - 1\).

\[
\Delta Y_t = \alpha + \delta Y_{t-1} + u_t 
\]

The null hypothesis would be \(H_0 : \delta = 0\). The asymptotic distribution of the t statistic under null hypothesis is known as the Dickey-Fuller distribution and test is known as the D.F. test. This paper applies the Augmented Dickey-Fuller test, which extend the DF test by adding the lagged values of the dependent variable \(\Delta Y_t\).
The following table shows the result of the Augmented Dickey-Fuller test with 12 lags and intercept for each relevant variable. The null hypothesis is that variable under testing has a unit root. It is observed that the Unemployment Rate, Housing price index, and Hang Seng index have a very high P-value, which means we are not able to reject the null hypothesis at a very high significance level. So I will estimate the first difference of equation (3) to remove the potential influence of the unit root problem.

**Table 2: Unit root test**

<table>
<thead>
<tr>
<th>Series</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase Agreement</td>
<td>0.0043</td>
</tr>
<tr>
<td>Unemployment Rate</td>
<td>0.4314</td>
</tr>
<tr>
<td>New Private Housing</td>
<td>0.1201</td>
</tr>
<tr>
<td>Housing Price</td>
<td>0.8439</td>
</tr>
<tr>
<td>Consent to build</td>
<td>0.0861</td>
</tr>
<tr>
<td>Hang Seng Index</td>
<td>0.8530</td>
</tr>
<tr>
<td>Land Supply</td>
<td>0.0026</td>
</tr>
<tr>
<td>New Public Housing</td>
<td>0.0774</td>
</tr>
</tbody>
</table>
Chapter Five: Empirical Results

In this Chapter, I apply the set of data described in Chapter 4 to the model proposed in Chapter 3. The method of Ordinary Least Square (OLS) is applied to estimate the equations introduced and the Statistical Package Eviews 6 is used to run the regression.

5.1 Effects of public housing and new housing supply

Table 3: Statistical results of Eq. (3) in the first difference:

\[ \Delta P = \delta_1 \Delta P_{\text{new}} + \delta_2 \Delta \text{Public} + \delta_3 \Delta \text{Public} + \delta_4 \Delta \text{Puragree} + \delta_5 \Delta \text{HSI} + \delta_6 \Delta \text{UnemRate} \]

<table>
<thead>
<tr>
<th>Explanatory Variables</th>
<th>Coefficient</th>
<th>P_value</th>
<th>Expected sign</th>
<th>Correct Sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>New completed</td>
<td>-0.005407</td>
<td>0.058*</td>
<td>-</td>
<td>Yes</td>
</tr>
<tr>
<td>Public Housing_1</td>
<td>-0.000109</td>
<td>0.163</td>
<td>-</td>
<td>Yes</td>
</tr>
<tr>
<td>Public Housing_2</td>
<td>-0.000107</td>
<td>0.152</td>
<td>-</td>
<td>Yes</td>
</tr>
<tr>
<td>Public Housing_3</td>
<td>-0.000245</td>
<td>0.011**</td>
<td>-</td>
<td>Yes</td>
</tr>
<tr>
<td>Purchase agreement</td>
<td>0.000198</td>
<td>0.007***</td>
<td>+</td>
<td>Yes</td>
</tr>
<tr>
<td>Hang Seng Index</td>
<td>0.000827</td>
<td>0.050**</td>
<td>+</td>
<td>Yes</td>
</tr>
<tr>
<td>Unemployment rate</td>
<td>-3.501961</td>
<td>0.018**</td>
<td>-</td>
<td>Yes</td>
</tr>
<tr>
<td>Observation</td>
<td>101</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted R square</td>
<td>0.35</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D.W.</td>
<td>2.09</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: *, **, *** denote significant at 10%, 5% and 1% significance level, respectively.

This table presents the regression results of how public housing and private housing influence housing price. The first column shows the name of the explanatory variables. The second and third show the estimated coefficients and probability value respectively. The signs shown in the fourth column are the expected sign of the influence that explanatory variables have on the housing price basing on the economic theory. Several interesting results are found in this regression.

Firstly, the fourth column shows that the sign of coefficients derived from empirical regression are all in accordance with our expectation. D.W test shows that
there is no serial problem in our estimation.

Secondly, the quantity of new private housing completed has a significant negative impact on housing price at 10% significance level. The coefficient tells us that every 1,000,000 m$^2$ of new construction usable floor area would decrease the housing price index by 5.4 points. It is not able to derive the dollar impact of new housing on price since the housing price index is used in the regression. Thus the empirical result shows that the new housing supply has a negative and statistically significant effect on the housing price.

Thirdly, the third lag quarter of new public housing completed has negative impact on the housing price at 5% significance level. Every ten thousand units of new public housing completed will decrease the private housing price index by 2.5 points. The first and second quarter lag of public housing do not significantly impact the housing price statistically at 10% significance level, but they all show the negative sign which agrees with our expectation. Few papers studied the impact of public housing on private housing, so the results here help fill this blank.$^6$

Fourth, the number of agreements of purchase and sale has a significant positive impact on the housing price at 1% significance level. Every ten thousand amount of agreements will increase the housing price by around 2 points. It supports the assumption that the number of agreements of purchase and sale can serve as a proxy of speculation demand for the housing. And it is influencing the housing price through shifting the demand curve. The coefficient of HSI on the housing price is statistically significant at 5% significance level. It supports the assumption that if the overall stock market performance was doing well, the income of investor may increase and the confidence over the economy may be enhanced. Then it tends to increase the demand for housing which can serve as a living place or investment tool as well. The

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$^6$ If only a proportion amount of public housing were allocated to the middle class, then the coefficient derived would be underestimated.
unemployment rate has negative impact on the housing price at almost 1% significance level, each percentage increase of unemployment rate will decrease housing price by 3.5 points. Since unemployment is a proxy of overall economic condition, higher unemployment rate can drive down the housing price. In addition, the higher unemployment rate will weaken the consumer confidence, thus lower the demand for the housing. Based on the results from the first component, I find that the public housing, newly completed housing, and unemployment rate all has a negative impact on the housing price. The number of purchase and sale agreement and stock market performance are observed to have a positive impact on the housing price. Some coefficients may seem to be quite small, but they are all statistically significant.

5.2 Effects of land supply on the new “Consent”

The second component is designed to explore what impact the land supply has on the potential future housing supply or the amount of “Consent to commence work”. Table 4 shows the empirical results basing on equation (4).

### Table 4: Statistical results of Eq. (4)

<table>
<thead>
<tr>
<th>Explanatory Variables</th>
<th>Coefficient</th>
<th>P_value</th>
<th>Expected sign</th>
<th>Correct Sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth Rate_1(P)</td>
<td>601.2602</td>
<td>0.012**</td>
<td>+</td>
<td>Yes</td>
</tr>
<tr>
<td>Land_1</td>
<td>0.000747</td>
<td>0.014**</td>
<td>+</td>
<td>Yes</td>
</tr>
<tr>
<td>Land_2</td>
<td>0.000747</td>
<td>0.093*</td>
<td>+</td>
<td>Yes</td>
</tr>
<tr>
<td>Land_3</td>
<td>0.001256</td>
<td>0.000***</td>
<td>+</td>
<td>Yes</td>
</tr>
<tr>
<td>Land_4</td>
<td>0.000615</td>
<td>0.103</td>
<td>+</td>
<td>Yes</td>
</tr>
<tr>
<td>Land_5</td>
<td>0.000643</td>
<td>0.236</td>
<td>+</td>
<td>Yes</td>
</tr>
<tr>
<td>Land_6</td>
<td>0.000617</td>
<td>0.167</td>
<td>+</td>
<td>Yes</td>
</tr>
<tr>
<td>Land_7</td>
<td>0.000895</td>
<td>0.035**</td>
<td>+</td>
<td>Yes</td>
</tr>
<tr>
<td>Purchase agreement_1</td>
<td>-0.000615</td>
<td>0.103</td>
<td>+</td>
<td>No</td>
</tr>
</tbody>
</table>

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

The first explanatory variable above is the first difference of housing price in logarithm form with one quarter time lag, which can tell us how the housing price performed in the previous quarter. The coefficient is significant at 5% significance.
level and the sign agrees with our expectation that a rise in the real-estate market will increase the incentive for developers to invest in new projects. The coefficient of agreements of purchase and sale is not significant statistically at 10% significance level and the sign is contradictory to our expectation.

I incorporate seven lags of land supply to my model. As explained before that land supply should have a positive influence on the potential future housing supply since there are more lands available for developing the housing project. All the sign of coefficients agree with our expectation and the one-, two-, three-, and seven-lag of land supply are all statistically significant at 10% significance level. The result indicates the real estate developers do take the land supply into account when making decision on the new housing program. Different lag term of land supply having significant impact on the housing project application shows that the Government land supply policy have the prolong influence on the future housing supply. One likely explanation is the land hoarding behavior of the real estate developers.

Previous literatures regress the housing supply on land supply directly; their empirical results show that land supply does not affect on the housing supply. The finding of my paper does not agree with their conclusion. In this paper, I explore their relationship indirectly by regressing “Consent to commence work” or potential future housing supply on the land supply. Therefore, it is indirectly proven that land supply will play a role in determining the housing supply. But what is the exact relationship between the amounts of “Consent to commence work” and real housing supply? This question will be discussed in the next.

5.3 “Consent” and “housing supply”

The third component of the model is to find the relationship between “Consent to commence work” and “New housing Completed”. I will test it in both the unrestricted
and restricted model.

5.3.1 Unrestricted Model

Firstly, I regress the unrestricted model without any restrictions on its coefficients. It contains all the variables in the regression of the basic equation (5) proposed in the third chapter. Then I test whether the summation of the coefficients equals to 1 by the following procedure.

\[ Q_{t,\text{new}} = \eta_1 Q_{t-9}^{\text{Consent}} + \eta_2 Q_{t-10}^{\text{Consent}} + \eta_3 Q_{t-11}^{\text{Consent}} + \eta_4 Q_{t-12}^{\text{Consent}} + \eta_5 Q_{t-13}^{\text{Consent}} + \nu_t \]

\[ \theta = 1 - \eta_1 - \eta_2 - \eta_3 - \eta_4 - \eta_5 \]

\[ H_0: \theta = 0 \]

\[ \eta_5 = 1 - \theta - \eta_1 - \eta_2 - \eta_3 - \eta_4 \]

\[ Q_{t,\text{new}} - Q_{t-13}^{\text{Consent}} = \theta (Q_{t-9} - Q_{t-13}^{\text{Consent}}) + \eta_1 (Q_{t-9} - Q_{t-10}^{\text{Consent}}) + \eta_2 (Q_{t-10} - Q_{t-12}^{\text{Consent}}) + \eta_3 (Q_{t-11} - Q_{t-13}^{\text{Consent}}) + \eta_4 (Q_{t-12} - Q_{t-13}^{\text{Consent}}) + \xi_t \]

If it is not able to reject the null hypothesis \( H_0: \theta = 0 \), then we cannot reject the hypothesis that accumulated effects of “Consent” on the future new housing completed does not equal to 1. In other words, the amount of “Consent” would fully convert to the future housing supply. The following table shows the testing result incorporating different lag term of “Consent”

<table>
<thead>
<tr>
<th>The range of lags</th>
<th>Summation of coefficients</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>7-13</td>
<td>0.935</td>
<td>0.1208</td>
</tr>
<tr>
<td>8-13</td>
<td>0.933</td>
<td>0.1065</td>
</tr>
<tr>
<td>9-13</td>
<td>0.928</td>
<td>0.0814</td>
</tr>
<tr>
<td>10-13</td>
<td>0.920</td>
<td>0.0535</td>
</tr>
<tr>
<td>10-12</td>
<td>0.911</td>
<td>0.0324</td>
</tr>
</tbody>
</table>

Five ranges of lags are tested as shown in the first column. These time periods are chosen because generally, it will take 2 to 3 years to complete the housing project. The second column shows the summation of coefficients in the specific range. The probability values of the test are shown in the last column. The value in this column
tells us whether we can reject the null hypothesis that the summation of coefficient equals to 1.

The table shows that the summation of coefficients and probability value gradually decreases as less lag terms of “consent to commence work” are added. When the ranges are 7-13 or 8-13 lags, null hypothesis cannot be rejected at 10% significance level. When the ranges are 9-13 or 10-13, it cannot be rejected at 5% significance level. When three quarters are chosen, which is from 10 to 12, we can reject the null hypothesis at 5% significance level. It indicates that the amount of “consent” building floor area will spread out in the next couple quarters. In other words, the completion times for housing projects are usually different. In order to transform 1 m² of “consent” to 1 m² real completed building area, 2 to 3 years lag term of “consent” should be incorporate at least.

5.3.2 Restricted Model

The unrestricted model supports the hypothesis that the amount of consent can be fully transformed into new housing floor area given sufficient time. To get an efficient estimate, I will estimate a restricted model. I imposed the restriction that the summation of coefficients equals to 1. By substituting one coefficient out, I get the following basic estimation equation with 5 lag term of consent.

\[
Q_{t}^{\text{new}} = \eta_0 Q_{t-9}^{\text{Consent}} + \eta_2 Q_{t-10}^{\text{Consent}} + \eta_3 Q_{t-11}^{\text{Consent}} + \eta_4 Q_{t-12}^{\text{Consent}} + \eta_5 Q_{t-13}^{\text{Consent}} + \delta_t
\]

\[
1 = \eta_1 + \eta_2 + \eta_3 + \eta_4 + \eta_5
\]

\[
\eta_5 = 1 - \eta_1 - \eta_2 - \eta_3 - \eta_4
\]

\[
Q_{t}^{\text{new}} - Q_{t-13}^{\text{Consent}} = \eta_1 (Q_{t-9}^{\text{Consent}} - Q_{t-13}^{\text{Consent}}) + \eta_2 (Q_{t-10}^{\text{Consent}} - Q_{t-13}^{\text{Consent}}) + \eta_3 (Q_{t-11}^{\text{Consent}} - Q_{t-13}^{\text{Consent}}) + \eta_4 (Q_{t-12}^{\text{Consent}} - Q_{t-13}^{\text{Consent}}) + \delta_t
\]

The following table shows the testing results with the coefficient and P-value incorporating different range lags of “Consent” applying the restricted form shown above.
In the unrestricted model, the null hypothesis of the first four ranges of lags, which are from 7-13 to 10-13, cannot be rejected at 5% significance level. So I test these ranges of lags in my restricted model. The adjusted $R^2$ significantly increase comparing to the unrestricted model and all the coefficients from 9th to 12th lag are significant at 5% significance level. It tells us the lag term of “Consent” does significantly impact the “New Housing Completed” in the future. This restricted model test enables us to find the numerical relationship between the two variables.

### 5.4 Discussion

**Comparison between public housing and private housing**

To meet the housing demand, Government can either directly provide the public housing, or encourage developers to build more private housing by increasing land supply. My empirical results show that both of methods would have a negative impact on the private housing price. Since public housing and private housing are both incorporated in equation (3), it enables me to explore which one would have a larger...
impact on the private housing price. One challenge encountered is that we cannot compare them directly since the new private housing completed is measured in usable floor area, while the public housing is measured in units. So it is necessary to convert the public housing from units to usable floor area. Two types of public housing, public rental flats and subsidized sale flats are measured basing on “internal floor area” and “saleable area” respectively. Both of them are divided into two types, less than 40 m\(^2\) and 40-69.9 m\(^2\). Suppose the average usable floor area of these two types of public housing ranges from 35 to 50 m\(^2\), and then it is able to compare the effects of public housing and private housing directly. Under this assumption and using the coefficients of public housing estimated earlier, I can derive that every 1,000,000 square meters usable floor area of public housing will have a negative impact on housing price ranging from 5.0 points to 7.14 points. Comparing the effects of private housing-5.4 points per 1,000,000 square meters of usable floor area derived from table-3, our empirical results show that the effects of new private housing on private housing price is in the range of effects of new public housing on private housing price.

Even though both public housing and land auction tend to reduce housing prices with a similar magnitude, Government has more control over public housing supply. Unlike public housing supply, the lagged effect of land supply on housing price depends crucially on decision of real estate developer.

**Dynamic effect of land supply on housing price.**

The empirical result of the first component shows that there is a significant relationship between new housing completed and the housing price. The second shows that land supply positively impact the amount of “Consent to Commence Work”. And the third component indicates that the amount of “Consent to Commence work” will eventually become the new housing supply. Basing on these three components and the estimated coefficients, I can roughly calculate the extent to which, the land supply will affect the future housing price. The underling mechanism is that the land supply will increase amount of “consent” which will influence the future
housing completed, and the new housing supply will influence housing price. The following table shows the relationship among these variables.

**Table 7: The effects of land supply on housing price**

<table>
<thead>
<tr>
<th>Land (m²)</th>
<th>Consented (m²)</th>
<th>New Completed (m²)</th>
<th>Price Index</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lag Amount</td>
<td>Lag Amount</td>
<td>Amount</td>
</tr>
<tr>
<td>1000 m² increase of Land Supply</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>747</td>
<td>10 119</td>
<td>0.000643</td>
</tr>
<tr>
<td>2</td>
<td>747</td>
<td>11 294</td>
<td>0.001588</td>
</tr>
<tr>
<td>3</td>
<td>1256</td>
<td>12 527</td>
<td>0.002846</td>
</tr>
<tr>
<td>4</td>
<td>615</td>
<td>13 815</td>
<td>0.004401</td>
</tr>
<tr>
<td>5</td>
<td>643</td>
<td>14 772</td>
<td>0.004169</td>
</tr>
<tr>
<td>6</td>
<td>617</td>
<td>15 828</td>
<td>0.004471</td>
</tr>
<tr>
<td>7</td>
<td>895</td>
<td>16 640</td>
<td>0.003456</td>
</tr>
<tr>
<td></td>
<td>17 568</td>
<td>0.003067</td>
<td></td>
</tr>
<tr>
<td></td>
<td>18 405</td>
<td>0.002187</td>
<td></td>
</tr>
<tr>
<td></td>
<td>19 323</td>
<td>0.001744</td>
<td></td>
</tr>
<tr>
<td>Sum</td>
<td>5520</td>
<td>5174</td>
<td>0.03</td>
</tr>
<tr>
<td>41000 m² (Mean)</td>
<td>226320</td>
<td>212134</td>
<td>1.23</td>
</tr>
</tbody>
</table>

The second column shows the effects of every 1000 m² land supply on the next 7 quarters of “Consent to Commence Work”. The numerical effects are obtained from the coefficient of each land supply in the second component. The third column shows how the “Consent to Commence work” transfer to the new private housing completed. The numerical effects are derived from the coefficients of the restricted model with the 9th to 13th lag. Each quarter of “Consent to Commence work” will affect the following four quarters of “New Housing Completed”. So the first lag of “Consent” will impact the 10th to 13th lag of new housing completed, and the second lag of “Consent” will impact the 11th to 14th lag of new housing completed and the rest are deduced by analogy. The number of the last column is calculated by using the estimation of the first model that every 1,000,000 m² of new housing would decrease the housing price by 5.4 points.

The row of “Sum” shows the accumulated effects of every 1000 m² land supply on the housing market. It will increase the future housing supply by 5174 m², and as a result, decrease the housing price index by 0.03 points. It is expected that the increase
floor area of housing supply should be larger than that of land supply since residential building has many floors. The figure indicates the magnification effect of land supply on new housing supply is about 5 times. There are two possible reasons for this relatively small magnification effect. One is that the developers may hold the land longer than the period estimated in my model. The other reason may be that the housing supply is measured in usable floor area, which is significant less than registered floor area because it excludes staircases, lift landings, kitchens etc.

The bottom row shows the mean of quarterly land supply is 41,000 m², and it will eventually convert to 212,134 m² new housing supply in the next 2 to 5 years together. If we add its effect on housing price each quarter, the accumulated effects of each quarter land supply on housing price would reach 1.23 points.

The following chart shows the negative impact of every 1 m² land supply on housing price. It starts impacting the housing price at around 10th quarter, then it reach the peak at 13th to 15th lag before gradually dies out.

**Chart-7 Negative Effects of land supply on housing price**

![Chart-7 Negative Effects of land supply on housing price](image)

Some evidence for land hoarding behavior of real estate developers

My empirical studies indicate that the real estate developers may absorb the land supply into their land bank because it takes longer to convert the land supply into the housing supply. I apply the data set 7 used in Lai & Wang (1999) to support the

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7 Data Sources: Hong Kong Housing Bureau and the Hong Kong Monthly Digest of Statistics by the Hong Kong Census and Statistics Department; and Annual Reports of the four major developers
assumption of real estate developers’ land hoarding behavior. The following chart shows the annual new land supply of the Government and changes of four major developers’ land bank in gross floor area (m²) from 1979 to 1997.

**Chart-8: Land supply and changes in land bank**

It can be observed that 12 out of 19 years, the change of land bank for major developers are positive, which means the land bank increased comparing to the previous year. And clearly, the increase amount is significantly larger than the decrease amount, so the total amount of land bank continues to climb. The author did not explain the sudden increase of land bank in 1992, but the trend of total land bank is still upward and the developers will have more and more land resource. Though the land bank in their paper includes the land used for residential, commercial buildings and other purpose, their data is still able to give us an intuitive idea of the land hoarding behavior.
Chapter Six: Conclusion and Future Works

6.1 Main results

This thesis has investigated the effects of land supply, public housing on private housing price in Hong Kong. As few studies have studied the effects of public housing sponsored by the Government, this study would serve as a pioneer on this front. In addition, most literatures are not able to find significance relationship between land supply and housing supply in their empirical study; this paper add an intermediate variable called “Consent to Commence Work” that has never been used in earlier studies. This variable helps catch the dynamic effect of land supply on housing supply. Three hypotheses are brought up in the first chapter, and a model with three components is designed to test these hypotheses.

The results of model support the first hypothesis that public housing has a negative impact on the private residential housing price. Public housing serves as substitute to the private housing. When more public housing is put on the market, the demand for private housing should drop and the decreasing of price would be expected. It is also observed that new private housing completed will have negative impact on the private housing price. By assuming the usable floor area of public housing ranging from 35 to 50 m², the impact of private housing is in the range of effects of public housing on the housing price.

The results support the second hypothesis that the land supply by Government has a significant impact on the decision of the housing developers. When more land is provided to the developers, they tend to increase the amount of housing they apply to build. The response of developers does not necessary have to be immediate. In other words, developer may hold the land for a while until they think the time is suitable to launch a new project. Although a maximum development period is fixed under a lease,
they can easily apply for an extension. The housing construction application of the developers is represented by the variable “Consent to commence work”, and the result shows that it significantly impacts the amount of “New Housing Completed” in the follow 2 to 3 years, which is the normal time used for constructions. Since the land supply has a positive impact on the housing supply and the latter one is negatively related to the housing price. The effect of land supply on housing price is indirectly derived.

6.2 Comparison with other studies

The basic idea in this thesis is very similar to other existing related studies. Structural equations were built first, and then try to identify the factors that are going to influence the housing price or housing supply. The result of this paper agrees with Peng & Wheaton (1994) that land supply has negative impact on the housing price. The difference is that they studied land supply and housing price directly, while this paper gets the same result but using a different approach. Peng & Wheaton(1994) could not find a significant relationship between land supply and housing supply, probably because they did take into account the land hoarding behavior of developers as pointed out by Tse(1998). Lai & Wong(1999) may also suffer the same problem. This paper utilizes the intermediate variable “Consent to commence work” connecting the land supply and housing supply, which better capture the relationship between them. Besides, this paper use the quarterly data instead of annually, consequently a longer time series.

6.3 Policy indication

The property market contributes a significant part of domestic growth and it is the anchor for the social stability. The property industry investment has been contributed a significant part to the growth of total GDP. The market value of the company related to property industry constitutes over 30% of the total Hong Kong stock market value. So the property industry represents a large percentage of nation wealth of Hong Kong.
As Case etc., (2005) point out the housing wealth has an large effect on household consumption. All these factors demonstrate the importance of a healthy and stable property market to the overall economy and stability of Hong Kong. Currently, the housing price in Hong Kong is one of the most expensive areas in the world and it is hitting at a record high price level. It increases the Government’s concern over the possible housing bubble.

In order to curb the rocketing housing price, the officials pledge to increase more land supply in different events. The previous studies indicate that increase of land supply would not increase the housing supply. This paper shows that land supply does have negative impact on the housing price by increasing the future housing supply. Considering the land hoarding behavior of developers, the Government can pose more time restrictions on the construction plan for the land sold to developers. This paper indicates that the public housing also has a negative impact on the housing price. Since only the Government has the resource to start the public housing program, the alternative way of policy would be to increase the supply of public housing.

6.4 Limitation and Future works

Only a few number of factors that are incorporated in my thesis. I took the Hong Kong property market as a whole to study, but property market’s performance may vary in different areas of Hong Kong. This thesis hasn’t studied the specific behavior of a few large developers who dominate the Hong Kong property market development. Several areas are worth of exploring to improve this research.

Firstly, I apply the aggregate data of Hong Kong, it would be interesting to break them into three different district areas and study them separately.

Secondly, the property transactions are usually financed by the financial institution. In addition to buyers and sellers, the availability of funding is the key
dependency for the property market. The future studies can try to study the effect of monetary policy or the credit constraint on the property market.

The third point is the monetary policy of China. The China currency RMB has appreciated more than 20% against Hong Kong Dollar since 2005 and it is expected to continue appreciating. So it is not strange to observe that a large number of properties are purchased by the buyer from mainland China. It would be interesting to explore whether the appreciation of RMB and credit explosion in China after the financial crisis would play a role in affecting Hong Kong property market.

Last but not least, the Hong Kong private housing supplier is composed of a few major developers and some small developers. The future studies can put more effect to study the decision making process of these major developers.
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