THE UNIVERSITY OF HONG KONG

AN EMIPIRCAL STUDY OF THE IMPACTS ON RESIDENTIAL PROPERTY PRICES AT THE CONNECTION POINTS UPON BRIDGE CONSTRUCTION IN HONG KONG

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BY

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DECLARATION

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

Signed: ________________________________

Name: ________________________________

Date: ________________________________

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ABSTRACT

Upon construction of infrastructure and improvement in transportation, the property prices in the nearby areas were usually found to be of a positive effect. However, it is plausible for us to assume that due to the construction of a bridge linking a more accessible and a less accessible point together, the properties in the two ends of the bridge will become less heterogeneous and thus the differences in prices between the two locations' properties will be reduced. Moreover, it is also conceivable to believe that the decreased heterogeneity between properties will provide rational investors more choices in selecting the properties. Therefore, the reservation prices for flats situated in the originally more accessible location will become lower.

Most of the previous studies only study either the price changes in one location of the infrastructure or the price gradients. However, most of the studies are concerning about the effects brought about by the railway or tolled tunnel construction. Very few studies are done on the effects of a toll-free bridge. Apart from observing the changes in price gradients over time, this study is also aimed to put emphasis on the percentage changes in prices of the two connection points of the bridge.

Two alternative hypotheses are set to be tested the empirical results by using two Cross-Sectional Inter-Temporal Hedonic Pricing Models with a location control. Regression analyses are done to track the percentage changes in general price levels and the property price changes in the two distinct connection points. Also, price gradient approach is also adopted to test the changes in price gradients between property prices in the two locations over time. The results imply that after the construction of the bridge was completed, the net change in general property price level in the nearby areas is found to increase slightly by about 0.39%. Also, there exists an increase of 11.17% in property prices in the more accessible location while a significant drop of 19.09% in that in the less accessible point. The price gradients are also found to be reduced after the date of commencement. In short, the results show that the construction of the bridge cause an increase the property prices in the remote area while a drop in the urban location after the bridge construction. This provides extensive implications for the government to consider about the connection points of the infrastructure, so as to minimize opposition voices from the general public and plan the city of Hong Kong in a more sophisticated way.

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CHAPTER 1 Introduction

1.1 Background of Study

"Transportation is always a vital part of life."

This sentence is particularly true for people living in prosperous and developed cities like Hong Kong. With the quick pace of the city, Hong Kong people tend to consider convenience as one of the major factors when they are choose a place to live.

Highways, bridges and tunnel constructions in Hong Kong have been rapid since the 1990s. It is a common belief that people in Hong Kong expect higher residential prices should be charged for properties which are close to newly constructed bridges or highways. It is because they consider improved transportation network and degree of convenience as important factors which impose positive effects on properties, especially the ones situated at respective connection points. However, is it really the case?

Admittedly, it is quite reasonable for people to believe that improved transportation brings an uptrend to nearby residential property prices, especially the ones near the exits and connecting points of highways or bridges. However, let alone the negative factors like air pollution, noise pollution, and the nuisance imposed upon construction, there is another important mindset in arguing against the generally proposed uptrend. The mindset is mainly based on simple economic concept of market competition which relates to the demand and supply of slightly differentiated goods. The theoretical justifications will be discussed further in the following chapters.

Actually, some researches have been done on related issues in Hong Kong. However, most of the researchers did not mention the impacts on residential prices at both connection points after the construction of a bridge or highway. Instead, many researchers only focus on things like impacts on prices of residential properties situated in only one side of an infrastructure, impacts brought by railway construction or ad-hoc case studies like effects on one particular main road, but not actually focus on the study of trends of residential property prices at both connection points before, throughout and after the construction of the highways or bridges.

Also, after reviewing some information from the journals and websites, I have more reservations on whether the facts support the general rule of "residential property prices increase with improved transportation". Even there exists an impact on residential property prices, it may be a negative correlation between the two factors. Therefore, I am particularly interested in finding out the facts in the reality by carrying out this research, instead of sitting down comfortably and believing in what is taught by theory and common belief. It is because I still have a belief that even the theory is right, it may not be generally applicable as assumptions which simplify the complicated world may not hold in the reality, and some may be obsolete and become no longer suitable for the ever changing 21st century.

1.2 Research Question

The research question set for this study is whether the construction of a bridge necessarily induces the increase in the prices of properties situated near the two connection points. Before introducing the methodology to confirm the hypotheses, the effects on property prices of transportation improvements will be studied through literature reviews. Also, background information about the bridge and the two connection points will be discussed.

1.3 Objectives of Study

The Hong Kong Government has been investing a large sum of public money and improving the road transport systems continuously since the 1990s. With the improved road network system, it is expected that the remote areas will become more favourable for people to live due to the reduced transportation costs and commuting time.

In Hong Kong, most researches carried out have been focusing on the effects of housing prices brought about by the implementation of the railways or the construction of tunnels. However, little research has been touched upon the effects of a toll free bridge. A bridge, in my sense, may be a little bit different from the railway system as the construction of the bridge may not really benefit the two nearby connection points, but may be other towns or satellite areas further apart. Therefore, this study aims to question on the general theory that property prices will increase due to improved transportation. In order to achieve this aim, three objectives are set in carrying out the study:

- To study the relationships between the general price changes in properties of the two connection points and the construction of the bridge;
- To examine the effects of increased competition on the supply of properties due to the transportation improvements
- To discover the changes in price gradients before and after the construction of the bridge

1.4 Development of Hypotheses

In order to test the effects of Ting Kau Bridge construction on the housing prices of the two connection points, alternative hypotheses, named as Hypothesis 1 and Hypothesis 2, are set in order to test whether the facts support a particular theoretical justification or another.

<u>Hypothesis 1</u>

The first hypothesis is that transportation improvement, i.e. construction of the Ting Kau Bridge, would impose a positive effect on residential property prices in both connection points. The reason backing up this hypothesis is that as there are access roads from the entrance points of the bridge to both areas, the construction of such bridge improve the transportation network and enhance the convenience of both areas situated at the connection points of the bridge. Therefore, the improvement of transport convenience can pose an effect of purchasers having higher expectations, estimating higher values on those properties and thus having a higher reservation price for every flat in the areas. Therefore, the bridge construction consequently leading to an increase in property prices in both ends of the bridge is well supported by past researchers who studied the general price increase in related properties upon transport improvements, like railway lines and tunnels.

<u>Hypothesis 2</u>

The hypothesis which is incompatible to Hypothesis 1 is that the construction of the bridge only brings the property prices of the originally less accessible point to raise while that of the place originally nearer to the Central Business District (CBD) to decrease. Assuming that the same group of people originally living in Tsing Yi having ability to make choices on which place for them to live in, the improvement in transportation may cause them to consider living in Sham Tseng where the property prices are lower. The main reason is that the construction of the bridge can save time and cost of commuting in Sham Tseng and the difference in utility due to locational attributes may be reduced and thus the property prices in the less accessible point increases while that of the more convenient point decreases, due to the theory of market competition imposed by the properties situated in the less accessible end of the bridge.

In order to test whether the factual data support hypothesis 1 or hypothesis 2, certain criteria have been set in order to test the results, which is shown in the following table.

Hypothesis	Property prices in Sham Tseng	Property prices in Tsing Yi	General Price Level of the two ends	Change in Price Gradient
Hypothesis 1	Increase	Increase	Increase	Not explained
Hypothesis 2	Increase	Decrease	Relatively Constant	Flattened

Table 1.1 Testing Criteria on Alterative Hypotheses

Hypothesis 3

In addition, an additional hypothesis, Hypothesis 3, is suggested that the construction of the bridge would bring the flattening (or reduction) in housing price gradients between the two connection points of the bridge. The reason for proposing this hypothesis is that due to the improvements made to the transportation network, the originally less accessible point, i.e. Sham Tseng, can benefit more for the locational disadvantages with the opening of the Ting Kau Bridge and thus the property prices in Sham Tseng increase more in Sham Tseng than in Tsing Yi, causing a reduction in price gradients between the two areas.

1.5 Importance of Study

As the Hong Kong Special Administrative Region Government is now undergoing a lot of large projects like the redevelopment of Kai Tak area and the construction of the Express Railway Link, infrastructural works will be of an increasing trend in the future. The decisions of the government on situations of the highway entrances and connection points of the infrastructures are important issues that may lead to different effects of, not only to the more rural areas, but both the more urban and rural areas.

Apparently, the construction of the Ting Kau Bridge does little improvement to the residents in Tsing Yi as most of the residents living there are either going to the CBD, Kowloon Peninsula, or the nearby Kwai Tsing District to work, rather than travelling a long way to places like Sham Tseng, Tuen Mun or Yuen Long. However, it seems the bridge construction benefits the residents in Sham Tseng a lot as they can have a more convenient and swifter way to get to the city centre and avoid the traffic congestion problems which often occur in the Tsuen Tsing Interchange during peak hours.

In studying the impacts brought about by the Ting Kau Bridge project on residential property prices in Sham Tseng and Tsing Yi, it is expected that the impacts can be generalized into a more developed land planning and transport system designing concept by further study on other land use aspects, such as commercial and retails. Also, implications on urban and transport planning can provide a direction for the Hong Kong government to review the impacts of construction of a toll free bridge.

Moreover, by recognizing the effects brought about to all the stakeholders, implications can be taken into consideration on future projects by the government upon its transport planning and policy making issues in order to plan in a thoroughly considered manner, gain majority support from the general public, avoid controversial issues and minimize opposition voices from the society, such as the Express Railway Link (ERL) incident happened few months ago.

1.6 Methodology Outline

The dissertation aims to test the hypotheses raised in chapter 1.4 by employing the cross-sectional inter-temporal model, price indices graph and price gradient approach, by means of the uses of hedonic pricing models. The real prices of properties situated in Sham Tseng and Tsing Yi will be used for the study of such effects. Those effects will be tested in three steps. First, the hypotheses will be tested by comparing the differences in general price level of the properties in the areas of study and the control area before and after the construction of the Ting Kau Bridge. Then, real prices in Sham Tseng and Tsing Yi before, during and after the construction of the Ting Kau Bridge can be estimated through the introduction of interactive terms in the cross-sectional inter-temporal hedonic model. The results are further verified by the estimated graphs and figures of the price indices and price gradients generated from the regression analysis.

1.7 Structure of Dissertation

The structure of the study is designed as follows:

Chapter 1 Introduction

This chapter introduces the subject of the research. It consists of background of study, research question, objectives of study, development of hypotheses, importance of study, methodology outline and the structure of dissertation.

Chapter 2 Literature Review

Literature Reviews on studies about effects on property prices of transportation improvements will be discussed in this chapter. Also, study on competition imposed by improved transportation will be discussed.

Chapter 3 Background of Study

This chapter will present the basic information and history of the Ting Kau Bridge. Also, background information about the areas of studies, i.e. Tsing Yi, Sham Tseng and Tai Kok Tsui, will be touched upon.

Chapter 4 Methodology

Methodology for the research will be discussed in details in this chapter. Different Models for multiple linear regression will be set up to test the hypotheses developed. Additionally, descriptions of dependent and independent variables, the expected results and statistical tests will also be included in this chapter.

Chapter 5 Data Collection and Processing

Data collection and processing will be described in this chapter. Data selected to be included in the data set will be talked about in details. Apart from introducing some basic facts and statistics of the data set, sources and reliability of data collected will also be discussed.

Chapter 6 Empirical Results and Analysis

Empirical Results will be presented in this chapter. After the obtaining the results of the study, analysis on the results will be done and implications of the results will be brought upon.

Chapter 7 Conclusion and Discussion

This chapter concludes the findings, results and implications of the dissertation. Limitations of this dissertation, as well as suggestions for further study, will be discussed at the end of this chapter.

CHAPTER 2 Literature Review

The literatures about the impacts brought about by the transportation improvements on property prices are reviewed in order to form the basis of my study about such impacts brought about by the bridge construction on the property prices of the two connection points – Sham Tseng and Tsing Yi. Therefore, literatures are reviewed as follows.

2.1 Theoretical Arguments about Transportation Improvements

The early theories which touch upon the impacts of the property prices, or in the older term, land rents, can be traced back to Hurd's study. As Hurd (1924) summarizes "*since value depends on economic rent, and rent on location, and location on convenience, and convenience on nearness…*", the presence of the word "*convenience*" implicates that geographical location is no longer the only concern in determining the rents, but transport network and its development are also taken into consideration. So, in my understanding, what Hurd wants to imply is that the improvement in transportation network leads to the geographical advantage which was originally enjoyed by the land closer to the city centre becoming less influential upon the determination of rents, and thus of property prices.

Haig (1927), on the other hand, explains the concept that property prices are affected by transportation improvement in his proposed concept about "friction of space". As proposed by Haig that the term "cost of friction" (of space) consists of site rentals and transportation costs, an infrastructure, such as the bridge under this study, will essentially reduce the transportation costs in some sense and "overcome" that “friction of space”. As he proposes that better transportation can lessen the friction and the effective mix of land uses can minimize the aggregate “cost of friction” to the society, we may rationally believe that each improvement in transportation may lead to the reallocation of land uses as such transportation improvement changes the “cost of friction” of various locations differently.

Alonso (1960) also supports the idea of Haig as he further establishes a trade-off theory in explaining the rents of the lands are of inverse proportion to the cost and time of commuting. With his illustration of the diagram of bid-price curves, he explains the abovementioned trade-off theory with different points along the negatively-sloped straight line while includes the degree of satisfaction of the bidders with the shifts of the bid-price curves.

And upon the further study by Alonso (1960) and Alcaly (1976) upon the impacts of transportation improvements on land rents, they propose that the land rent near the city centre is reduced while that of a site distant away from the city centre is increased upon the improvements in transport. Though both the study by Alonso and Alcaly are of no empirical support as they focus on the discussion in economic terms, their study form the basis of hypothesis 3 of my study in order to test whether this economic theory proposed is applicable to the residential markets in Hong Kong.

Though Alonso (1960) and Alcaly (1976) agrees with what Haig (1927) proposes and further develop their ideas on land rent upon transportation improvements, there also exist some rejection of Haig’s theory. Ratcliff (1949) rejects the concept proposed by Haig on the basis of behavioural economics. Ratcliff proposes that a phenomenon of overbidding of land by humans due to “the highest bid wins” system, implicating that the transport improvements may not lead to a decrease in total "cost of friction" as there is no support to judge whether the extent of increase in overbidding of site rents is greater or that of the decrease in transportation cost is greater. Therefore, what Ratcliff proposes may indicate the reason why hypothesis 1 may not stand. Therefore, hypothesis 2 is also proposed in order to test whether the empirical results support the argument that property prices are overbid at first and dropped drastically as the "friction of space" is not overcome as much as it is expected.

For the theoretical arguments about the impacts on property prices upon transportation improvements, the abovementioned theories only provide a general concept that the improvement in transportation can reduce the cost and time of commuting but they do not arrive at a general acceptance on whether such improvement lead to an increase or a decrease in property prices in the originally more urban area, also called the originally more accessible point. As main focus in my study lies on the price changes in not only the less accessible point, but also the more accessible point, it is considered essential to undergo an empirical study on the originally more accessible point in my dissertation as no prior theory has any direct implication on this issue.

2.2 Previous Studies about Transportation Improvements

In finding out the previous studies about the relationship between the property or land price and the improvement in transportation, there are actually quite a lot literatures related to the issue. Some of the examples are Antwi (1993; 1994), Dewees (1976), Forrest et al. (1992) and Stucker (1975).

In some of the studies, some researchers support the theory that improvements in transportation essentially pose positive impacts on residential prices with their studies. For instance, Du and Mulley (2005) suggest that improved transportation system would have an increased property value for areas close to the city centre by confirming the trend of gentrification. In addition, by researching the special pattern of land values in Jakarta, Han and Basuki (2000) reinstates the positive impacts with figures showing that the nearer the land to the highway entrance, the higher its property land values, implicating that a new highway connection point created would always have a positive effect on residential property prices. In Yiu and Wong's (2005) "*The Effects of Expected Transport Improvements on Housing Prices"*, they study on the effects imposed upon the construction of a new cross-harbour tunnel and find out that there would be a positive expectation effect on property prices during the construction period of such tunnel. They confirm that the positive price effect brought about by the improved transportation network and recognize the positive expectation effects on housing prices brought about by such improvements of the transport network in Hong Kong.

The anticipated effect of improved transportation on housing prices is also proved to exist by Agostini and Palmucci (2008). They study the impact on housing prices along the newly built metro line and arrive at a result that the average price of such apartment marked an increase from 4.2 percent to 7.9 percent upon the announcement of the construction. Also, the study reveals that the degree of increase in capitalization is of a close relation to the distance between the stations and the location of the apartments by stating that the closer the apartment to the metro line station, the higher the capitalization increase. Furthermore, in Voith (1991), it is found that the housing prices has capitalized some part of the value of the commuter rail systems, with an effect of about 6% of such value in aggregate for houses in the sub-urban areas.

Even for the study by *Tomkins et al.* (1997) on the topic of "*Noise versus Access: The Impact of an Airport in an Urban Property Market*", it is concluded that the local property market in England is positively influenced by the development of Airport in terms of the ease of access and employment opportunities created. The boost in housing prices within the local market suggest that the positive influences are rated much higher than the negative impacts, such as noise, brought about during the construction and operation of the airport.

However, some researchers like Glascock *et al.* (2008) suggest that the improvement in transport convenience imposes an inconsistent effect on housing prices in Hong Kong and state that the value of transport convenience should not be overstated in high-density metropolitan areas. The study suggests that the impact of transport convenience on housing prices is not constant over time, and tend to vary across regions. Besides, Bae *et al.* (2002) prove that a tunnel called Subway Line 5 in Seoul has brought very little positive impact on the nearby residential property prices as its impact is researched to be even less than the one due to the accessibility to a nearby river, indicating that the transport convenience factor is minimal. Furthermore, Henneberry (1998), on his study of the impacts by the provision of trams, suggested a significant drop in property prices upon the announcement of the tram construction. The drop is later followed by a recovery increase in prices of such properties after the date of completion. This suggest that the improvement of such transport network does not significantly bring property prices to an increase, as opposed to the theories and studies abovementioned.

On the other hand, some ad-hoc examples suggested by researches are done in rejecting the classical scholars' theory of increased land prices due to improved transportation. According to another research done by Du and Mulley (2005), the improved accessibility only makes a house easier and quicker to be sold, i.e. increase the liquidity of the asset (house), rather than increase the value of the residential property, in a research study on short-term land values in Sunderland after the completion of urban rail transit construction.

For studies of such effects in Hong Kong, a research done by Chau and Ng (1998), revealed that improvement in public transportation has a negative effect on the price gradient with their study on one-building-per-station residential property prices along Kowloon-Canton Railway stations with the topic of "*The effects of improvement in public transportation capacity on residential price gradient in Hong Kong*". Also, upon their railway study, price gradient in property prices along the transportation line decreases as the time cost of commuting is reduced with improvements done to enhance public transportation. In addition, So *et al.* (1997) carried out a study of the impact brought by public transport and found out that there exists a positive price effect on property prices upon the provision of minibuses' routes and presence of subway stations in Hong Kong.

Apart from that, as mentioned above, Yiu and Wong (2005) find out the presence of positive expectation effect on property prices during the construction period of the Western Harbour Tunnel and the reduction in price gradients upon the construction period. Therefore, the changes in property prices seem to follow the general trend to increase upon transportation improvements. However, these study often focus on one side of such infrastructure, rather focusing on both connection points of the infrastructure.

Besides, in Yiu's (2007) "*Housing Price Gradient Changes between Macau and Hong Kong*", it is conducted through the spatial-temporal differencing method developed by Yiu and Tam (2007) and concluded that the housing price gradient between the two cities become flatten upon increasing visiting frequency between workplaces. It is sensible for us to believe that visiting frequency is closely related to the transport convenience, so that improved transportation, such as constructions of bridges, tunnels or highways, increases the visiting frequency and thus flattens the price gradient between two places. Tse and Chan (2003) studied the price gradient in terms of transportation cost and time needed to get to the central-business district. By using 600 random transactions, a major result is drawn to be that the price gradients on time of commuting and cost of transportation were negative.

2.3 Competition induced upon Transportation Improvements

Hurd (1924) applies the theory of market competition on the land values in order to figure out the competition that is induced by both the bidders and the situation of land. He raises the competition theory to discuss the selling of land to the highest bidder. Also, he states that upon improvement in transportation, the average land values depreciate due to the increase in supply of lands upon the increased accessibility. This competition on “supply of land” is the basis of this research about the impact posed by the originally less accessible point, Sham Tseng, on the originally more urban area, Tsing Yi, upon the construction of the Ting Kau Bridge.

By theoretical justification, it is sensible for us to believe that assuming the living environment and quality of housings in Sham Tseng and Tsing Yi are indifferent, the only difference in their property prices is due to the difference in locations which is closely related to the transportation network and accessibility to the CBD because most of the residents living in these new towns or remote areas come to the city centre to work in daytimes. Therefore, with the construction of Ting Kau Bridge, the transportation from one location to another is improved. But on the other hand, the accessibilities to the CBD are becoming less different as the toll-free transport improvement enables residents from the less accessible point to have a shorter commuting time and even a lower commuting cost to get to the CBD.

However, the construction of Ting Kau Bridge cannot reduce the time and cost of commuting of the Tsing Yi residents to get to the CBD. What is more is that the construction of Ting Kau Bridge may pose extra burden to the roads from Tsing Yi to the CBD and may impose more traffic congestion to the Tsing Yi residents as Tsing Yi may act as a transportation transition point upon the journey from Tuen Mun, Yuen Long and Sham Tseng to the CBD.

Furthermore, as the improved transportation leads purchaser to act more indifferently between purchasing a flat in Tsing Yi and Sham Tseng, the decrease in heterogeneity of flats may lead people to think that the flats at two locations are closer substitutes. In viewing the property price in Tsing Yi, as there are increase in supply for such “substitutes” while at the same time the Ting Kau Bridge does no or even negative improvement in transportation, the property price in Tsing Yi can be reasonably deduced to be negative upon the construction of the bridge, with other factors being constant.

The property prices in Sham Tseng are also believed to be a lower one, as transportation is not as good as Tsing Yi and the shopping centers there are not as large-scale as that in Tsing Yi. Therefore, when transportation is becoming more facilitative and convenient for the originally less accessible point, it is believed that some investors may hold the speculative behavior for investing those properties in Sham Tseng while some other purchasers may rationally choose a location with lower rents and property prices, and switch to live in Sham Tseng.

CHAPTER 3 Background of Study

In studying the impacts of the Ting Kau Bridge construction on the property prices of the two connection points, it is essential for us to know more about the background of the Ting Kau Bridge, the two location points – Sham Tseng and Tsing Yi and the control area – Tai Kok Tsui. Therefore, a more detailed study will be done on the bridge and the selected areas for the study in this chapter.

3.1 Background Study on Ting Kau Bridge

3.1.1 Basic Information about Ting Kau Bridge

The Ting Kau Bridge is a long cable-stayed bridge which links the North West Tsing Yi Interchange with the Tai Lam Tunnel of the country park section (CPL) of Route 3 and the Tuen Mun Road of Route 9. The total length of the bridge is 1,177 meters, consisting of two major spans of 448 and 475 meters and two 127-meter span at the two ends. It was supported by three towers, which are located on the Ting Kau headland, a reclaimed artificial island in Rambler Channel and the northwestern part of Tsing Yi respectively.

There are a three-lane traffic highway and a hard shoulder on each side of the towers which can resist extreme wind loads and typhoons. The toll-free bridge is a part of Route 3 which connects the northwest New Territories and the western part of Hong Kong Island.

As a government infrastructure, the Ting Kau Bridge project was tendered to and completed by the Ting Kau Contractors Joint Venture. The Joint Venture, comprised of Paul Y of Hong Kong, Downer and Co. of Australia, Ed. Zublin of Germany, Cubiertas Y MZov and Entrecanales Y Tavora of Spain, won the Ting Kau Bridge and Approach Viaduct contract of HK$1.94 billion from the Hong Kong Government. The date of commencement of works was on 23rd August, 1994 and the works are completed on 6th May, 1998.

3.1.2 Ting Kau Bridge in the Transport Network

In order to study the effect on the connecting places' property prices, the whole network of the related road systems in the nearby areas should be studied. First, we have to take a brief look on the route 3 in order to figure out the significance of the Ting Kau Bridge.

Before the construction of the Ting Kau Bridge, as shown in blue line in the following diagram, the quickest way to get to Sham Tseng from Hong Kong Island or Kowloon is to go along Route 5 (through Kwai Chung Road and Tsuen Wan Road), then switch to either Castle Peak Road or Route 9 along Tuen Mun Road. Upon the growth in population in Tuen Mun, as well as in Sham Tseng, the original road network imposed a serious congestion problem in Tsuen Wan. Therefore, Ting Kau Bridge is decided to be built in order to solve the problem.

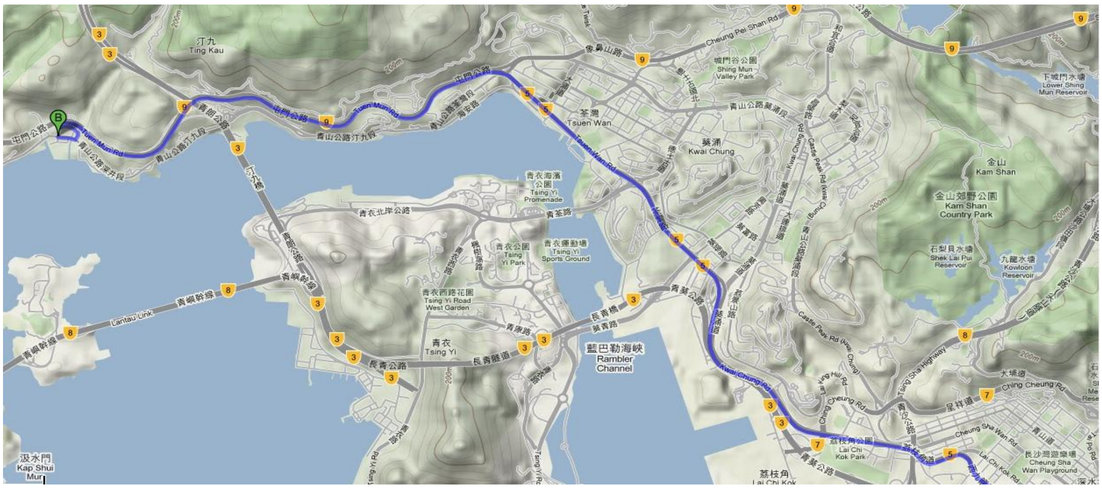

Figure 3.1 Route from districts in Kowloon to Sham Tseng before construction of Ting Kau Bridge

Upon the construction of the Route 3 as illustrated in the following diagram, Ting Kau Bridge serves as an infrastructure to divert the traffic from Tuen Mun, Sham Tseng and Yuen Long, as well as to provide an expressway to connect the western New Territories with the Hong Kong International Airport. The more remote areas, such as Sham Tseng, Tuen Mun and Yuen Long, are thus believed to benefit a lot from the construction of the Ting Kau Bridge as the bridge enhances transportation from Sham Tseng and other remote areas to the Kowloon Peninsula and the Hong Kong Island, as well as the Central Business District (CBD).

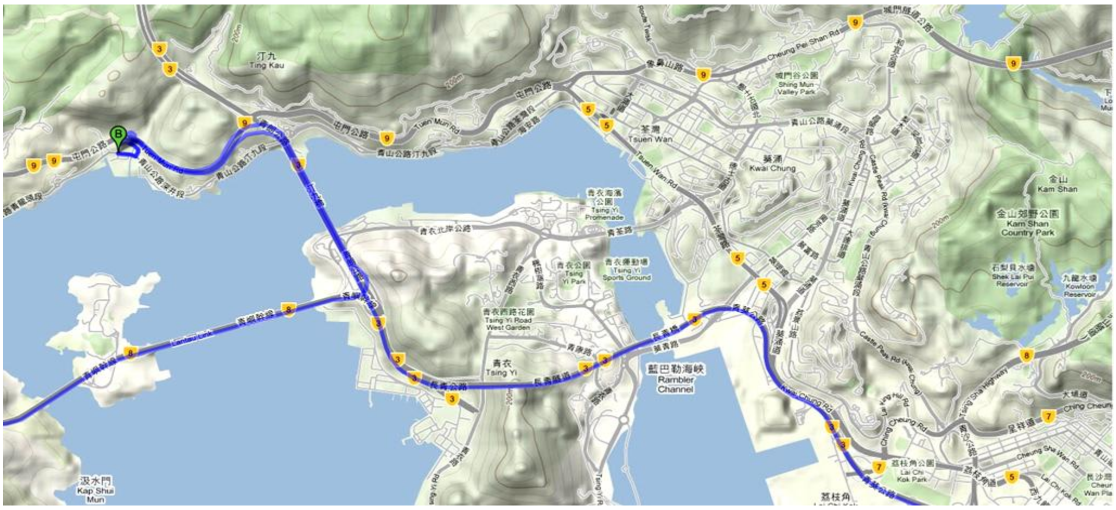

Figure 3.2 Route from Hong Kong International Airport and districts in Kowloon to Sham Tseng before construction of Ting Kau Bridge

However, the effect of the bridge on the property prices of Tsing Yi may not benefit much as the bridge only provides improved accessibility of Tsing Yi to more remote areas in the New Territories such as Yuen Long and Tuen Mun. Therefore, upon a closer look in the background of the connection areas, by theoretical justification, hypothesis 2 is believed to be more reasonable to hold.

3.2 Background Study on the connection points

3.2.1 Background Study on Tsing Yi

Tsing Yi is an island of about 10.69 km^2, situated in northwest of the Hong Kong Island, north of the Stonecutter's Island, west of Kwai Chung and southwest of the developed new town Tsuen Wan. Originally, Tsing Yi was of a smaller size. However, upon large-scale reclamation and annexation of two nearby islands, Nga Ting Chau and Chau Tsui, the Tsing Yi Island expanded a lot to enable its development towards a new town in the New Territories.

Before the development of residential hub, Tsing Yi was an industrial area with factories, plants, storage centers and even power stations. Back from the 1920s, a site on Tsing Yi Island was developed into a lime (calcium compound) factory. The heavy industrial factories, ship-manufacturing factories and oil depots also move in and occupy the sites on the Tsing Yi Island to turn the island into an industrial hub.

As more and more industries move onto Tsing Yi, the entrepreneurs of those companies realized the need to have road transport access to the island and thus six companies formed the Tsing Yi Bridge Company Limited and built the Tsing Yi (South) Bridge running over the Rambler Channel with a HK$17 million construction cost. With the cooperation of the Hong Kong Government in contributing HK$7.5 million in linking the bridge to the nearby road transport, the accessibility from the Kowloon Peninsula, Tsuen Wan and Kwai Chung to the Tsing Yi Island was greatly enhanced and thus population in Tsing Yi began to rise.

The government, following the completion of the Tsing Yi Bridge, decided to develop Tsing Yi as a residential new town with developing two large-scale public housing estates in the late 1970s, three public estates and four Home Ownership Scheme (HOS) housings in the 1980s.

However, the development of residential units in Tsing Yi also faced some problems. For instance, due to the potential dangers imposed by the Mobil's oil storage depot on the Island, the development of Mayfair Garden, which is of close proximity to the depot, was hindered and the last phase of the development was halted by the government in order to resolve the public concerns questioning about the safety issues and such hazards aroused from the presence of the oil depot. Therefore, as can be seen in the data set, Block 1 to 4 of Mayfair Garden was not built due to the abovementioned incident.

Due to the drastic increase in population and traffic upon the government housing development policy, the dual one-way Tsing Yi (South) Bridge was overburdened and traffic congestions often occurred as a result. Therefore, the Government decided to build the Tsing Yi North Bridge, or called Tsing Tsuen Bridge, to solve the congestion problem. The North Bridge, connecting Tsing Yi and Texaco Road Roundabout in Tsuen Wan, was completed on 10th December, 1987 by a Japanese contractor.

The selection of properties in the study takes the history of Tsing Yi into account and thus chooses Mayfair Garden, which is a development project started just after the completion of Tsing Yi (South) Bridge, Tsing Yi Garden, which is a residential development after the reclamation of the Tsing Yi Tong and Mun Tsai Tong and before the construction of Tsing Tsuen Bridge, and Greenfield Garden which is built after the completion of the Tsing Tsuen Bridge.

The construction of Tsing Ma Bridge to the newly constructed International Airport in the Lantau Island and the commencement of Ting Kau Bridge improved the transportation of Tsing Yi to the Lantau Island and the northwest New Territories. Also, the construction of those infrastructures in the Airport Core Project (ACP) before the resumption of sovereignty in 1997 led Tsing Yi to become a transition point for citizens in the urban areas to get to the Airport, Lantau Island and other areas in the western part of the New Territories.

The more expensive residential projects have flourished since the announcement of the construction of the MTR Airport Express and Tung Chung Line via the Tsing Yi MTR Station in November, 1994. More and more quality housing blocks, such as Villa Esplanada, Grand Horizon Tierra Verde and Mount Haven were built after the announcement of the works. The developments in Tsing Yi have not been stopped by the Asian financial crisis in 1998. In the contrary, the large-scale private housing projects proceed until 2003 when Rambler Crest was completed.

With the establishment of the new public transport terminal near the Tsing Tsuen Bridge, the opening of the Tsing Yi North Coastal Road on 1st February, 2002 and the introduction of the mega-shopping centre, the Maritime Square, Tsing Yi has successfully "turned around" and becomes a residential area with bulks of quality residential blocks.

3.2.2 Background Study on Sham Tseng

Sham Tseng was originally a place where Sham Tseng Village was located. In the old days, apart from the village houses, there were no residential units in this area. Instead, some of the factories did move into Sham Tseng to operate due to its low land price and proximity to the former popular industrial area – Tsuen Wan.

The first famous factory operating in Sham Tseng was the Sham Tseng Brewery, which was the former company of the San Miguel before 1969. Sham Tseng Brewery began its operation in 1948. Then, the bakery giant Garden Company Limited moved into Sham Tseng in 1962. After five times of expansion, the Garden Company Limited is now acquiring the land next to the Bellagio with the total area of its factory being 70,000 square meters.

Due to the originally small population in Sham Tseng, the transport, recreational and public facilities for the residents, as well as the villagers, were insufficient. However, in the 1980s, some developers spotted out the outstanding characteristics of Sham Tseng that the residential units there can provide the residents good scenic seaviews of Lantau Island and the Ma Wan Channel, as well as great variety of famous restaurant meals and tranquil environment. These developers then went on to develop Sham Tseng by constructing large-scale quality housing estates, like Lido Garden, Rhine Garden, Sea Crest Villa and Rhine Terrace.

However, the transportation network connecting Sham Tseng and the nearby areas is still not sophisticated and traffic congestions often occur in both Castle Peak Road Sham Tseng section and the road connecting Sham Tseng to Tuen Mun Road. Therefore, the government, though facing limitations due to the landscape on which the Tuen Mun Road sits on, tried its best to expand the expressways in Tuen Mun Road and constructed Ting Kau Bridge in order to provide another exit to divert the traffic on Tuen Mun Road.

Upon the traffic improvements were made, luxurious housing blocks, such as Ocean Pointe and Bellagio, were built along the coastal line in order to exploit the potential of Sham Tseng and the close proximity from the housing units to the seashore, with the pleasant view from the Rambler Channel, Tsing Ma Bridge, Ma Wan Channel, to the Lantau Island.

The expansionary expressway works in Tuen Mun Road is still an ongoing project carried out by the Gammon Construction Limited and it is expected that the road system to Sham Tseng is going to be more comprehensive and capable in solving the congestion problems. Therefore, it is of no surprise that developers will continue acquiring and developing lands in Sham Tseng in the near future although no sites can be found in the List of Sites for Sale by Application (Application List) 2010-2011 published by the Lands Department of the Hong Kong Government.

3.3 Background Study on Control Area – Tai Kok Tsui

Tai Kok Tsui, situated in the south of Sham Shui Po and west of Mongkok, is originally an old district with a lot of aged and even obsolete buildings. It was an old district which was developed by the government since 1928. At the beginning, Tai Kok Tsui was mainly an industrial area with the presence of dockyards, town gas plants and a lot of metal production factories.

In the 1950s, more residential housings were built in Tai Kok Tsui and made Tai Kok Tsui a residential-industrial mixed area. The industrial buildings were redeveloped into commercial buildings since the industries moved to the mainland China in the 1980s. However, the public order in the district had not improved at all. Robberies, attacks on police officers and violent incidents could still be found in the area, making the district unpleasant for residents to live in.

After the West Kowloon Highway was completed on 20th February, 1997, there were residential housings beginning to be built such as the Olympian City, Central Park and Island Harbourview. The construction of West Kowloon Highway, however, cannot benefit Tai Kok Tsui a lot as the accessibility from the highway to the area as the Highway only provides exit near Jordan but no direct entrance from the centre of the Tai Kok Tsui area to the Highway is provided. But the residential housings, together with the adjacent shopping malls and brought-about commercial developments, to some extent, revitalized the coastal part Tai Kok Tsui into a place which gives residents a better impression and developers more incentives in developing the area.

With the construction of Olympic MTR Station and Nam Cheong MTR Station due to the construction of MTR Tung Chung Line and the former KCRC West Rail, more major developments were introduced into the district, bringing an increase in both passenger and pedestrian flows. The residential development trends are still continuing with the sale of two newly constructed development projects, namely Florient Rise and Shinning Heights.

Choosing Tai Kok Tsui as the controlling point in the study is to act as a reference point to counter off the effect of railway station construction in Tsing Yi. As there exist both constructions of railway stations in Tai Kok Tsui and Tsing Yi, and as the presence of Tsing Yi station may impose a positive impact on the property prices on Sham Tseng as well due to the introduction of a new green-minibus line from the Tsing Yi MTR Station to the centre of Sham Tseng. Therefore, in order to study the effect of the Ting Kau Bridge while eliminating the effect brought about by the railway transport improvement, Tai Kok Tsui is chosen to be the controlling point where the major improvement in transportation is the railway station as the West Kowloon Highway. Due to the lack of entrance to the centre of Tai Kok Tsui area, the Ting Kau Bridge is assumed to pose little impact upon the properties in the area.

Therefore, with reference to the change in property prices in Tai Kok Tsui, it is assumed that the results are mainly due to the effect of the Ting Kau Bridge construction, rather than the opening of the Tung Chung MTR Station.

CHAPTER 4 Methodology

This chapter of the dissertation is to identify the methodology used in the research in order to investigate the effects on property prices at the two connection points before and after the construction of the Ting Kau Bridge.

4.1 Hedonic Pricing Model

In the study of the effect on residential property prices at the two connection points upon bridge construction in Hong Kong, multiple linear regression technique is applied to generate the result of the study. Among various multiple linear regression models, hedonic pricing model, first used by Griliches (1961) in his fixed asset study, is considered to be the most suitable for the study due to the heterogeneous nature of residential properties.

4.1.1 Application of Hedonic Pricing Model

Hedonic pricing model is one of the econometric means to study the prices of a good, or a set of goods, which consist of different characteristics "implicit" in it. With the definition of Rosen (1974), hedonic pricing model is applied to estimate "the implicit prices of attributes" (Rosen, 1974), as well as to identify the "observed prices of differentiated products and the specific amounts of characteristics associated with them" (Rosen, 1974).

The hedonic pricing model is widely used due to its ability to solve the problem of differentiated residential properties in the reality as the effect on prices induced by every characteristic of the properties under investigation can be calculated separately. In this study, price will be investigated as dependent variables because the effects of each attribute, called independent variable, will be reflected as coefficients for further analysis of the implicit general prices of the attributes in chapter 4.5.2.

Different purchasers may rate the attributes' effects differently in money terms, upon both signs and magnitudes. Due to the difference in behavior of the market players, hedonic pricing model can only estimate the general trend of the effect of a specific attribute on prices where ad hoc examples may arise. Therefore, the result from this study is only the general impact on residential prices at the two sides before and after the construction of the Ting Kau Bridge.

4.1.2 Attributes in Hedonic Pricing Models

In determining the price of a flat, a rational person would take various attributes from that particular flat into consideration as to decide his reservation price for that particular flat in an economic point of view. Therefore, upon the study of the relationship between the construction of the bridge and the property prices, several determinants will be included as independent variables in order to account for the effects brought about by these attributes and verify the regression results.

Upon determining the attributes to be included as independent variables, various journals provide different suggestions. According to Little and Yinger (1977), attributes such as location, structural characteristics, public services within the community and surrounding environment are regarded as important attributes in setting the prices of residential properties.

There are a lot of literatures concerning summarizing different determinants of residential property prices into various categories (Bajic, 1983; Guntermann and Norrbin, 1987; Sirpal, 1994; Mok et al., 1995; Huh and Kwak, 1997). Generally, the determinants are grouped into three different categories – structural, location and neighbourhood. However, upon the study in a time-series manner, it is considered important for us to introduce an additional category of time in order to explain the time effects brought about by various events such as economic upsurge and downturn.

In conclusion, I would like to group the attributes that is considered influential to the residential property prices into the following table:

Attributes	Categories	Description Details
Age	Structural	Age of building at transaction date
Floor		Floor level of the housing unit
GFA		Gross Floor Area of the housing unit
Sea View		Presence of sea view from housing unit
Location dummy variables	Location	Location of housing unit, either in Sham Tseng, Tsing Yi or Tai Kok Tsui
Period dummy variables	Time	Period of construction of the Ting Kau Bridge when transaction took place
Location-period interaction terms	Interaction Term (Location-Time)	Effect of bridge construction on the price difference between locations
Time dummy variables (from 1992Q2 to 2009Q4)	Time	Quarter in a year at which transaction of housing unit took place

Table 4.1 Description and Classification of Housing Attributes

In the study of effects on prices of residential properties at two connection points upon the construction of Ting Kau Bridge, it is assumed that all the attributes introduced into the estimation equation are known and the buyers act rationally to form the transaction price according to those attributes.

4.2 Multiple Linear Regression

In the study, multiple linear regression technique is used to estimate the effect on prices by different attributes, no matter that they are of location, structure and time. By setting price as the dependent variable, the impact and relationship between various independent variables and the dependent variable can be estimated and identified upon data analysis.

Multiple linear regression can be expressed in the form of equation where:

$$y_i = \alpha_0 + \sum_{i=1}^{n} \alpha_i \times x_i + \varepsilon_k$$

$y_i = Dependent\ Variable$

$\alpha_0 = constant\ term\ (y - intercept\ of\ the\ regression\ line)$

$\alpha_i = coefficient\ of\ i^{th}\ independent\ variable$

$y_i = Dependent\ Variable$

$\varepsilon_k = residual\ value\ or\ error\ term$

Ordinary Least Square (OLS) method is also employed in the proposed models as the principle underlying in this method aims to estimate the best fitted regression line by minimizing the sum of the residuals' squares.

4.3 Functional Form

4.3.1 Importance in Selection of Functional Form

Upon a hedonic pricing model, decision on choosing which functional form is very influential. There are a lot of functional forms, such as the linear form, semi-logarithmic form, logarithmic form and polynomial form. These functional forms have been widely used by various scholars all around the world to study the effects on property prices. Linneman (1980) stated that the choice of functional form is crucial as a suitable functional form can provide a much more accurate and significant result when Rosen (1974) adopted the approach of determining the form by achieving best-fit (R^2) obtained by the regression.

When determining which form should be used in this study, the focus is on the definitions and the statistical implications that every functional form gives. Semi-logarithmic form can provide statistical implication of that the coefficients of an independent variable represents the percentage increase or decrease of the dependent variable when change in one unit in that particular independent variable occurs.

4.3.2 Application of Semi-logarithmic Form

The general equation for semi-logarithmic hedonic pricing model is as follows:

$$ln(y) = \alpha_0 + \sum_{i=1}^{n} \alpha_i \times x_i + \varepsilon_k$$

where

- y represents the dependent variable
- α_0 represents the constant or intercept term
- α_i represents the coefficients of the independent variable i
- x_i represents the independent variable
- ε_k represents the residual value or error term

As the study is mainly focus on the percentage increase or decrease of the housing price during and after the construction of the Ting Kau Bridge, as compared to the one before construction, it is considered suitable to apply this semi-logarithmic as the functional form in this study.

4.4 Eliminating Time Effects by introducing Time Dummy

As in Hong Kong, the residential property sector is very much influenced by the performance of the Hong Kong Stock Exchange as "*the correlation coefficient between the growth rates in stock prices and residential real estate prices is 0.553*" (Tse, 2001). The impacts on different properties, however, are not of the same extent, for instance, an economic downturn may influence more on newly developed luxurious housings than the 20-year-old building blocks. Therefore, though Hang Seng Index is proved to be partially correlated to the residential prices, it should not be employed as a price deflator to explain the time effects in the model.

Some other scholars adopted the approach using the general property price index for the entire country or city to account for the time effects. However, criticisms arose as properties in different districts may have different price changes in the same horizon of time, so some scholars proposed to use a location-time price index in order to provide a higher precision for deflating the prices. In the study of effect of improvement and electrification of the Kowloon-Canton Railway (KCR) on residential prices, Chau and Ng (1998) deflated the transaction price by using the location-time residential price index. That deflator took account for location, time, use and class of the properties. However, this is also not accepted by some scholars as the price index may include properties without the data sets under investigation and thus a more specific approach was suggested empirically by Yiu and Wong (2005).

A more specific approach is to introduce a "time dummy" to capture the effects brought about due to the different time periods in which transactions are being made. This "*intertemporal approach by using a time dummy*" (Yiu and Wong, 2005) to track the residential property price changes before and after transport improvements have been adopted by Yiu and Wong (2005). As this approach can explain the time effect using all data sample under investigation, it can eliminate the disadvantage of data from being affected by transactions of "external" properties. Therefore, it is considered to be a more appropriate method to eliminate the time effects due to various events, for instance, economic situations upon the dates of transactions.

4.5 Construction of Hedonic Pricing Models

4.5.1 Testing of Alternative Hypotheses

In order to test the hypotheses, we have to construct models on a step-by-step approach in order to test the effects brought about by the construction of the Ting Kau Bridge on the two connection points, Sham Tseng and Tsing Yi. Before constructing the models, the hypotheses should be briefly outlined for the selection of the appropriate methodology.

Hypothesis 1 and Hypothesis 2 are two alternative hypotheses which cannot be held at the same time. Hypothesis 1 refers to the positive effects on housing prices in both areas with exits of the bridge due to the construction of the bridge. This hypothesis states the assumption that the competition induced within two areas is minimal and thus negligible. Hypothesis 2, however, states clearly that the competition of residential properties in the two areas will become more fierce upon the construction of the bridge as such transport improvements lead to the reduction in locational advantages enjoyed by properties in the originally more accessible connection point, which means Tsing Yi in this study.

Sham Tseng and Tsing Yi are selected because of two major reasons. First, the two places are adjacent to the vehicle entrances of the bridge, so it is expected that the influence upon the construction of Ting Kau Bridge lies on these two locations most significantly. Second, the private housing units in these two areas are of high homogeneity and number of recorded transactions in these housing units is considered adequate and sufficient throughout the periods of study.

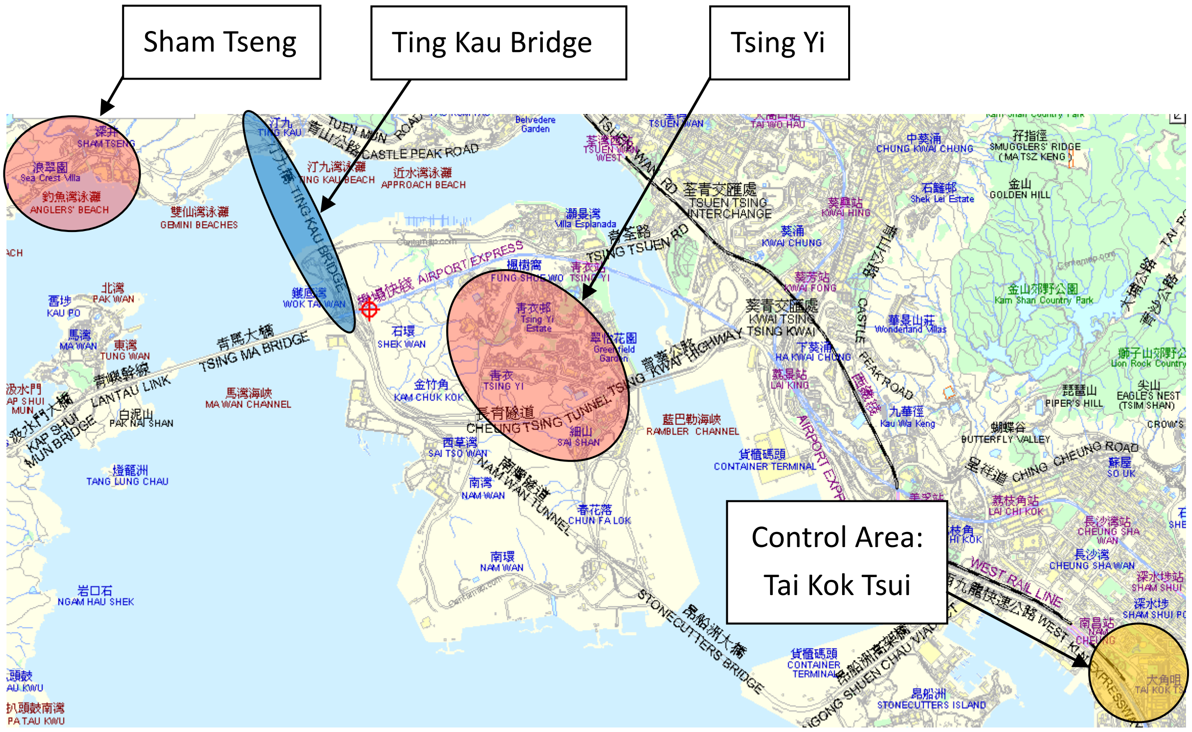

Figure 4.1 Map indicating locations of Sham Tseng, Tsing Yi, Tai Kok Tsui and Ting Kau Bridge

In the research, hedonic pricing model forms the basis of methodology in the study while quarterly time dummy variables are introduced in the second model. The effects of inflation and adverse economic conditions are expected to be explained by such quarterly time dummies. In the following, two models, Model A and Model B, are constructed in order to test the abovementioned hypotheses.

Model	Results from Models	Related Hypothesis
A. Cross-Sectional Inter-Temporal Model	Changes in General Price Level of the areas of study (red area on Figure 4.1), relative to control (orange area)	Hypotheses 1 and 2
B. Inter-Temporal Spatial-Temporal Model	Percentage changes in property prices in Sham Tseng and Tsing Yi respectively	Hypotheses 1 and 2
C. Price Index and Price Gradient Approach	Trend of Price Indices and Changes in Price Gradients	Hypotheses 3

Table 4.2 Brief Description of Results from Models and related Hypotheses

4.5.2 Construction of Cross-Sectional Inter-Temporal Model

Model A

Model A is modified from the cross-sectional inter-temporal model which was first proposed by Chau et al. (2003). The model proposed was to study the effects brought upon by refurbishment. It is considered suitable to be modified and applied in this study as this approach can help in keeping various attributes constant.

With the basis of the "Cross-sectional Inter-temporal approach" concept from Chau et al. (2003), this model is modified to track the effects of the Ting Kau Bridge construction on Sham Tseng and Tsing Yi before, during and after the construction period of the bridge. Model A, estimates the general percentage changes in property prices in the areas of study, relative to that of the control area, Tai Kok Tsui. The changes in price levels during and after construction of the Ting Kau Bridge are estimated relative to the real prices before the commencement date (23/08/1994) of constructing the bridge. The equation of model A is as follows:

$$\begin{aligned}\ln(\mathrm{PRICE}) = {} & \alpha_0 + \alpha_1\mathrm{GFA} + \alpha_2\mathrm{AGE} + \alpha_3\mathrm{FLOOR} + \alpha_4\mathrm{FLOOR}^2 + \alpha_5\mathrm{SEAVIEW} \\ & + \alpha_6\mathrm{P2\ DOC\ CPL} + \alpha_7\mathrm{P3\ AFTER\ CPL} \\ & + \sum_{i=1}^{72}\beta_i\ (\mathrm{70\ TIME\ DUMMY\ VARIABLES}) + \varepsilon_1\end{aligned}$$

Where

- ln (PRICE) is the natural logarithmic values of transaction prices of the properties (in millions of Hong Kong Dollars);

- AGE is the building age when transactions took place (in year term between the date when Occupation Permit and the date of transaction of such property was granted);
- FLOOR is the floor level at which the transacted property is located (in terms of number of storeys);
- $FLOOR^2$ is to capture the potential non-linear effects on property prices to record an increase or decrease at an increasing or decreasing rate with increasing floor level;
- SEAVIEW is the dummy variable that equals to 1 when the property enjoys the sea view, and 0 otherwise;
- P2 DOC CPL is the period dummy variable that equals to 1 when the transactions took place between the date of commencement (23/08/1994) and date of completion (06/05/1998) of the Ting Kau Bridge, and 0 otherwise;
- P3 AFTER CPL is the period dummy variable that equals to 1 when the transactions took place after the date of completion (06/05/1998) of the Ting Kau Bridge, and 0 otherwise;
- α_0 is the coefficient of the constant term that is to be estimated;
- α_i is the coefficients to be estimated, where i ranges from 1 to 7;
- β_i is the coefficients of the 70-variable time dummy for explaining the time effects of data from quarter 2 of 1992 to the latest quarter 4 of 2009;
- ε_1 is the stochastic or error term of the model.

By generating the regression with the 17119 transaction data of Tsing Yi and Sham Tseng with 1484 transactions of Tai Kok Tsui, the percentage changes in property prices at construction and completion stages, compared to the preconstruction stage of the bridge, can be estimated by the signs and magnitudes of the coefficients.

4.5.3 The Construction of Inter-Temporal Spatial-Temporal Model

Model B:

This model is formed and modified with basis of the extended price gradient approach adopted by Yiu and Wong (2005) upon their study on expectation effects of anticipated transport improvements on property prices in Sheung Wan and Sai Ying Pun upon the construction of the Western Harbour Tunnel. It was modified by introducing (m x n – 1) interactive terms to form a (m x n) matrix rather than the method used in that research. The illustration of the (m x n) matrix is illustrated as follows:

Time-period / Area of Study	Before date of commencement	During Construction of Ting Kau Bridge	Beyond Completion of Ting Kau Bridge
Tai Kok Tsui (Control)	(Dropped out for normalization)	Inter_TKT_P2	Inter_TKT_P3
Sham Tseng	Inter_ST_P1	Inter_ST_P2	Inter_ST_P3
Tsing Yi	Inter_TY_P1	Inter_TY_P2	Inter_TY_P3

Table 4.3 Table of Interactive Independent Variables in Model B

This model is aimed to track the changes in residential property prices in Tsing Yi and Sham Tseng respectively. Time-location interaction terms are introduced in this model to track the transaction records in every location at all periods. With the introduction of such interaction terms illustrated above, the residential price changes in Tsing Yi and Sham Tseng can be estimated with dropped interactive term Inter_TKT_P1 (Tai Kok Tsui x Before commencement date) acting as the referencing control. Also, time dummy is introduced to explain the time effects in the following multiple linear regression equation:

$$\ln(\mathrm{PRICE}) = \theta_0 + \theta_1\mathrm{GFA} + \theta_2\mathrm{AGE} + \theta_3\mathrm{FLOOR} + \theta_4\mathrm{FLOOR}^2 + \theta_5\mathrm{SEAVIEW} + \sum_{i=2}^{3}\theta_{i+4}\mathrm{TKT} \times \mathrm{Pi} + \sum_{i=1}^{3}\theta_{i+7}\mathrm{ST} \times \mathrm{Pi} + \sum_{i=1}^{3}\theta_{i+10}\mathrm{TY} \times \mathrm{Pi} + \sum_{i=1}^{72}\varphi_i \text{ (70 TIME DUMMY VARIABLES)} + \varepsilon_2$$

Where

- ST is the location dummy variable that equals to 1 when the transaction is of a property in Sham Tseng, and 0 otherwise;
- TKT is the location dummy variable that equals to 1 when the transaction is of a property in Tai Kok Tsui, and 0 otherwise;
- TY is the location dummy variable that equals to 1 when the transaction is of a property in Tsing Yi, and 0 otherwise;
- P1 is the period dummy variable that equals to 1 when the transactions took place before the date of commencement (23/08/1994) of the Ting Kau Bridge, and 0 otherwise;

- P2 is the period dummy variable that equals to 1 when the transactions took place between the date of commencement (23/08/1994) and date of completion (06/05/1998) of the Ting Kau Bridge, and 0 otherwise;
- P3 is the period dummy variable that equals to 1 when the transactions took place after the date of completion (06/05/1998) of Ting Kau Bridge, and 0 otherwise;
- θ_0 is the coefficient of the constant term that is to be estimated;
- θ_i is the coefficients to be estimated, where i ranges from 1 to 13, while θ_6 to θ_{13} are the coefficients of location-time interactive terms;
- φ_i is the coefficients of the 70-variable time dummy for explaining the time effects of data from quarter 2 of 1991 to the latest quarter 4 of 2009;
- ε_2 is the stochastic or error term of the Model B.

4.5.4 Price Index and Price Gradient Approach

Apart from the above two models used to test the two alternative hypotheses, a time-series approach is also introduced to test the third hypothesis of the study – reduction in price gradient upon the construction of the bridge. Basically deriving from the price index construction approach adopted by Yiu and Wong (2005), the price index and price gradient approach bases on the concept of capturing the changes in property prices over the period of time and changes in price differentials among properties in different areas over every point of time.

Price indices of two different locations at a single unit of time are closely related to the price gradient at that point of time as that particular price gradient is referred as the differential between the price indices of properties in Sham Tseng and Tsing Yi. The price gradient can be estimated by subtracting the interactive terms' coefficients of the two areas at the same quarter. The trend of price gradients can reveal whether hypothesis 3 is supported by this fact with the use of the following equation:

Model C

$$
\begin{aligned}
\ln(\text{PRICE}) = {} & \gamma_0 + \gamma_1\text{GFA} + \gamma_2\text{AGE} + \gamma_3\text{FLOOR} + \gamma_4\text{FLOOR}^2 + \gamma_5\text{SEAVIEW} \\
& + \gamma_{\text{ST 1991Q2}}\text{INTER ST 1991Q2} + \gamma_{\text{ST 1991Q3}}\text{INTER ST 1991Q3} \\
& + \sum_{k=1}^{2} \gamma_{\text{ST 1992Q(2k-1)}}\text{INTER ST 1992Q(2k} - 1) \\
& + \sum_{i=3}^{9}\sum_{k=1}^{4} \gamma_{\text{ST 199iQk}}\text{INTER ST 199iQk} \\
& + \sum_{i=0}^{9}\sum_{k=1}^{4} \gamma_{\text{ST 200iQk}}\text{INTER ST 200iQk} + \gamma_{\text{TY 1991Q2}}\text{INTER TY 1991Q2} \\
& + \gamma_{\text{TY 1991Q3}}\text{INTER TY 1991Q3} \\
& + \sum_{k=1}^{3} \gamma_{\text{TY 1992Q(2k-1)}}\text{INTER TY 1992Q(2k} - 1) \\
& + \sum_{i=3}^{9}\sum_{k=1}^{4} \gamma_{\text{TY 199iQk}}\text{INTER TY 199iQk} \\
& + \sum_{i=0}^{8}\sum_{k=1}^{4} \gamma_{\text{TY 200iQk}}\text{INTER TY 200iQk} \\
& + \sum_{k=1}^{3} \gamma_{\text{ST 2009Qk}}\text{INTER TY 2009Qk} + \gamma_{\text{TKT 1991Q2}}\text{INTER TKT 1991Q2} \\
& + \gamma_{\text{TKT 1991Q3}}\text{INTER TKT 1991Q3} + \gamma_{\text{TKT 1992Q4}}\text{INTER TKT 1992Q4} \\
& + \sum_{i=3}^{9}\sum_{k=1}^{4} \gamma_{\text{TKT 199iQk}}\text{INTER TKT 199iQk} \\
& + \sum_{i=0}^{9}\sum_{k=1}^{4} \gamma_{\text{TKT 200iQk}}\text{INTER TKT 200iQk} + \varepsilon_3
\end{aligned}
$$

Where

- INTER ST 199iQk refers to the time-location interaction term that the transaction took place in quarter k of the year of 199i, with transacted properties situated in Sham Tseng, to become 1, and 0 otherwise;
- INTER ST 200iQk refers to the time-location interaction term that the transaction took place in quarter k of the year of 200i, with transacted properties situated in Sham Tseng, to become 1, and 0 otherwise;
- INTER TY 199iQk refers to the time-location interaction term that the transaction took place in quarter k of the year of 199i, with transacted properties situated in Tsing Yi, to become 1, and 0 otherwise;
- INTER TY 200iQk refers to the time-location interaction term that the transaction took place in quarter k of the year of 200i, with transacted properties situated in Tsing Yi, to become 1, and 0 otherwise;
- INTER TKT 199iQk refers to the time-location interaction term that the transaction took place in quarter k of the year of 199i, with transacted properties situated in Tai Kok Tsui, to become 1, and 0 otherwise;
- INTER TKT 200iQk refers to the time-location interaction term that the transaction took place in quarter k of the year of 200i, with transacted properties situated in Tai Kok Tsui, to become 1, and 0 otherwise;
- γ_0 is the coefficient of the constant term that to be estimated;
- γ_i is the coefficients to be estimated, where ranges from 1 to 5;
- ε_3 is the stochastic or error term of Model C.
- Some of the quarters are omitted as there exist either no transaction records in Sham Tseng, Tsing Yi, Tai Kok Tsui or even both of them.

By taking exponential of the coefficients of $\gamma_{ST\,199iQk}$, $\gamma_{TY\,199iQk}$, $\gamma_{TKT\,199iQk}$, $\gamma_{ST\,200iQk}$, $\gamma_{TY\,200iQk}$ and $\gamma_{TKT\,200iQk}$, price indices over the time (from 1991Q2 to 2009Q4) can be obtained. Also, by calculating the difference of the coefficients of Sham Tseng and Tsing Yi in the same quarter time-period, price gradients for each quarter of the year can be obtained and thus the changes in price gradients over the periods of study can be estimated.

4.5.5 Flow of Methodology in testing hypotheses

The Flow of Methodology is concluded as follows:

For Hypothesis 1 & Hypothesis 2

As hypotheses 1 and 2 are alternative, meaning that either one of these hypotheses can stand or even both of them may be rejected, the two hypotheses is tested simultaneously. The percentage change in general price level and the percentage changes in prices at the two connection points are estimated through the construction of model A and B respectively. The results are used to confirm or reject the hypotheses raised.

	Model A	Model B	
	General Price Level of the two ends	Property prices in Sham Tseng	Property prices in Tsing Yi
Hypothesis 1	Increase	Increase	Increase
Hypothesis 2	Relatively Constant	Increase	Decrease

Table 4.4 Table of Re-statement on Alternative Hypothetical Results

Hypothesis 3

The hypothesis that reduction in price gradients between the two locations, i.e. Tsing Yi and Sham Tseng, results from the construction of the bridge is proposed to be tested by model C. A time-series measure on the price gradients between the two connection points can be estimated by model C. The time-series approach in measuring the price gradients between Sham Tseng and Tsing Yi is considered to be more appropriate, precise and informative as the time periods are divided into a quarterly manner.

4.6 Variables

4.6.1 Selection of Dependent Variable

For the prices of the residential units in the two connection points of the Bridge and the control region, transaction prices are chosen to be included as the dependent variable. Transaction prices, but not rental prices, are chosen as it is considered that the behavior of the buyer in purchasing and owning a flat will take into account of those attributes selected as independent variables more seriously. Also, the effects brought about by the potential increase in prices due to anticipation of improved transportation can be reflected upon transaction prices of properties while it cannot be logically deduced and reflected by the study of rental values.

Moreover, actual transaction prices of property, but not quoted transaction prices, are chosen. The reason behind is that quoted prices are often less reliable as quoted prices may be different among different real estate agents and property owners, even though the prices are of the same housing unit at the same period of time. Furthermore, quoted prices are of a nature to be overstated as it is a usual practice for agents to quote the prices high and give a discount in order to raise the buyers' bid-the-price-down satisfaction by this behavioral technique. Therefore, actual transaction prices are considered more reliable and significant for the study.

All the transaction prices were obtained through the Economic Property Research Centre (EPRC) website in nominal term. Therefore, by introducing 72 time-dummy variables into the estimating equation, the process of deflating the nominal prices into real prices by either an internal or external price index can be abridged. Therefore, the transaction prices obtained from the EPRC can be directly applied as dependent variable without any adjustments.

4.6.2 Selection of Independent Variables

Independent variables are selected mainly due to the prediction of purchaser consideration upon owning a flat and the review of the literatures. Size, floor level and age of the housing units are considered important by many of the scholars in their past studies. Square term of floor level is introduced in order to capture the non-linear properties upon the change in rate of increase or decrease while the number of storeys of the transacted housing unit increases. Independent dummy variable named as "SEAVIEW" is introduced to act as another variable to control the structural attribute differences among the housing units.

Location dummies, period dummies and location-period interaction terms are introduced to test the hypotheses and identify the effects on residential property prices of the construction of the Ting Kau Bridge along the timeline. The 72 time-dummy variables are added in order to explain the quarterly price changes among the data set due to different time effects throughout the period of study.

4.6.2.1 Continuous Variables

Gross Floor Area (GFA)

The Gross Floor Area (GFA) is a major factor directly affecting the price of a residential property. The larger the GFA, the larger the size and the more the space the property owner owns in his housing unit. The more the space, the higher the reservation price set by the purchaser is. Therefore, it is logical to regard that the property prices of residential units are in direct correlation to the GFA of the residential units and thus the coefficient for GFA is expected to be a positive one. All the data of GFA in the data set is obtained from the EPRC website, and those records without indicating the GFA of the residential property is excluded.

Building Age (AGE)

This independent variable is defined as the buildings' ages at which transactions are being made, as indicated by the EPRC. The building age is measured upon obtaining of the Occupation Permit (OP) of the building as OP represents that the building passed the final checks of health, safety and in compliance with the statutory requirements by Buildings Department of the HKSAR Government. The date of transaction, on the other hand, simply means the date when the formal Agreement of Sales and Purchase (ASP) is being signed by both parties.

With the increment of the building age, buildings are found to be more defective and less user-friendly in terms of building layout, functional appliances and structural conditions, or even of architectural designs and aesthetic impressions. Therefore, people would expect an "older" building having a higher chance to occur deteriorated defects. So, the coefficient of this variable, AGE, is expected to be a negative one as the purchaser would determine a lower reservation price for "older" building.

Floor Level (FLOOR)

Floor level indicates the number of storeys where the housing unit transacted is situated on. The variable, FLOOR, is particularly important as most of the properties are either of sea view or mountain view in Tsing Yi and Sham Tseng, so there will be different view for different floor levels and thus the impacts of floor level is expected to be significant upon logical reasoning.

It is expected that the higher the floor level, the higher the price willing to be paid to purchase a flat by a buyer, ceteris paribus. Therefore, the coefficient of this variable is expected to record a positive sign. A point to note is that the duplex housing units appeared in the data set are excluded as they accounted for different floor levels and also distorted the general price trend of the whole data set as these units are often of a particularly higher price.

Square Term of Floor Level ($FLOOR^2$)

The $FLOOR^2$ term is added into the estimating equation as it is to capture the potentially non-linear change upon the increase or decrease of property prices when floor level ascends. The data is obtained simply by taking square on the values in the variable FLOOR for every transaction data. It is expected that the FLOOR records a positive sign while $FLOOR^2$ records a negative one as I expect there is an increasing percentage change in price at a decreasing rate when floor level increases in terms of number of storey that the property is situated on.

4.6.2.2 Dummy Variables

Apart from quantitative variables such as price, age of building and floor, some contributing attributes cannot be quantified into figures. In order to deal with such significant but unquantifiable attributes, dummy variables are introduced to deal with the qualitative factors or categorical variables. The simple theory of introducing dummy variables is that in the data set, if that particular property involves that particular attribute, then the existence of dummy will be assigned as "1", and "0" otherwise.

Sea view

Due to the limitation that it is difficult to "measure" the amount of sea view enjoyed by a particular flat, we can only categorize flats into whether they have sea view or they do not have sea view. Sea view is considered to be influential to purchasers' preference and price consideration as purchasers are willing to pay a price premium for a flat with sea view of an apartment in Hong Kong (Tse, 2002). Additionally, as there are a substantial amount of data in Sham Tseng and Tsing Yi having sea view, it is considered important and thus inappropriate to be omitted.

The determination of a flat whether it has a sea view or not is based on a two-step process. First, the geographical location and orientation of the housing units are identified by viewing digital maps available at www.centamap.com. Then, the visibility of sea view is confirmed by estimation made in site visit on the spots. A property with sea view will be assigned “1” in the dummy variable “SEAVIEW”, and “0” otherwise. The expectation of the coefficient of the sea view is a positive one as the presence of sea view is considered to be a factor for inducing purchasers’ willingness to pay for a higher price for the property.

Period Dummy

Period dummy is introduced to track the effects of the percentage changes in transaction prices along the timeline from before the construction of the bridge to after the completion of such. The models are consisted with three major period dummy variables. The three are respectively called P1_BEFORE_DOC, P2_DOC_CPL and P3_AFTER_CPL. They simply take all the changes before, during and after the construction period of the Ting Kau Bridge into account for studying the impacts of transportation improvements brought about by the construction of the Ting Kau Bridge.

Here is the table showing the 3-period dummy variables of models:

Variable Name	Description of Time Period	Period	To
P1_BEFORE_DOC	Before Date of Commencement (DoC) of Ting Kau Bridge	04/04/1991	22/08/1994
P2_DOC_CPL	Between DoC and Completion of Ting Kau Bridge	23/08/1994	05/05/1998
P3_AFTER_CPL	After Date of Completion of Ting Kau Bridge	06/05/1998	31/12/2009

Table 4.5 Description on the three periods in the study

Time Dummy

The 70 time-dummy variables are added in order to track the time effects in the models. The signs and magnitudes of the time dummy enable deflation of all the transaction prices from nominal into quarterly-measured real prices, with reference to quarter 4 of the year of 2009.

4.6.2.3 Interactive Variables

There will be 8 and 216 interactive variables, as known as interaction terms, introduced in order to track the price changes of different locations during the timeline under study for the inter-temporal spatial-temporal model and price index and price gradient approach respectively. The interactive variables mainly consist of two components – period and location. Therefore, location factor and time factor are to be discussed in the following paragraphs.

The interactive variables start with "INTER" for identifying it as interactive term, followed by an underscore, then the location, then by another underscore and finally by the time period of transaction. For example, INTER_ST_P2 represents that datum is taken to be "1" when such transaction was carried out within the period P2 and the transacted property was located in Sham Tseng. Similarly, TY represents Tsing Yi and TKT represents Tai Kok Tsui while the time periods (Pi) ranges from P1 to P3 in the inter-temporal spatial-temporal model.

The price index and price gradient approach consists of 216 interactive variables. The following table shows the location-time interactive variables in the approach:

Period (YYYY [Q]Quarter)	Location		
	Sham Tseng	Tsing Yi	Tai Kok Tsui
1991 Q2	INTER_ST_1991Q2	INTER_TY_1991Q2	INTER_TKT_1991Q2
1991 Q3	INTER_ST_1991Q3	INTER_TY_1991Q3	INTER_TKT_1991Q3

1992 Q1	INTER_ST_1992Q1	INTER_TY_1992Q1	(No Transaction Available)
1992 Q3	INTER_ST_1992Q3	INTER_TY_1992Q3	(No Transaction Available)
1992 Q4	INTER_ST_1992Q4	INTER_TY_1992Q4	INTER_TKT_1992Q4
1993 Q1 – Q4	INTER_ST_1993Q1 – INTER_ST_1993Q4	INTER_TY_1993Q1 – INTER_TY_1993Q4	INTER_TKT_1993Q1 – INTER_TKT_1993Q4
1994 Q1 – Q4	INTER_ST_1994Q1 – INTER_ST_1994Q4	INTER_TY_1994Q1 – INTER_TY_1994Q4	INTER_TKT_1994Q1 – INTER_TKT_1994Q4
1995 Q1 – Q4	INTER_ST_1995Q1 – INTER_ST_1995Q4	INTER_TY_1995Q1 – INTER_TY_1995Q4	INTER_TKT_1995Q1 – INTER_TKT_1995Q4
1996 Q1 – Q4	INTER_ST_1996Q1 – INTER_ST_1996Q4	INTER_TY_1996Q1 – INTER_TY_1996Q4	INTER_TKT_1996Q1 – INTER_TKT_1996Q4
1997 Q1 – Q4	INTER_ST_1997Q1 – INTER_ST_1997Q4	INTER_TY_1997Q1 – INTER_TY_1997Q4	INTER_TKT_1997Q1 – INTER_TKT_1997Q4
1998 Q1 – Q4	INTER_ST_1998Q1 – INTER_ST_1998Q4	INTER_TY_1998Q1 – INTER_TY_1998Q4	INTER_TKT_1998Q1 – INTER_TKT_1998Q4
1999 Q1 – Q4	INTER_ST_1999Q1 – INTER_ST_1999Q4	INTER_TY_1999Q1 – INTER_TY_1999Q4	INTER_TKT_1999Q1 – INTER_TKT_1999Q4
2000 Q1 – Q4	INTER_ST_2000Q1 – INTER_ST_2000Q4	INTER_TY_2000Q1 – INTER_TY_2000Q4	INTER_TKT_2000Q1 – INTER_TKT_2000Q4
2001 Q1 – Q4	INTER_ST_2001Q1 – INTER_ST_2001Q4	INTER_TY_2001Q1 – INTER_TY_2001Q4	INTER_TKT_2001Q1 – INTER_TKT_2001Q4
2002 Q1 – Q4	INTER_ST_2002Q1 – INTER_ST_2002Q4	INTER_TY_2002Q1 – INTER_TY_2002Q4	INTER_TKT_2002Q1 – INTER_TKT_2002Q4
2003 Q1 – Q4	INTER_ST_2003Q1 – INTER_ST_2003Q4	INTER_TY_2003Q1 – INTER_TY_2003Q4	INTER_TKT_2003Q1 – INTER_TKT_2003Q4
2004 Q1 – Q4	INTER_ST_2004Q1 – INTER_ST_2004Q4	INTER_TY_2004Q1 – INTER_TY_2004Q4	INTER_TKT_2004Q1 – INTER_TKT_2004Q4
2005 Q1 – Q4	INTER_ST_2005Q1 – INTER_ST_2005Q4	INTER_TY_2005Q1 – INTER_TY_2005Q4	INTER_TKT_2005Q1 – INTER_TKT_2005Q4
2006 Q1 – Q4	INTER_ST_2006Q1 – INTER_ST_2006Q4	INTER_TY_2006Q1 – INTER_TY_2006Q4	INTER_TKT_2006Q1 – INTER_TKT_2006Q4
2007 Q1 – Q4	INTER_ST_2007Q1 – INTER_ST_2007Q4	INTER_TY_2007Q1 – INTER_TY_2007Q4	INTER_TKT_2007Q1 – INTER_TKT_2007Q4
2008 Q1 – Q4	INTER_ST_2008Q1 – INTER_ST_2008Q4	INTER_TY_2008Q1 – INTER_TY_2008Q4	INTER_TKT_2008Q1 – INTER_TKT_2008Q4

2009 Q1 – Q3	INTER_ST_2009Q1 – INTER_ST_2009Q3	INTER_TY_2009Q1 – INTER_TY_2009Q3	INTER_TKT_2009Q1 – INTER_TKT_2009Q3
2009 Q4	INTER_ST_2009Q4	(Dropped out for Normalization)	INTER_TKT_2009Q4
Total Number of Variables (By Areas)	73	72	71
	Total Number of Interactive Variables:		**216**

Table 4.6 List of Location-Quarter Interactive Variables in Model C

INTER_TY_2009Q4, representing the prices at 2009 quarter 4 of the properties transacted in Tsing Yi, is dropped out for normalization of the regression matrix. The dropping out of this variable means that the coefficients obtained in other interaction terms are percentage differences in prices with reference to the transaction prices made for Tsing Yi properties at quarter 4 of 2009.

Quarter 1 & 4 of the year 1991 has no data transacted in those properties in the three areas. For quarter 2 of the year 1992, there are four data obtained in Sham Tseng but there are no data obtained in Tsing Yi and Tai Kok Tsui properties. Therefore, 1992Q2 is also omitted from the dataset. Though for quarter 1 & 3 of 1992, there exist no transaction records from the Tai Kok Tsui area, we are still able to estimate the price gradients between the two connection points from the Tsing Yi and Sham Tseng data, so time quarters 1992Q1 and 1992Q3 are kept in the dataset.

4.7 Expected Results

In accordance to the hypotheses, Tables 4.7 – 4.9 for different models are made upon:

Model A: Cross-Sectional Inter-Temporal Model (Sham Tseng and Tsing Yi)		
Independent Variable	Expected Sign	
	Hypothesis 1	Hypothesis 2
GFA	Positive	
AGE	Negative	
FLOOR	Positive	
$FLOOR^2$	Negative	
SEAVIEW	Positive	
P2_DOC_CPL	Positive	Relatively Constant
P3_AFTER_CPL	Positive	Relatively Constant

Table 4.7 Expected Results for Model A (Sham Tseng and Tsing Yi)

Model B: Inter-Temporal Spatial-Temporal Model		
Independent Variable	Expected Sign	
	Hypothesis 1	Hypothesis 2
GFA	Positive	
AGE	Negative	
FLOOR	Positive	
$FLOOR^2$	Negative	
SEAVIEW	Positive	
INTER_TKT_P2	Positive	Positive
INTER_TKT_P3	Positive	Positive
INTER_ST_P1	Negative	Negative
INTER_ST_P2	Greater than that of INTER_ST_P1	Greater than that of INTER_ST_P1
INTER_ST_P3	Greater than that of INTER_ST_P2	Greater than that of INTER_ST_P2

INTER_TY_P1	Negative but greater than INTER_ST_P1	Negative but greater than INTER_ST_P1
INTER_TY_P2	Greater than that of INTER_TY_P1	Negative (Smaller than INTER_TY_P1)
INTER_TY_P3	Greater than that of INTER_TY_P2	Negative (Smaller than INTER_TY_P2)
72 Time Dummy Variables	Unknown	Unknown

Table 4.8 Expected Results for Model B

Model C: Price Index and Price Gradient Approach	
Independent Variable	Expected Sign
	Hypothesis 3
GFA	Positive
AGE	Negative
FLOOR	Positive
$FLOOR^2$	Negative
SEAVIEW	Positive
INTER_ST_1991Q2 to INTER_ST_2009Q4	The Differences between coefficients of interaction terms at Sham Tseng and Tsing Yi are large from 1991Q2 to 1994Q3 but the differences reduce since 1994Q3 and become minimal after 1998Q2, at which the Ting Kau Bridge was completed
INTER_TY_1991Q2 to INTER_TY_2009Q3	
INTER_TKT_1991Q2 to INTER_TKT_2009Q4	Unknown

Table 4.9 Expected Results for Model C

4.8 Statistical Tests

In the above hedonic pricing models, when regression analyses are performed, various statistical tests are applied in order to test the significance and the appropriateness of the results. In this study, adjusted coefficients of determination (adjusted R^2), t-statistics (t-stat) and p-values are used to test the statistical results.

4.8.1 Adjusted Coefficients of Determination (Adjusted R^2)

No matter for coefficients of determination (R^2) or adjusted coefficients of determination (Adjusted R^2), the R^2 test relies on the principle that R^2, or adjusted R^2, represents the percentage of variation in the dependent variable being explained by such variation in those independent variables within the regression equation. For instance, obtaining a R^2 value of 0.95 reveals that 95% of the changes in the value of the dependent variable can be explained by the changes in value of the independent variables.

However, R^2 receives many criticisms of that the R^2 would increase upon the introduction of irrelevant or inappropriate independent variables. This, as pointed out by many scholars, may result in wrong estimation, and thus unreasonable implications of the regression results.

Therefore, instead of using R^2 as the statistical tests, the values obtained by adjusted R^2, which do not increase, but even decrease, upon introduction of non-explaining variables, are considered to be more appropriate. Therefore, adjusted R^2 is considered for finding out how much the data fits the proposed hypothetical models.

4.8.2 T-statistics and P-values

By holding other factors constant, t-statistics can be used to determine the statistical significance of one particular independent variable on the dependent variable. T-stats obtained thus represent the impact on the dependent variable upon the introduction of such particular independent variable, while it does not test the significance of the signs and magnitudes of the coefficients of the independent variables.

Obtaining a higher absolute value of the an independent variable's t-statistics means that it is more unlikely for the coefficient of that particular variable to be equal to zero, meaning the introduction of such variable has no effect on the dependent variable. If the t-statistics is very small, which is often regarded as low if smaller than two, then the independent variable can be seen as insignificant and thus its effect on the dependent variable can be neglected. The t-tests, therefore, is often regarded as a common statistical test for the null hypothesis.

An easier way to test the significance of the existence of an independent variable is the p-value. The p-value of a particular independent variable is defined as the probability for getting a zero coefficient of that variable in the estimating equation. The p-value, therefore, represents the significance of the independent variable at a percentage level. For instance, obtaining p-value of 0.0314 (<0.04) means that the independent variable is significant at 4% level. Therefore, it can be concluded that the independent variable is more significant if the p-value obtained is closer to 0.

The significance levels will be set at 1%, 5% and 10%, so independent variables can be identified at four stages of significance, as illustrated in the following table:

	Confidence Level (1 – p-value)	Degree of Significance	Remarks in Tables
1	Higher than 99%	Extremely Significant	Nil
2	Between 95% and 99%	Very Significant	*
3	Between 90% and 95%	Significant	**
4	Below 90%	Insignificant	***

Table 4.10 Confidence Level for data significance of independent variables

CHAPTER 5 Data Collection and Processing

In this chapter, the data collected from the estates and buildings in the three locations, Sham Tseng, Tsing Yi and Tai Kok Tsui will be discussed. Following the information of the housing estates and building blocks, basic facts about the database will also be discussed. Sources of data, selection and omission of data and reliability of data will also be touched upon.

5.1 Selection of properties for study

The data are collected from three different locations, Sham Tseng, Tsing Yi and Tai Kok Tsui. The properties forming the data set in Sham Tseng and Tsing Yi are multiple-block private housing estates with ages of buildings ranging from 17 years to 27 years. For the Tai Kok Tsui data collected, only one housing estate is of four building blocks while other properties are either two-block or single-block buildings.

5.1.1 Properties selected in Sham Tseng

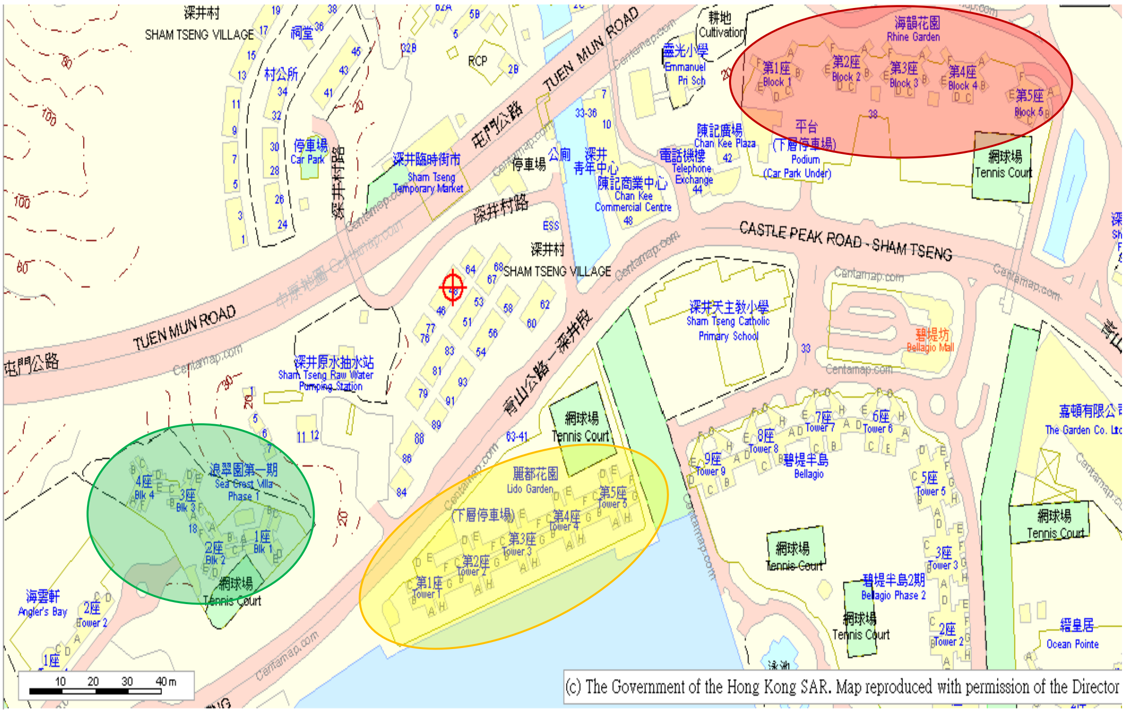

Figure 5.1 Map showing selected housing estates in Sham Tseng

In Sham Tseng, data from Rhine Garden (red circle), Sea Crest Villa – Phase 1 (green circle) and Lido Garden (yellow circle) are selected to track the property price changes before, during and after the construction of the bridge. The general information about the housing estates are as follows:

Housing Estates	Building Blocks	Number of Units	Date of issuance of Occupation Permit	Number of Transactions
Rhine Garden	1 – 5	1068	28 / 12 / 1992	2207
Sea Crest Villa (Phase 1)	1 – 4	867	02 / 11 / 1992	2453
Lido Garden	1 – 5	1392	23 / 03 / 1989	2541

Table 5.1 Descriptive Table of selected buildings in Sham Tseng

The three housing estates are of high similarity in size, type, scale, facilities and location. The transacted flats are of medium size, ranging from 572 to 869 square feet, except two transactions with 1650 square feet from Rhine Garden combining two adjourning units. The number of units per floor for those three estates ranges from 6 to 8 while the scales of developments are similar with either 4 or 5 building blocks per estate. Although only Sea Crest Villa has a clubhouse for the estate owners, all three housing estates have excellent facilities, including tennis courts, swimming pools and shuttle bus services, for their users.

In terms of location and transportation facilities, the three housing estates are very close together. Several bus routes and minibuses are readily available at bus stops along the Castle Peak Road – Sham Tseng section, taking residents of the three housing blocks from Sham Tseng to various places like Tsuen Wan, Tsing Yi and Mongkok. As Sea Crest Villa (Phase 1) is located at the hillside where physically not attached to Castle Peak Road – Sham Tseng section, the transportation of this housing estate can be regarded as less convenient, as compared to Rhine Garden and Lido Garden.

5.1.2 Properties selected in Tsing Yi

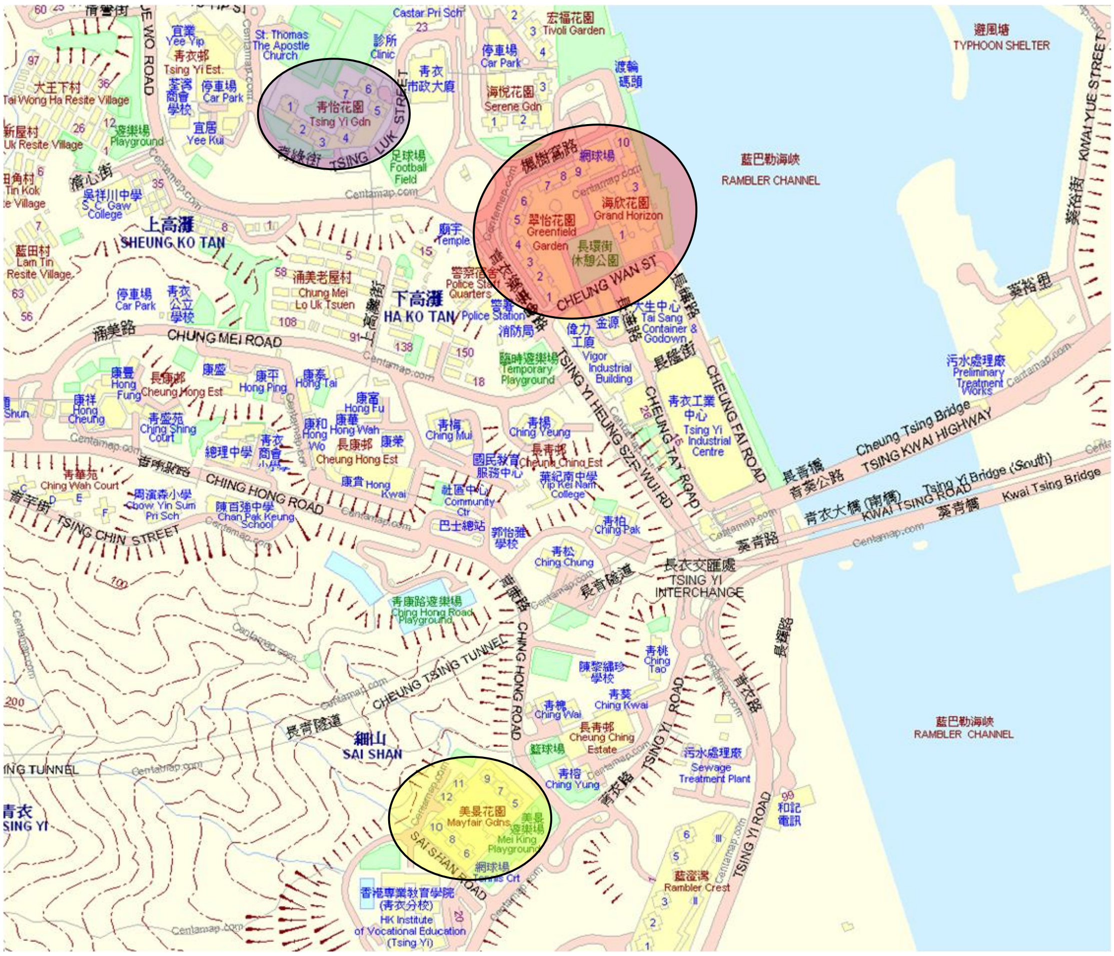

Figure 5.2 Map showing selected housing estates in Tsing Yi

In Tsing Yi, data from Tsing Yi Garden (purple circle), Greenfield Garden (red circle) and Mayfair Garden (yellow circle) are selected to track the property price changes before, during and after the construction of the bridge. The general information about the housing estates are as follows:

Housing Estates	Building Blocks	Number of Units	Date of issuance of Occupation Permit	Number of Transactions
Tsing Yi Garden	1 – 7	1520	18 / 11 / 1986	2059
Greenfield Garden (TY)	1 – 6	1776	07 / 11 / 1989	5287
	7 – 9	848	23 / 01 / 1990	
	10 – 11	592	20 / 04 / 1990	
Mayfair Garden	5, 7, 9	768	20 / 12 / 1984	2572
	6, 8, 10 – 12	1144	01 / 03 / 1982	

Table 5.2 Descriptive Table of selected buildings in Tsing Yi

The three housing estates are similar in flat size, property type, scale of development, facilities and location. The transacted flats are of small to medium size, ranging from 428 to 699 square feet, except three transactions coming from the same flat from Mayfair Garden of 1398 square feet in GFA, combining two adjourning units. All the three estates are of 8 units per floor while the scales of developments are quite large, ranging from 7 to 11 building blocks per estate. All three housing estates have a great variety of facilities, including small-sized soccer fields, central gardens, swimming pools and podiums, for recreation, entertainment and even shopping.

In terms of location and transportation facilities, as Tsing Yi Garden and Greenfield Garden are of close proximity, they are similar in these aspects. Mayfair Garden, situated at the other side of the Tsing Yi Bridge, is of less transport convenience but there are still several bus and green minibus routes having access to the estate. As the transportation from Tsing Yi to other parts in Hong Kong is well developed since the early 1990s, the accessibility in terms of railway, bus and other public transports, is considered better than the developments located in Sham Tseng.

5.1.3 Properties selected in Tai Kok Tsui

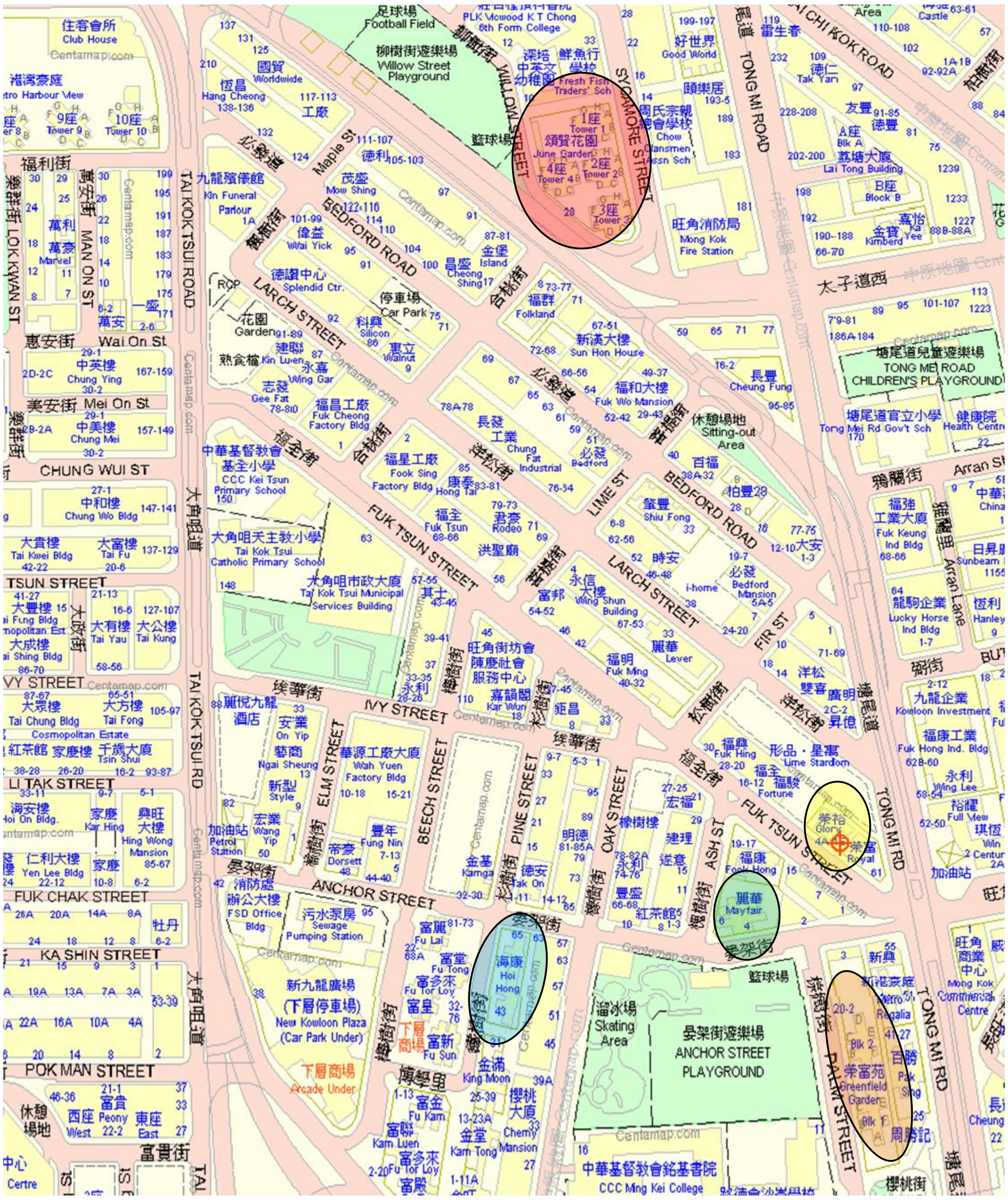

Figure 5.3 Map showing selected building blocks and estates in Tai Kok Tsui

In Tai Kok Tsui, data from June Garden (red circle), Hoi Hong Building (blue circle), Greenfield Garden (orange circle), Glory Court (yellow circle) and Mayfair Mansion (green circle) are selected to track the property price changes before, during and after the construction of the bridge. The general information about the housing estates are as follows:

Housing Estates	Building Blocks	Number of Units	Date of issuance of Occupation Permit	Number of Transactions
June Garden	1 – 4	480	15 / 01 / 1988	579
Hoi Hong Building	1 – 2	104	25 / 06 / 1989	139
Greenfield Garden (TKT)	1 – 2	248	01 / 12 / 1992	521
Glory Court	1	64	22 / 10 / 1992	114
Mayfair Mansion	1	136	12 / 1991	131

Table 5.3 Descriptive Table of selected buildings in Tai Kok Tsui

The five housing estates, except June Garden, are all very small developments with only one or two blocks. The transacted flats, except those from Greenfield Garden (TKT), are of small to medium size, ranging from only 336 to 632 square feet. However, the flat sizes from Greenfield Garden (TKT) are of a large range from 419 to 937 square feet, and one transaction from a combined flat even acquires 1727 square feet. Mayfair Mansion and June Garden are of 8 units per floor, Greenfield

Garden is of 6 units per floor while Hong Hoi Building and Glory Court are of 4 units per floor. All five housing estates do not have many facilities provided by their developers. The only recreational facilities available for the five estates are the football fields, playground and basketball courts in Willow Street Playground and Anchor Street Playground. Also, as Tai Kok Tsui is a densely populated area with great variety of shops within the district and small developing sites, the provision of clubhouses is not considered suitable or valuable in enhancing the values of the developments.

In terms of location and transportation facilities, as Hong Hoi Building, Greenfield Garden (TKT), Glory Court and Mayfair Mansion are of close proximity, so they are similar in these aspects. Though June Garden is situated in the northern side of Tai Kok Tsui, near Lai Chi Kok, the transport convenience is as good as other buildings in the data set. As Tai Kok Tsui is situated near the transportation hub – Mongkok – of Kowloon, the accessibility to the CBD and transport network to other places in Hong Kong are well-established and sophisticated.

Though criticisms may be made upon the difference in structural and neighbourhood attributes between housing blocks in Tai Kok Tsui and the other two connecting points of the Ting Kau Bridge, it should be admitted that the only suitable location to act as a control for the MTR effect brought about by the Tung Chung Line and Airport Express is Tai Kok Tsui as Tung Chung has not been developed in that time and other places, like tenement housing blocks in Jordon near the Kowloon Station before the MTR property developments, are of even greater difference in terms of structural attributes. Also, as most of the housing in Lai King are of Home Ownership Scheme (HOS), a lot of data through Economic Property Research Centre (EPRC) cannot be traced. Furthermore, as Hong Kong Station is located in the reclaimed habourfront in Central where existing buildings nearby are all of commercial or recreational purposes, such as the Exchange Square and City Hall.

Therefore, though the control area is not excellent comparables in terms of structural and neighbourhood attributes, they are considered the most preferred data set in acting as a reference upon tracking the price changes in Tsing Yi and Sham Tseng.

5.2 Brief Facts about the Database

There are altogether 18603 transaction data employed in the full data set for the regression analysis. The following table shows the number of transactions for each housing estate / building in the area of study.

Name of Estates / Buildings		**Number of Transaction Records**
Sham Tseng Data Set		
Sea Crest Villa (Phase 1)	4 Blocks	2207
Rhine Garden	5 Blocks	2453
Lido Garden	5 Blocks	2541
	TOTAL	7201
Tsing Yi Data Set		
Tsing Yi Garden	7 Blocks	2059
Mayfair Garden	8 Blocks	2572
Greenfield Garden	11 Blocks	5287
	TOTAL	9918
Tai Kok Tsui Data Set		
Hoi Hong Building	2 Blocks	139
June Garden	4 Blocks	579
Greenfield Garden	2 Blocks	521
Glory Court	1 Block	114
Mayfair Mansion	1 Block	131
	TOTAL	1484
TOTAL NUMBER OF TRANSACTIONS		**18603**

Table 5.4 Brief Summary on Data Collection at three locations

The regression analysis makes use of many transaction data, for example, age of the building at the transaction date, floor level, transaction prices and Gross Floor Area (GFA) of the units. The tables below show the statistical summary of these data which are employed as independent variables in the regression analysis:

	TRANSACTION PRICE (HK$ in million)	LN(PRICE)	AGE (Years)	FLOOR (Storeys)	GFA (Square Feet)
Mean	1.903	0.564	10.412	17.483	608.478
Median	1.700	0.541	9.000	17.000	589.000
Maximum	7.450	2.008	27.000	39.000	1727.000
Minimum	0.080	-2.526	0.000	1.000	336.000
Std. Dev.	0.799	0.394	6.172	9.984	136.218

Table 5.5 Statistical Summary on Continuous Variables in Full data set

The statistics of the key dummy variables are presented in the following tables:

Model A – Cross-sectional Inter-temporal Model (Sham Tseng and Tsing Yi)				No. of Observations: 17119	
Dummy Variables	Mean	Max	Min	Std. Dev.	No. of Transactions Obtaining "1" in the Dummy Variable
SEAVIEW	0.421	1.000	0.000	0.494	7213
P1_BEFORE_DOC (dropped out for normalization)	0.166	1.000	0.000	0.372	2835
P2_DOC_CPL	0.331	1.000	0.000	0.471	5672
P3_AFTER_CPL	0.503	1.000	0.000	0.500	8612

Table 5.6 Statistical Summary on Dummy Variables in Model A (TKT)

Model A – Cross-sectional Inter-temporal Model (Tai Kok Tsui)				No. of Observations: 1464	
Dummy Variables	Mean	Max	Min	Std. Dev.	No. of Transactions Obtaining "1" in the Dummy Variable
SEAVIEW	0.230	1.000	0.000	0.421	342
P1_BEFORE_DOC (dropped out for normalization)	0.314	1.000	0.000	0.464	466
P2_DOC_CPL	0.261	1.000	0.000	0.439	387
P3_AFTER_CPL	0.425	1.000	0.000	0.495	631

Table 5.7 Statistical Summary on Dummy Variables in Model A (ST&TY)

Model B – Inter-temporal Spatial-temporal Model (Statistics of SEAVIEW is for both Model B & C)				**No. of Observations: 18603**	
Dummy Variables	Mean	Max	Min	Std. Dev.	No. of Transactions Obtaining "1" in the Dummy Variable
SEAVIEW	0.406	1.000	0.000	0.491	7555
INTERACT_TKT_P1 (dropped out for normalization)	0.025	1.000	0.000	0.156	466
INTERACT_TKT_P2	0.021	1.000	0.000	0.143	387
INTERACT_TKT_P3	0.034	1.000	0.000	0.181	631
INTERACT_ST_P1	0.084	1.000	0.000	0.277	1563
INTERACT_ST_P2	0.138	1.000	0.000	0.345	2571
INTERACT_ST_P3	0.165	1.000	0.000	0.371	3067
INTERACT_TY_P1	0.068	1.000	0.000	0.252	1272
INTERACT_TY_P2	0.167	1.000	0.000	0.373	3101
INTERACT_TY_P3	0.298	1.000	0.000	0.457	5545

Table 5.8 Statistical Summary on Dummy Variables in Model B

5.3 Sources of Data

Among the 18603 transaction data recorded and included in generating the regression results, majority of the data used were collected from the Economic Property Research Centre (EPRC) website.

The EPRC purchases the records and tracks those transactions into its database from the Land Registry of the Hong Kong Special Administrative Government, which means the data collected in our study are eventually from the Land Registry. When a deal is agreed between the original flat owner and the purchaser, the purchaser has to register in the Land Registry and thus transaction records are recognized by the Land Registry. The information kept by the Land Registry includes all the characteristics and specifications of both the premise itself and the transaction. Therefore, most of the details of the transactions can be acquired from the digital database of EPRC.

Also, there are other sources of data collection, like site visits and digital maps, undergone in the study. The details about data collection and processing will be mentioned below, categorized in terms of different variables.

5.3.1 PRICE, GFA, AGE, FLOOR

The data of the dependent variable (PRICE), which refers to the transaction prices of properties in the deal made, are collected through the EPRC database. Also, some independent variables revealing the basic characteristics of the properties, such as the floor levels, gross floor areas (GFA) specified in the agreement of sale and purchase, the dates of obtaining Occupation Permit (OP) and the units of housings.

A point to note is that there are no adjustments made on transaction prices of the property in order to deflate it with an "external" or a property price index. It is because the real prices can be obtained by introducing different time dummy variables into the regression equation as mentioned in Chapter 4. Therefore, no adjustments and data collections are needed for the "price index".

PRICE, GFA and FLOOR can be directly obtained from the raw collection data. However, some adjustments should be made on the independent variable AGE. The variable AGE refers to the age of the building at the time when it is purchased and aims to record the drop in prices of the properties due to deterioration of such. Therefore, AGE of the building is obtained by measuring the age of the building at the transaction date with reference to the date of issuance of OP. Truncation, but not rounding up, is adopted in the calculation of age, which means that the age is only counted as 1 when the difference between transaction date and the issuing date of OP is between 1 year and 2 year. Also, the age of transactions upon presales of the properties will be recorded as 0 in order to be consistent with the building age rationale that the age is associated with the deterioration of such building.

5.3.2 SEAVIEW

In the data collection of determining whether a flat with sea view or not, the unit of the flat obtained by the EPRC database acts as the basis of determination. By knowing the unit of the transacted property and viewing the digital map on the internet, Centamap, orientation of the flats can be known. The last step that I have to take is to do site visits at the location where the properties are situated.

During the site visits, I have to first look at the window orientation of the flats and stand on the pedestrian street at the same orientation and horizontal location of such. Then, by estimating the window locations at the floor level of the housing units and the potential blockages of sea views by other buildings, the visibility of the sea view from the flat can be logically deduced. Assumptions that the sea view exists are made in the cases where the window location is not aiming at the sea but somehow a portion of view can be seen as sea view.

5.3.3 TIME PERIODS

The information about the dates of the construction and completion of the Ting Kau Bridge can be retrieved from the government documents kept readily available at the Hong Kong Special Administrative Government website. Also, by visiting the website of the Mass Transit Railway Corporation (MTRC), the date of construction and opening of the MTR Tung Chung Line can also be found in order to provide a timeframe for explaining the MTR effect on Tsing Yi with choosing the control of Tai Kok Tsui, where MTR effect is assumed to be the same in Tai Kok Tsui and Tsing Yi. Thus, the effect on the Ting Kau Bridge can be observed alone with Tai Kok Tsui providing a good reference point for explaining the MTR effect.

The timeframe is as follows:

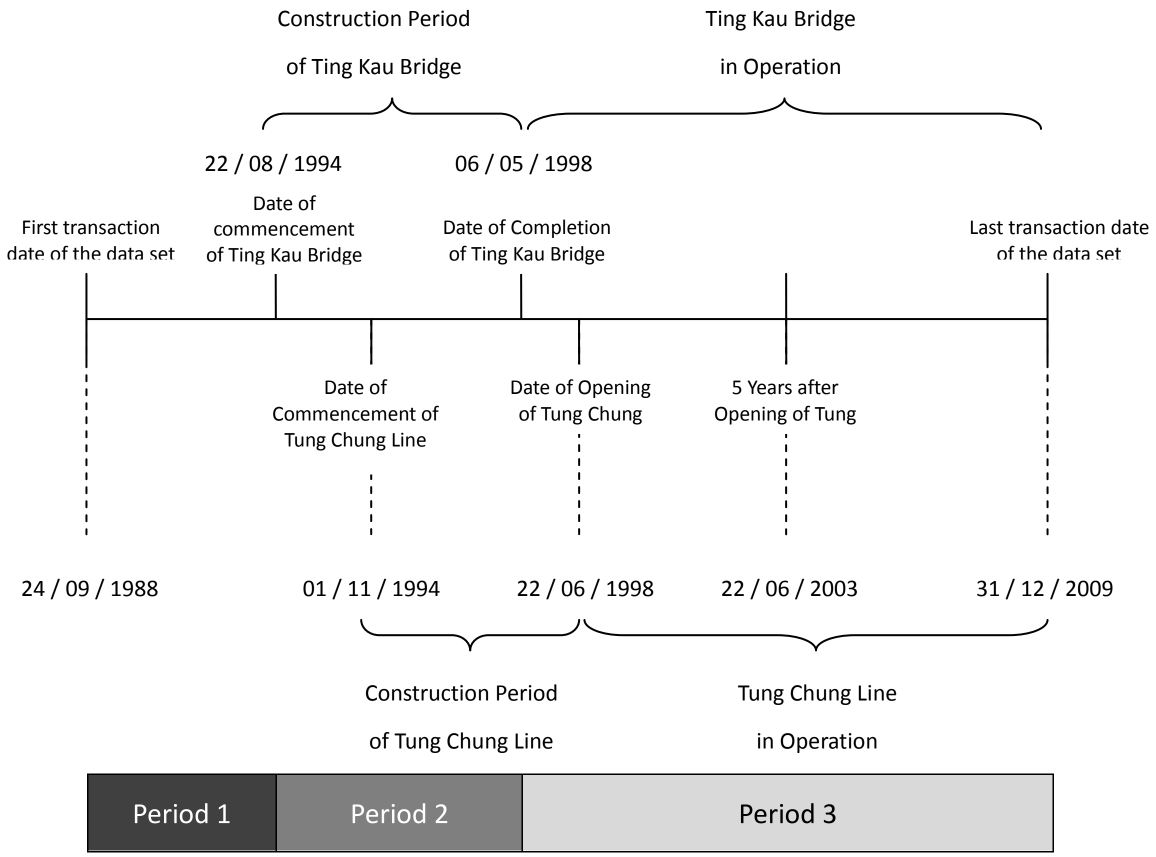

Figure 5.4 Timeline for construction of Ting Kau Bridge and MTR Tung Chung Line

5.3.4 TIME DUMMIES

The 74 time dummy variables are generated in a quarterly manner, in accordance to the dates of transactions as recorded by the EPRC. For instance, if the transaction took place on 23rd February, 2001, a “1” would be recorded in the variable “TIME_2001Q1” and “0” for the remaining 71 dummy variables. The decision for quarterly time dummy is made due to simplicity as the number of dummy variables is only 72, instead of 291 of the monthly measure. And it is expected that the estimates would not differ seriously as the effects on housing prices often last for more than one month, therefore, a quarterly estimate is also considered appropriate to explain the time effects due to inflationary and recessionary impacts.

5.4 Rationale of choosing the Time Period

The rationale for choosing the abovestated time period in this study is that an effect of construction of transport infrastructure on property prices may not reflect only on the time period upon its completion. It may, due to the expectation effects stated by Yiu and Wong (2005), or due to the time lag for potential purchasers to take responses to the infrastructural changes. Therefore, it is essential to take a thorough look in the whole timeframe before, during and after the construction of the Ting Kau Bridge, with acknowledging the effects brought about by other infrastructures which may bring transportation improvements to the areas of study.

Also, the timeline for study is not limited as time dummies are used to explain the potential effects induced by inflation and adverse economic situations. Therefore, a relatively long period of study can be achieved to have a more general view on the price changes due to the construction of the Ting Kau Bridge.

5.5 Data Selection and Omission

In the data collection stage, only transactions involving the signing of Agreement of Sales and Purchase (ASP) are recorded for the selected building blocks. Originally, 18612 transaction data were extracted from the EPRC website for the properties of the buildings or housing estates in Table 5.4. After that, data were grouped in a quarterly manner of time. The quarter in which either Sham Tseng or Tsing Yi does not have any transaction data would be omitted. This forms the first criterion of data omission and thus a total of six records, one in 1988Q3, one in 1990Q3 and three in 1992Q2, are omitted.

The second criterion of data omission occurs when the transaction prices recorded were equal to zero. As a zero-price transaction is considered unable to reflect the market price, those transactions involving no price in transactions are omitted. There are 2 records in total being omitted due to this criterion.

The third criterion of data omission is also related to the transaction prices of the properties. As the price per GFA ranges from around HK$3,000 to HK$8,000 per square feet for the most properties in Sham Tseng, Tsing Yi and Tai Kok Tsui under the data, it is considered unable to represent the actual market trend for transactions with price per GFA of over HK$15,000 per square feet. Therefore, based on this criterion, only one record, with a flat of 683 square feet costing HK$19.56 millions, is omitted for more accurate estimation.

After the omission process of the data is undergone, 9 data was omitted in the regression analysis and thus the remaining 18603 transaction records are left for the study of the effects of the Ting Kau Bridge construction on residential property prices in the two connection points, i.e. Tsing Yi and Sham Tseng.

5.6 Reliability of Data Collected

An important clarification for the results obtained in chapter 6 is that the results are very much affected by the reliability of the data collected, which depends on the sources of them. The reliability of data can be discussed in terms of the sources as follows:

5.6.1 Economic Property Research Centre (EPRC)

As majority of the data are from the EPRC, the reliability of EPRC is very important. As mentioned above, the EPRC purchases the data from the Land Registry of the Hong Kong Special Administrative Region Government, the data should be of a high reliability due to its formality.

However, there are doubts about some data such as a flat of 683 square feet costs HK$19.56 millions mentioned in chapter 5.4. Other transaction records involve no prices for the purchase of the flats, which do not reveal the reality of property market. Some records even miss out the data of gross floor area of the flat, which hinders the analysis. Therefore, those transaction data, including the 8 records omitted as mentioned in chapter 5.4, are considered unsuitable or inapplicable to be included in the regression models.

5.6.2 Centamap (www.centamap.com)

The centamap provides convenient digital mapping services online to search for such properties' details, such as the orientation of the flats and the distance from the entrance of the building to the Ting Kau Bridge in order to facilitate the determination of the presence of sea view and the relevancy of the targeted area of study respectively. Also, by clicking the hyperlinks in the property searching function of the centamap, some properties' details can provide a reasonable description on whether the flat is of sea view or mountain view. By taking these descriptions as primary information yet to be confirmed, site visits have been carried out to estimate the visibility of the sea from the properties in the study.

5.6.3 Site Visits

Site visits have been carried out on two days in early January. The properties in Tai Kok Tsui were visited on one day while that in Sham Tseng and Tsing Yi were visited on the other day. Basically, the site visits serve as a confirmatory measure for estimation on sea views of those properties, in terms of the orientation of the flats and the existence of windows in such orientations facing the sea. As there is a limitation that I could only estimate the visibility of sea views from the ground floor level and judge the visibility of such by sense for higher floor levels, some data are, therefore, of genuine estimates, but not in actual terms. However, it is believed that most of the information and estimation made in the site visits are reliable.

CHAPTER 6 Empirical Results and Analysis

In this chapter, the empirical results estimated by the three different hedonic models will be presented and interpreted. The results will be analyzed in a model-by-model basis and a general interpretation will be drawn.

In obtaining the following results, computer software for statistical analysis, EViews 5, was employed to estimate the numerical results by regression. The numerical results generated by the computers will then be interpreted by analyzing the signs and magnitudes of the coefficients of the independent variables, the p-value of the respective independent variables, the adjusted R^2 of the regression model and even the magnitude of the F-statistics.

The results of the general variables which appears in all three models, namely GFA, AGE, FLOOR, $FLOOR^2$ and SEAVIEW, will be discussed after the discussions of the key results, near the end of this chapter.

6.1 The Cross-Sectional Inter-Temporal Model (Model A)

6.1.1 Brief Recapitulation of Model A

In the cross-sectional inter-temporal model (Model A), key variables for the two regression models – the Tai Kok Tsui model and the Sham Tseng & Tsing Yi model – are P2_DOC_CPL and P3_AFTER_CPL. These two independent variables measure the general percentage changes in property price levels during construction and after completion stage of the Ting Kau Bridge, in the Tai Kok Tsui control and the two connection points. By analyzing the results from these two variables, the general price changes due to the effect of Ting Kau Bridge construction can be estimated.

Estimating Equation:

$$\ln(\text{PRICE}) = \alpha_0 + \alpha_1\text{GFA} + \alpha_2\text{AGE} + \alpha_3\text{FLOOR} + \alpha_4\text{FLOOR}^2 + \alpha_5\text{SEAVIEW}$$

$$+ \alpha_6\text{P2 DOC CPL} + \alpha_7\text{P3 AFTER CPL}$$

$$+ \sum_{i=1}^{70} \beta_i \text{ (70 TIME DUMMY VARIABLES)} + \varepsilon_1$$

6.1.2 Empirical Results of Model A – Tai Kok Tsui

Empirical Results of Model A – Tai Kok Tsui regression:

Dependent Variable: LN_PRICE
Method: Least Squares
Sample: 1 1484
Included observations: 1484

TKT Model A

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GFA	0.0018	0.0001	15.1321	0.0000
AGE	-0.0378	0.0045	-8.3865	0.0000
FLOOR**	0.0060	0.0031	1.9142	0.0558
FLOOR2***	3.42E-05	0.0001	0.3286	0.7425
SEAVIEW	0.0690	0.0167	4.1373	0.0000
P2_DOC_CPL	0.2203	0.0327	6.7376	0.0000
P3_AFTER_CPL*	0.1033	0.0449	2.3019	0.0215
C**	0.2419	0.1306	1.8517	0.0643

R-squared	0.7735
Adjusted R-squared	0.7611
F-statistic	62.3493
Prob(F-statistic)	0.0000

Table 6.1 Regression Results of Model A (Tai Kok Tsui)

Results of the 70 time dummy coefficients are omitted in Table but a complete version of the regression model is presented in Appendix I.

In the Model A (Tai Kok Tsui), in order to know about the proportion of changes in ln(price) explained by the changes in included independent variables, adjusted R^2 is required to act as the statistical measure. The figure of R^2 in Model A (Tai Kok Tsui), showing 0.7611, shows that 76.11% of the changes in dependent variable ln(price) can be explained by the changes in the independent variables. The R^2 obtained is very high, revealing that the explanatory power of the Tai Kok Tsui Model A is very high. The value of F-statistics is also very large and thus rejects the null hypothesis for all independent variable coefficients being zero with Prob(F-stat) less than 0.01%.

Among the all independent variables, only the coefficients of the independent variable $FLOOR^2$ and a time dummy variable TIME_2009Q3 are insignificant at the 10% level. The statistical insignificance in $FLOOR^2$ reveals that the increase in property prices is linearly proportional to the increase in floor level.

Most of the other variables shown above are statistically significant. The signs of these variables are also estimated of close proximity to the expected results.

6.1.3 Analysis of Key Variables in Model A – Tai Kok Tsui

P2_DOC_CPL

This independent dummy variable shows 0.2203 and significant at 1% level. The numerical interpretation is that the transaction prices of the properties are generally 22.03% higher during the period of Ting Kau Bridge construction than the prices before the date of commencement of works of the Ting Kau Bridge. As Tai Kok Tsui is acting as a control area, the percentage increase / decrease in general prices of Sham Tseng and Tsing Yi properties, as obtained in model A (Sham Tseng and Tsing Yi), is used to compare with this percentage change in price in order to find if the construction of the Ting Kau Bridge alone poses a positive or negative impact on the property prices of the two connection points.

P3_AFTER_CPL

This independent dummy variable shows 0.1033 in coefficient, with p-value of 0.0215, showing that the coefficient is significant at 5% level. The numerical interpretation, similar to that of the P2_DOC_CPL, represents that there are the general property prices after the completion of Ting Kau Bridge is 10.33% higher than that before the date of commencement of the bridge. Again, similar to the function of the dummy variable P2_DOC_CPL, this figure also is used to compare with the respective coefficient obtained in Model A (Sham Tseng and Tsing Yi) to study the impact on property prices before and after the construction of the Ting Kau Bridge.

The two variables are important as the coefficients are used as a control to compare whether the impact brought about by the bridge construction is positive, relatively constant or negative.

6.1.4 Empirical Results of Model A – Sham Tseng and Tsing Yi

Empirical Results of Model A – Sham Tseng and Tsing Yi regression:

Dependent Variable: LN_PRICE
Method: Least Squares
Sample: 3 63 68 15747 15749 17126
Included observations: 17119

ST & TY Model A

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GFA	0.0002	2.05E-05	11.5278	0.0000
AGE	-0.0116	0.0008	-15.4788	0.0000
FLOOR	0.0063	0.0008	7.9528	0.0000
FLOOR2	-0.0001	2.04E-05	-5.3876	0.0000
SEAVIEW	0.0442	0.0044	10.1547	0.0000
P2_DOC_CPL**	0.2499	0.0296	1.9853	0.0919
P3_AFTER_CPL*	0.1072	0.0432	2.4826	0.0131
C	0.7193	0.0500	14.3723	0.0000

R-squared	0.5856
Adjusted R-squared	0.5837
F-statistic	304.7979
Prob(F-statistic)	0.0000

Table 6.2 Regression Results of Model A (Sham Tseng and Tsing Yi)

\# Results of the 70 time dummy coefficients are omitted in Table but a complete version of the regression model is presented in Appendix II.

In the Model A (Sham Tseng and Tsing Yi), in order to know about the proportion of changes in ln(price) explained by the changes in included independent variables, adjusted R^2 is again required to act as the statistical measure. The figure of adjusted

R^2 in Model A (Sham Tseng and Tsing Yi) shows that 58.37% of the changes in dependent variable ln(price) can be explained by the changes in the independent variables. The R^2 obtained is satisfactorily high. The value of F-statistics is also very large, with the figure of 304.7979. The figure is even greater than the one obtained in model A (Tai Kok Tsui). Therefore, the null hypothesis for all independent variable coefficients being zero is again rejected.

Among the independent variables in the equation, only the coefficient of a time dummy variable TIME_1998Q1 is insignificant at the 10% level. The coefficient in variable P2_DOC_CPL is marginally significant at 10% level, with the p-value of 0.0919, showing that the estimation made in the coefficient is significant.

The remaining variables are statistically significant at the 10% level. The signs of these variables are also estimated in a logical and expectable manner.

6.1.5 Analysis of Key Variables in Model A – Sham Tseng and Tsing Yi

In the Model A (Sham Tseng and Tsing Yi), as mentioned in 6.1.3, the coefficients of P2_DOC_CPL and P3_AFTER_CPL are used to compare with the respective coefficients obtained in the model A (Tai Kok Tsui) in order to estimate the sole effect of Ting Kau Bridge construction on property prices in the two connection points.

P2_DOC_CPL

In the model, the variable P2_DOC_CPL shows positive 0.2499 in coefficient, with p-value of 0.0919. The coefficient obtained by this dummy variable is marginally significant at 10% level. Therefore, it can be concluded that the general property prices at the period from date of commencement to that of completion of the Ting Kau Bridge construction, as compared to the property prices in these two places before construction takes place, are about 25% higher in general property prices.

The net change in property prices before and during the construction period of the Ting Kau Bridge in the two connection points, relative to the control, Tai Kok Tsui, is estimated to be increased slightly by 2.96% (24.99% - 22.03%), solely due to the construction of the Ting Kau Bridge.

P3_AFTER_CPL

The variable P3_AFTER_CPL also shows a positive 0.1072 in coefficient and 0.0131 in p-value. The coefficient obtained is statistically significant at 5% level. Therefore, the general property prices at the period when construction works were undergone are of 10.72% higher than that before the construction works commenced.

The net change in property prices before construction and after completion of the Ting Kau Bridge in the two connection points, relative to the control, Tai Kok Tsui, is estimated to be increased minimally by 0.39% (10.72% - 10.33%), due to the sole reason of the opening of Ting Kau Bridge.

6.1.6 Interpretation of the Key Variable Results in Model A

By interpreting the results obtained above, the transacted prices of properties in Sham Tseng and Tsing Yi, due to the impact of the transportation improvement brought about by the Ting Kau Bridge, increase slightly (2.97%) during the construction period and drop to only a minimal increase of only 0.39% upon the completion of Ting Kau Bridge, as compared to the period before the date of commencement of the Ting Kau Bridge.

	Before Construction	During Construction	After Completion
Date From	04 – 04 – 1991	23 – 08 – 1994	06 – 05 – 1998
Date To	22 – 08 – 1994	05 – 05 – 1998	31 – 12 – 2009
Change in Property Prices in Sham Tseng and Tseng Yi		Increase 24.99%	Increase 10.72%
Change in Proeprty Prices in Tai Kok Tsui		Increase 22.03%	Increase 10.33%
Net Change in Property Prices in Sham Tseng and Tsing Yi, relative to Tai Kok Tsui as control		Net Increase 2.97%	Net Increase 0.39%

Table 6.3 Summary of Analytical Results in Model A

The slight increase in property price levels have not rejected either of the alternative hypothesis as the general prices record an increase in property prices in the two connection points, but of a little extent.

6.2 Empirical Results from Inter-Temporal Spatial-Temporal Model (Model B)

6.2.1 Brief Recapitulation of Model B

With the introduction of location-period interaction terms, the inter-temporal spatial-temporal model (Model B), the property prices at every location at every period, i.e. before, during and after the construction period, of the Ting Kau Bridge can be estimated. The key variables in the regression models are the interaction terms, including INTERACT_TKT_P2, INTERACT_TKT_P3, INTERACT_ST_P1, INTERACT_ST_P2, INTERACT_ST_P3, INTERACT_TY_P1, INTERACT_TY_P2 and INTERACT_TY_P3. All the coefficients obtained are the percentage difference in property prices of the above mentioned periods relative to the transaction prices of properties in Tai Kok Tsui before construction of Ting Kau Bridge takes place.

By analyzing the coefficients from the eight interaction terms, the real price changes in each location along the three periods can be estimated. Additionally, by observing the real price changes of properties in Sham Tseng and Tsing Yi, the price differences between the two connection points can be estimated in a cross-sectional manner, with three time periods – before, during and after the Ting Kau Bridge construction.

<u>Estimating Equation:</u>

$$\ln(\mathrm{PRICE}) = \theta_0 + \theta_1\mathrm{GFA} + \theta_2\mathrm{AGE} + \theta_3\mathrm{FLOOR} + \theta_4\mathrm{FLOOR}^2 + \theta_5\mathrm{SEAVIEW}$$
$$+ \sum_{i=2}^{3}\theta_{i+4}\mathrm{TKT} \times \mathrm{Pi} + \sum_{i=1}^{3}\theta_{i+7}\mathrm{ST} \times \mathrm{Pi} + \sum_{i=1}^{3}\theta_{i+10}\mathrm{TY} \times \mathrm{Pi}$$
$$+ \sum_{i=1}^{70}\varphi_i\ (\text{70 TIME DUMMY VARIABLES}) + \varepsilon_2$$

6.2.2 Empirical Results of Model B

Empirical Results of Model B regression:

Dependent Variable: LOG_PRICE
Method: Least Squares **Model B**
Sample: 3 65 70 10107 10109 15404 15406 17140 17142 18612
Included observations: 18603

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GFA	0.0004	2.86E-05	13.3122	0.0000
AGE	-0.0128	0.0008	-16.5195	0.0000
FLOOR	0.0073	0.0008	9.6817	0.0000
FLOOR2	-0.0001	1.95E-05	-6.8139	0.0000
SEAVIEW	0.0577	0.0042	13.6474	0.0000
INTERACT_TKT_P2	0.1532	0.0358	4.2784	0.0000
INTERACT_TKT_P3	-0.0682	0.0473	-4.6812	0.0000
INTERACT_ST_P1	-0.0231	0.0144	-2.8629	0.0042
INTERACT_ST_P2***	0.1150	0.0333	1.1506	0.2499
INTERACT_ST_P3	0.0204	0.0470	4.6338	0.0000
INTERACT_TY_P1	0.1946	0.0139	9.3398	0.0000
INTERACT_TY_P2***	0.1811	0.0327	0.8518	0.3943
INTERACT_TY_P3	-0.0645	0.0462	-2.8753	0.0040
C	0.7049	0.0506	13.9265	0.0000

R-squared	0.5954
Adjusted R-squared	0.5935
F-statistic	320.5846
Prob(F-statistic)	0.0000

Table 6.4 Regression Results of Model B

\# Results of the 70 time dummy coefficients are omitted in Table but a complete version of the regression model is presented in Appendix III.

In the Model B, similar to that in model A, in order to know about the proportion of changes in ln(price) explained by the changes in included independent variables, adjusted R^2 is again employed to test the explanatory power of the model. The figure of adjusted R^2 in Model B is 0.5935, showing that 59.35% of the changes in dependent variable ln(price) can be explained by the changes in the independent variables. The R^2 obtained is very close to 60%, which is satisfactorily high. The value of F-statistics is also very large, with the figure of 320.5846 this time. The figure is even greater than the one obtained in model A (Sham Tseng and Tsing Yi). Therefore, the null hypothesis for all independent variable coefficients being zero is again rejected with prob(F-statistics) is less than 0.01%.

The time-location interaction variables INTERACT_ST_P2 and INTERACT_TY_P2 are insignificant as the t-statistics are 1.1506 and 0.8518, and p-values are 0.2499 and 0.3943, respectively. The insignificances of the two location-period interaction terms are both at the period in which Ting Kau Bridge was under construction. Therefore, the focus of the model shifts to the study of real price changes of the two areas before and after construction of the Ting Kau Bridge, relative to the changes in property prices in Tai Kok Tsui. The other independent variable which is statistically insignificant is TIME_1998Q1, same as that in Model A (Sham Tseng and Tsing Yi) as the p-value for this variable is 0.1266, which means the time dummy variable being insignificant at the 10% level.

The remaining interaction variables are all statistically significant at the 1% level. The signs of these variables are quite different from the expected results as indicated in chapter 4.7.

6.2.3 Analysis of Key Variables in Model B

In the Model B, the coefficients of the interaction terms at the time period before construction (P1) and after completion (P3) of the Ting Kau Bridge are useful in estimating the percentage change in property prices of Sham Tseng, Tsing Yi, with reference to that of Tai Kok Tsui, and figuring out the sole effect on property prices at those locations brought about by Ting Kau Bridge construction.

INTERACT_TKT_P2

This interactive variable shows positive sign with a coefficient of 0.1532 with p-value less than 0.0001. The interactive variable is thus of high statistical significance. It reveals that for the properties in the same location, Tai Kok Tsui, prices during the construction period of the Ting Kau Bridge are 15.32% higher than that before the construction period, as estimated by inter-temporal spatial-temporal model.

INTERACT_TKT_P3

The interaction term is of a negative coefficient of -0.0682, which reveals that the property prices in Tai Kok Tsui after the construction period is 6.82% lower than that before the construction of the Ting Kau Bridge. This variable, is again, of statistical significance as the p-value is again less than 0.0001.

INTERACT_ST_P1

The interactive variable INTERACT_ST_P1 shows a negative coefficient of -0.0231 with p-value of 0.0042. The statistical significance reveals that before the works for constructing the Ting Kau Bridge commenced, the property prices at Sham Tseng is 2.31% lower than that in Tai Kok Tsui. The main reasons for the difference in original price levels in the two locations are that Sham Tseng is much more inconvenience in transportation and of a locational disadvantage, compared to Tai Kok Tsui. Therefore, the properties in Tai Kok Tsui are more favourable to the purchasers and originally more expensive than that in Sham Tseng.

INTERACT_ST_P2 and INTERACT_TY_P2

These two variables, having the coefficients of 0.1150 and 0.1811, are insignificant statistically as their p-values are 0.2499 and 0.3943 respectively, as mentioned in chapter 6.2.2. Therefore, the two interaction terms, together with the reference interaction term of the same period, INTER_TKT_P2, are no longer regarded as the focus in this model as it is inappropriate to apply the statistically insignificant data to analyze the results.

INTER_ST_P3

This variable is found to be statistically significant at 1% level and positive in sign with coefficient of 0.0204. The magnitude of the variable shows that the property prices at Sham Tseng after the construction of the bridge is 2.04% higher than that at Tai Kok Tsui before the commencement of works.

INTER_TY_P1

The interactive variable is found to be significant at 1% level and 0.1946 in coefficient. The meaning of the coefficient means that before construction, the property prices in Tsing Yi is 19.46% higher than that in Tai Kok Tsui. The explanation for the difference in price levels include that at the period between 1991 and 1994, the transportation network to Tsing Yi is already very convenient with the completion of Tsing Tsuen (Tsing Yi North) Bridge. Also, the fame of the housing estates and the impression of the general public towards Tsing Yi are better than Tai Kok Tsui. Therefore, with these reasons, it is still logical to believe in the estimation though the transportation network of Tai Kok Tsui is believed to be better than that of Tsing Yi as Tai Kok Tsui geographically closer and more accessible to the Central Business District (CBD), as well as most prosperous places on the Hong Kong Island and in the Kowloon Peninsula.

INTER_TY_P3

This interaction term is of negative coefficient of -0.0645 and statistically significant with p-value equals to 0.0040. It indicates that the prices of the Tsing Yi properties after the construction of the bridge are 6.45% higher than that of the Tai Kok Tsui properties before the commencement of the bridge construction works.

6.2.4 Interpretation of the Key Variable Results in Model B

The changes in property prices before and after the Ting Kau Bridge construction at different locations can be summarized in a table as follows:

	Sham Tseng (ST)	Tsing Yi (TY)	Tai Kok Tsui (TKT)
Before Construction (P1)	-0.0231	0.1946	0.0000
After Construction (P3)	0.0204	-0.0645	-0.0682
Net Change in Property Prices in Percentage Term	+4.35%	-25.91%	-6.82%

Table 6.5 Change in Property Prices of locations from Results in Model B

	Sham Tseng with reference to Tai Kok Tsui **(ST – TKT) for each period**	Tsing Yi with reference to Tai Kok Tsui **(TY – TKT) for each period**
Before Construction (P1)	-0.0231	0.1946
After Construction (P3)	0.0886	0.0037
Net Change in Property Prices in Percentage Term (Relative to TKT change)	+11.17%	-19.09%

Table 6.6 Summary of Analytical Results in Model B

Therefore, setting Tai Kok Tsui as the reference point which is assumed to be not being affected by the construction of the Ting Kau Bridge, the percentage change in property prices in Sham Tseng and Tsing Yi can be interpreted as shown in Table 6.6, in terms of net percentage changes in property prices relative to the change in the controlling reference point – Tai Kok Tsui.

Interpretation of the results can be drawn upon the construction of the Ting Kau Bridge as the percentage changes in property prices in Sham Tseng record a positive with 11.17% increase while that in Tsing Yi record a drop in property prices of 19.09%. The results as shown above indicate that the data supports the hypothesis 2 which proposes that the less accessible point will pose an increase in land supply and a competition on property prices in the more accessible point, leading to an increase in the property prices in the less accessible point while a drop in the originally more accessible location. The results reject hypothesis 1 as the percentage change in property prices in Tsing Yi records a decline of 19.09%.

An interesting point which is out of the author's expectation is that the property price level in Sham Tseng is 8.49% higher than that in Tsing Yi. The expected result is that Tsing Yi is still of a higher property price level than Sham Tseng, or at the extreme of the properties at the two locations being perfect substitutes and having the same property price level. However, the price level of Sham Tseng higher than Tsing Yi is something unexpected.

There may be reasons to explain this situation to happen. One explanation is that after the Ting Kau Bridge was completed, a large-scale development, Bellagio, started construction in Sham Tseng with prestigious quality and a great deal of advertisements. The new construction of such large-scale and good-quality project may induce a positive influence on prices of the nearby properties, including Rhine Garden, Lido Garden and Sea Crest Villa in the data set.

Another explanation is because of the negative externalities brought about by the operation of the new dioxin burning plant in 2004 and the nuisances from the construction of the Stonecutter’s Bridge and Nam Wan Tunnel, which are infrastructures mainly for the improving the transport network between the Hong Kong International Airport and the other urban areas while they serves very little in improving the accessibility of the residents to the CBD from Tsing Yi Island.

6.3 Empirical Results from Price Index and Price Gradient Approach (Model C)

6.3.1 Brief Recapitulation of Model C

The Price Index and Price Gradient Approach includes 216 location-time interaction terms which are with reference to the prices of properties transacted at Tsing Yi in quarter 4 of the year 2009. The location-time interaction terms can estimate the price indices at different geographical locations along the period of study. The estimating equation is as follows:

Estimating Equation:

$$\ln(\text{PRICE}) = \gamma_0 + \gamma_1\text{GFA} + \gamma_2\text{AGE} + \gamma_3\text{FLOOR} + \gamma_4\text{FLOOR}^2 + \gamma_5\text{SEAVIEW}$$

$$+ \gamma_{\text{ST 1991Q2}}\text{INTER ST 1991Q2} + \gamma_{\text{ST 1991Q3}}\text{INTER ST 1991Q3}$$

$$+ \sum_{k=1}^{2} \gamma_{\text{ST 1992Q(2k-1)}}\text{INTER ST 1992Q(2k} - 1)$$

$$+ \sum_{i=3}^{9}\sum_{k=1}^{4} \gamma_{\text{ST 199iQk}}\text{INTER ST 199iQk}$$

$$+ \sum_{i=0}^{9}\sum_{k=1}^{4} \gamma_{\text{ST 200iQk}}\text{INTER ST 200iQk} + \gamma_{\text{TY 1991Q2}}\text{INTER TY 1991Q2}$$

$$+ \gamma_{\text{TY 1991Q3}}\text{INTER TY 1991Q3}$$

$$+ \sum_{k=1}^{3} \gamma_{\text{TY 1992Q(2k-1)}}\text{INTER TY 1992Q(2k} - 1)$$

$$+ \sum_{i=3}^{9}\sum_{k=1}^{4} \gamma_{\text{TY 199iQk}}\text{INTER TY 199iQk}$$

$$+ \sum_{i=0}^{8}\sum_{k=1}^{4} \gamma_{\text{TY 200iQk}}\text{INTER TY 200iQk}$$

$$+ \sum_{k=1}^{3} \gamma_{\text{ST 2009Qk}}\text{INTER TY 2009Qk} + \gamma_{\text{TKT 1991Q2}}\text{INTER TKT 1991Q2}$$

$$+ \gamma_{\text{TKT 1991Q3}}\text{INTER TKT 1991Q3} + \gamma_{\text{TKT 1992Q4}}\text{INTER TKT 1992Q4}$$

$$+ \sum_{i=3}^{9}\sum_{k=1}^{4} \gamma_{\text{TKT 199iQk}}\text{INTER TKT 199iQk}$$

$$+ \sum_{i=0}^{9}\sum_{k=1}^{4} \gamma_{\text{TKT 200iQk}}\text{INTER TKT 200iQk} + \varepsilon_3$$

The details of the interaction terms will not be shown in the table of results below but they will be shown in Appendix IV.

6.3.2 Empirical Results of Model C

Empirical Results of Model C regression:

Dependent Variable: LN_PRICE
Method: Least Squares **Model C**
Sample: 3 65 70 10107 10109 15404 15406 17140 17142 18612
Included observations: 18603

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GFA	0.0004	2.83E-05	12.9489	0.0000
FLOOR	0.0069	0.0007	9.2988	0.0000
FLOOR2	-0.0001	1.94E-05	-6.4972	0.0000
AGE	-0.0126	0.0008	-16.2340	0.0000
SEAVIEW	0.0570	0.0043	13.3727	0.0000
C	0.5395	0.0293	18.4073	0.0000

R-squared	0.6031
Adjusted R-squared	0.5983
F-statistic	126.3839
Prob(F-statistic)	0.0000

Table 6.7 Regression Results of Model C

In Model C, adjusted R^2 is employed to test the proportion of changes in ln(price) explained by the changes in included independent variables in the regression model. The figure of adjusted R^2 in Model C is 0.5983, showing that 59.83% of the changes in ln(price) can be explained by the changes in the included independent variables, including the interaction terms.

Out of the 216 location-time interaction variables, only 19 of them are insignificant at the 10% level. All the variables which reveal the physical attribute of the residential properties are extremely significant with all the p-value being less than 0.0001. All the variables, including GFA, AGE, FLOOR, $FLOOR^2$ and the dummy variable SEAVIEW, are not only statistically significant, but also of expected signs. The R^2 obtained is very close to 60%, which is satisfactorily high. The value of F-statistics is 126.3839, which is quite large. The value of prob(F-statistics) is again less than 0.01%. Therefore, the null hypothesis for all independent variable coefficients being zero is rejected in model C. Therefore, model C, which is of a substantially high explanatory power, can be regarded as an appropriate model for analyzing the property price changes at different locations along the time periods of study.

6.3.3 Construction of Price Indices and Price Gradients

In obtaining the coefficients from the regression analysis of Model C, the price indices at different locations over the quarterly time periods can be constructed and presented in the following graph:

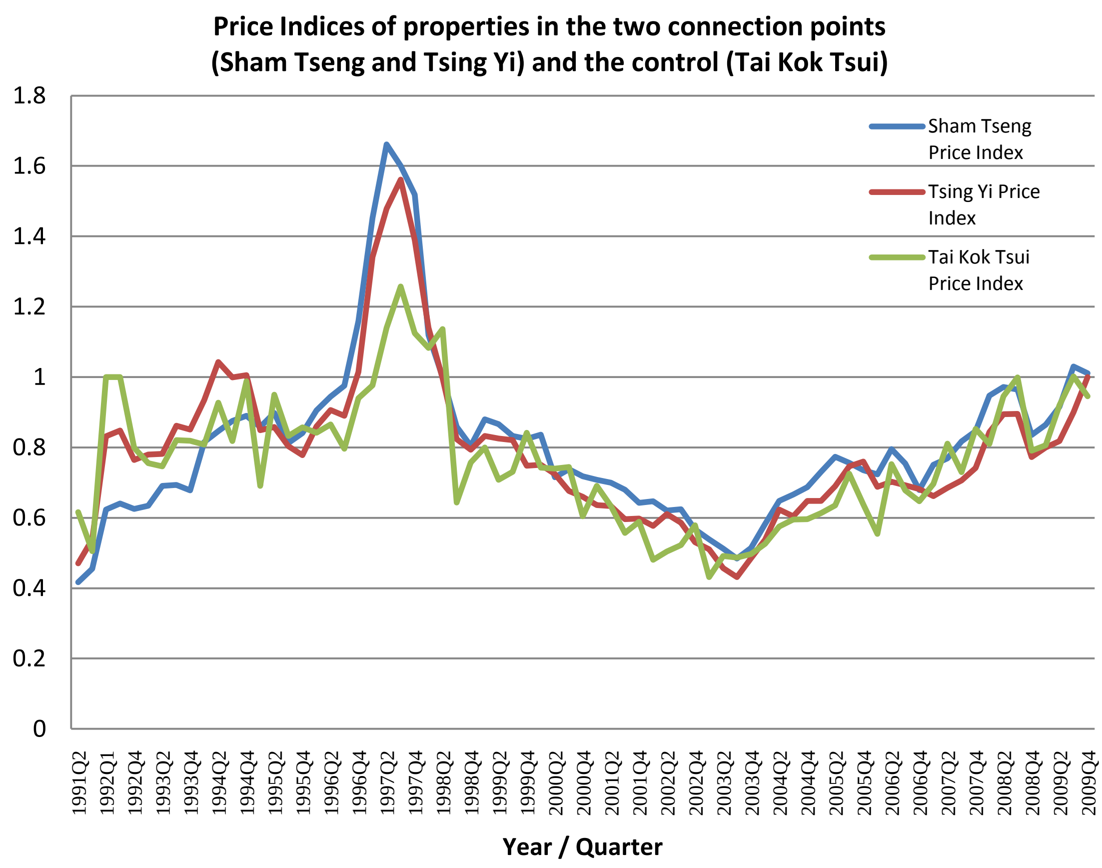

Figure 6.1 Estimated Price Indices of the three locations by Model C

The above figure shows the trend of price indices of the three different locations at different quarters in a continuous manner. Conclusions can be drawn that the general price trends in the three areas are similar, but magnitude of changes in property prices in Tai Kok Tsui is of a lesser extent, particularly can be seen in the period near the year of 1997 where there exists a huge boost and then a huge drop of property prices in Sham Tseng and Tsing while the property prices in Tai Kok Tsui is of a smaller extent in both the increase and drop in property prices.

The above figure may cause some difficulties in figuring out the difference in price levels of the two connection points, Tsing Yi and Sham Tseng, along the period of study. Therefore, by omitting the line representing the price indices of the control – Tai Kok Tsui, another figure with easier observation in difference in price levels, which is closely related to the price gradient, can be observed as follows:

Figure 6.2 Estimated Price Indices of the two connection points by Model C

In the above figure, it can be seen that the differences in price levels between the two locations at the earlier years, i.e. from 1991Q2 to 1994Q3, are higher than the later years when the Ting Kau Bridge was under construction and after completion.

The price indices over time quarters are only of a rough estimate by viewing the trend and the difference between the price indices in Figure 6.2. Therefore, a more appropriate method, i.e. price gradient, should be employed in order to estimate the property price differentials between the two locations over various time quarters.

For higher statistical efficiency, price gradients, as mentioned in chapter 4.5.4, can be estimated by taking the difference between coefficients of interactive variables of the same time-period but of different locations. By differencing the coefficients at every quarter of time, a chart showing the price gradients over time can be obtained as follows:

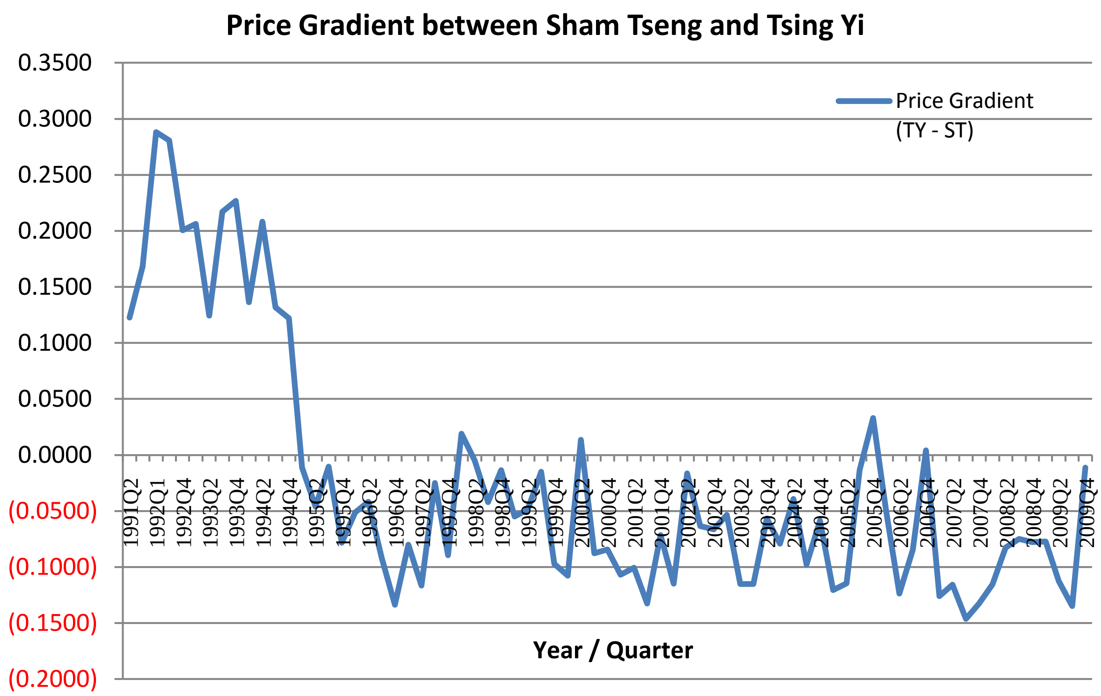

Figure 6.3 Price Gradients between two connection points by Model C

The figures of price gradients over the time periods will be presented in a detailed table in Appendix V.

As shown in Figure 6.3 above, the results in price gradients can be observed that at the beginning, the price gradient between Sham Tseng and Tsing Yi is ranging from 0.1221 to 0.2881 before quarter 3 of the year of 1994. However, following a lag of one quarter after the date of commencement of the Ting Kau Bridge, the price gradients drop significantly from 0.1221 of 1994 quarter 4 to -0.0112 of 1995 quarter 1. Afterwards, the price gradient remains a reduced level, which is much closer to 0, ranging from only 0.0330 to -0.1462.

The reduction in price gradient greatly reveals that hypothesis 3 is supported by the results of the study, with the prices in Sham Tseng chasing ahead of that in Tsing Yi and remaining at constant price gradients between the properties in the two connecting locations of the Ting Kau Bridge during and after the construction of the Ting Kau Bridge.

6.4 Discussions of Empirical Results

The empirical results of the five generally included independent variables in Model A (Tai Kok Tsui), Model A (Sham Tseng and Tsing Yi) and Model B, will be discussed in a sequential way as follows.

GFA

The independent variables GFA are shown with positive signs, ranging from 0.0002 to 0.0018 and are significant at 1% level in the above models. The results are of expectation as the owners are willing to pay a higher price for a flat which is of a larger size, in terms of Gross Floor Area (GFA). The result can be logically interpreted as the size of the flat is directly correlated to the price of the flat.

AGE

The independent variables AGE are shown with negative signs, ranging from -0.0116 to -0.0378, and are also significant at 1% level. The results are also of expectation and logical interpretation as the reservation prices of a buyer on a new flat with less building age are generally higher than that on a flat in an aged building.

FLOOR

The independent variables FLOOR are of positive signs, ranging from 0.0060 to 0.0073, and are all significant at 10% level in above models. The results can also be logically deduced and explained as the purchasers are willing to pay for a flat of a higher floor level due to the better view that can be enjoyed by the flat users, resulting in both a higher reservation prices upon transactions and higher rental charges upon letting the flat out.

$FLOOR^2$

The coefficients of the independent variable, FLOOR2, estimate the non-linearity change of the increase in property prices upon the increase in floor level. The results are generally negative and significant as expected, except for the Model A with the Tai Kok Tsui data set. The variable's coefficient in the Model A (Tai Kok Tsui) shows positive 3.42×10^{-5} but insignificant with p-value of 0.7425, meaning that the increase in property prices can be regarded as linearly proportional to the increase in floor level for the properties under study in Tai Kok Tsui.

SEAVIEW

The independent dummy variables SEAVIEW are shown to be of positive signs, ranging from 0.0442 to 0.0690, with all of them being significant at 1% level. The results reveal that premium of about 4.42% to 6.90% is paid for a flat with sea view when comparing the same flat without sea view. It is expected as a buyer would like to have a pleasant sea view from his flat in general and thus they are willing to pay for a higher price for the flat, when comparing with a flat of the same quality but without sea view.

6.5 Interpretational Summary of Key Results

From the results of Model A, B and C, the results can be summarized as follows:

Hypothetical Model	Issues Under Study	Major Results
Model A (Cross-Sectional Inter-Temporal Model)	Net Change in General Property Prices in Sham Tseng and Tsing Yi, relative to Tai Kok Tsui as control	As compared to the period before construction, combined General Price Level in Sham Tseng and Tsing Yi recorded a net increase of 2.97% slightly during construction, then dropped back by 2.58% after the Ting Kau Bridge was completed

Model B (Inter-Temporal Spatial-Temporal Model)	Net Change in Property Prices in Tsing Yi in Percentage Term (Relative to changes in TKT)	Relative to the property prices in Tsing Yi before commencement of the Ting Kau Bridge, the property prices in Tsing Yi after completion of the bridge dropped by 19.09%
	Net Change in Property Prices in Sham Tseng in Percentage Term (Relative to changes in TKT)	Relative to the property prices in Sham Tseng before commencement of the Ting Kau Bridge, the property prices in Sham Tseng after completion of the bridge increased by 11.17%
Model C (Price Index and Price Gradient Approach)	Change in Price Gradients between Sham Tseng and Tsing Yi over time	A significant reduction in Price Gradient is recorded at the time one month after the date of commencement of the Ting Kau Bridge, and the Price Gradient remains at a low level afterwards

Table 6.8 Interpretational Summary Table for the Model A, B & C

By recalling and modifying the hypothetical table in chapter 4.5.5, the following table shows the hypothetical results and the empirical results in comparable manner:

	Model A	Model B		Model C
	General Price Level of the two ends	Property prices in Sham Tseng	Property prices in Tsing Yi	Change in Price Gradient
Hypothesis 1	Increase	Increase	Increase	
Hypothesis 2	Relatively Constant	Increase	Decrease	
Hypothesis 3				Reduce
Empirical Results	**Increase Slightly** Increase 2.97% during construction followed by a drop by 2.58% after completion	**Increase** Increase by 11.17% after completion of the bridge	**Decrease** Drop by 19.09% after completion of the bridge	**Reduce** Reduction in magnitude and shifting from Positive to Negative in sign

Table 6.9 Comparison Table of Hypothetical and Empirical Results

By comparing the hypothetical results proposed by Hypotheses 1, 2 and 3, the empirical results suggest that hypothesis 2 is confirmed while hypothesis 1 is rejected among the two alternative hypotheses. Also, hypothesis 3, stating the reduction in price gradients between two connection points upon the construction of the bridge, is also confirmed with the results of model C.

Therefore, as the empirical results confirming hypothesis 2 and 3, the interpretation on results can be made that upon the construction of the Ting Kau Bridge, the transportation and accessibility from Sham Tseng to the CBD improves and the locational advantage which is originally enjoyed by Tsing Yi over Sham Tseng becomes less as the improvement brought about by the toll-free bridge reduces the time and cost of commuting for residents living in the less accessible point to get to the CBD.

Also, the increase in transportation through the more accessible point, Tsing Yi in the study, may pose extra burden to the road traffic of Tsing Yi and thus increase the chance of traffic congestion to occur. For instance, in this study, Tsing Yi is acting as a transition point for transportation from more remote areas, like Sham Tseng, Yuen Long and Tuen Mun, upon their journeys to the CBD.

Also, the reduction, as well as the eventually and persistently negative, price gradients over time suggest that the transportation improvement made to the less accessible point may overcome the originally locational disadvantage and thus the property prices rise as rational purchasers may see the flats situated in the less accessible point as “closer substitute” or even “better substitute” after taking other structural and locational features into account. Furthermore, if flat buyers and investors see that the flats in the less accessible point are of better speculative and investing potentials, they would rationally and behaviorally choose to live or invest in properties there, resulting in the bidding up, or even overbidding, of the property prices and rents there.

CHAPTER 7 Conclusion and Discussion

In this final chapter, findings in the dissertation will be summarized. Also, limitations of study and areas for further study will also be touched upon. Though there exists some of the limitations in the study, it is still desired that the findings and suggestions can provide implications for government policies upon the construction of bridges and other infrastructures, which are provided to link a less accessible area to a more accessible location, in the future.

7.1 Summary of Findings

The major objective of this study is to empirically examine the effects of bridge construction on the two connecting locations. Though a lot of past research has touched upon the effects of transportation improvements, this research is a bit different as it takes both the originally more accessible location and the more remote connection points into consideration. Also, the study not only focuses on the price gradients between the two connection points, but it also concerns about the property price changes in both the primarily more accessible and the less accessible points.

Ting Kau Bridge is selected as the bridge for the study and residential properties in the two ends of the bridge, Sham Tseng and Tsing Yi, are selected to be the areas of study. Transaction prices of residential units in the selected housing estates and building blocks are used as the dependent variable to proxy the effects of property prices in the two connecting locations. Three different hedonic pricing models are used to test the general percentage changes in price of the two connecting points, the percentage changes in prices of respective locations and the changes in price gradients over time, before, during and after the construction of bridge.

From the empirical findings on the general price level of the two connection points, it is shown that the general price level in Sham Tseng and Tsing Yi raised slightly by 2.97% during the construction, but dropped by 2.58% after the opening of the bridge. The aggregate impacts on general price level brought about by the bridge is only a 0.39% increase after the completion, compared to the price level before the works for constructing the bridge was commenced.

The second model shows empirically that the property prices in Sham Tseng record an increase of 11.17% while the property prices in Tsing Yi declines by 19.09% when the effects of bridge construction on the two locations' property prices before date of commencement and after completion are studied upon. Therefore, among the two alternative hypotheses, hypothesis 2, stating that improvement in transportation would cause an increase in the originally less accessible point while a decline in the geographically more advantageous location, is confirmed while hypothesis 1 is rejected. The third model also confirmed the hypothesis of reduction in price gradient upon the construction of infrastructure which improves transportation.

The findings in the dissertation are somehow consistent to what past scholars suggested, particularly the application of market competition on land values by Hurd (1924). The findings in my dissertation reveals that the transportation made to the less accessible location may induce an increase in supply of similar properties to the geographically more urban area as locational differences are reduced. Also, the potential extra burden on the more accessible point imposed by the increased traffic from the more remote areas may impose negative externalities on the property prices in the originally more accessible area.

Moreover, the behaviours of the investors and home buyers also lead to a drastic increase in property prices in the more remote end while a significant drop in the more urban area. Upon transport improvements, the purchasers may see flats in the less accessible area as “closer substitutes” or even “better substitutes” to those situated in the more urban area. Therefore, the bidding up, or overbidding, of property prices may exist in the less accessible end as they may raise the reservation prices and speculate on future increase in property prices in the more remote area while “over-cooling” effect may occur on properties situating in the more accessible location.

The results implicate that the construction of a toll-free infrastructure linking a more urban location to a more remote area poses a significantly impact not only positively on the less accessible place, but also negatively on the geographically more urban location. The empirical results obtained for the study not only provide implications for government policies upon construction of transport infrastructures, but also indicate the future price movements of the two ends for home buyers, investors and even the property owners.

The results of significant increase in property prices in the less accessible point suggests that the infrastructural project can be financed by selling land parcels at the more remote location, rather than increasing the tax burden on the general public which causes controversy, opposition, and even adversely affects the confidence on the political governance. As the prices are expected to be higher upon the completion of road works, the land parcels can be sold at a higher land prices and the “self-financing mechanism” for the infrastructure can work effectively. However, in selecting which land parcel to be sold, serious consideration on other aspects, such as possible externality, environmental, social and even preservative issues should be thoroughly considered to minimize the opposition voices in the society.

7.2 Limitations of Study

Limitation on data sample in Tai Kok Tsui is one of the key limitations in the study. In order to find a suitable control location with the construction of MTR railway line in the same period of time, locations along the Tung Chung Line is most preferred. However, residential housings having building age more than 15 years near the Kowloon Station and Lai King Station are considered unsuitable as the tenement housing blocks in Jordon near Kowloon Station are of even greater differences in structural and neighbourhood attributes while most of the buildings near Lai King Station are building blocks of Home Ownership Scheme (HOS), of which transaction data are not achievable even through the Economic Property Research Centre (EPRC). Also, as Tung Chung is not yet developed before the construction of the bridge while the areas near Hong Kong Station are mostly commercial or recreational, the residential transactions in Tai Kok Tsui near the Olympic Station and Nam Cheong Station are of highest achievability and suitability.

Also, the amount of transaction data in Tai Kok Tsui is also very few, compared to that in Tsing Yi and Sham Tseng. There are only 1484 data used for carrying out the regression analysis in the models. Therefore, the results from the control may not act very robustly for tracking the general price levels and regional price changes in the models. However, nearly all appropriate transaction data at Tai Kok Tsui have already been collected for the study in order to act in the best way against limitations.

The period of study is quite long in order to eliminate the possibility that the improvement in transportation is reflected on property prices with a long period of time lag. Therefore, the data used in the regression analysis include transactions occurred in the past 19 years, from 1991 to 2009. In order to test whether the effect posted by the bridge on the property prices at the two locations is short-term, continuous price indices and price gradients have been employed to observe the effect.

Also, it is inevitable that some of the transaction data cannot reflect the market trend and reasonable property prices. However, it is impossible for us to judge which transaction is reasonable on a case by case basis. Therefore, omissions of some data like the zero-price transactions are done in order to enhance the accuracy of the estimation.

7.3 Areas for Further Study

This dissertation only provides the empirical results of transport improvement imposing a positive impact on property prices of the less accessible point while causing in a decline in property prices of the geographically more accessible location, resulting in a reduction in price gradients between the two locations. However, it is expected that the vehicular flow along the infrastructure and the occurrences of traffic congestion before and after the construction of the bridge in nearby locations also contribute to the changes in property prices as time of commuting is also an important consideration for a flat buyer when setting the reservation prices. Therefore, it is suggested that study on relationship between vehicular flow, occurrences of traffic congestions before and after the construction of new infrastructure and property prices at the nearby areas can be done to have better implications for transport and city planning in Hong Kong.

Also, based on the empirical results within the city of Hong Kong, studies about the impacts of the construction of Hong Kong-Zhuhai-Macau Bridge on property prices in both Zhuhai, Macau and Hong Kong. It is still an unanswerable question about the impact on Hong Kong property prices brought about by this inter-city infrastructure as it is still under construction. The empirical study on Hong Kong-Zhuhai-Macau Bridge is expected to have influential implications for government policies on dealing with cooperative projects and inter-city linkages with the government in Mainland China. By comprehensive and careful reviews on empirical results and implications from such study, it is hoped that the Hong Kong Special Administrative Region (HKSAR) Government can enhance the inter-city linkages, improve the transportation infrastructures, maintain a prosperous property market and develop Hong Kong into a globally recognized world city.

Appendix I Regression Results of Model A – Tai Kok Tsui (Cross-Sectional Inter-Temporal Model)

Dependent Variable: LN_PRICE
Method: Least Squares
Sample: 1 1484
Included observations: 1484

TKT Model A

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GFA	0.0018	0.0001	15.1321	0.0000
AGE	-0.0378	0.0045	-8.3865	0.0000
FLOOR	0.0060	0.0031	1.9143	0.0558
FLOOR2	0.0000	0.0001	0.3286	0.7425
SEAVIEW	0.0690	0.0167	4.1373	0.0000
P2_DOC_CPL	0.2203	0.0327	6.7376	0.0000
P3_AFTER_CPL	0.1033	0.0449	2.3019	0.0215
TIME_1991Q2	-1.1213	0.1088	-10.3112	0.0000
TIME_1991Q3	-0.9555	0.1006	-9.4958	0.0000
TIME_1992Q4	-0.7520	0.1024	-7.3448	0.0000
TIME_1993Q1	-0.7351	0.0987	-7.4476	0.0000
TIME_1993Q2	-0.6595	0.0973	-6.7760	0.0000
TIME_1993Q3	-0.6014	0.0962	-6.2548	0.0000
TIME_1993Q4	-0.5565	0.0987	-5.6407	0.0000
TIME_1994Q1	-0.5133	0.0944	-5.4370	0.0000
TIME_1994Q2	-0.3654	0.0913	-4.0012	0.0001
TIME_1994Q3	-0.5269	0.0807	-6.5301	0.0000
TIME_1994Q4	-0.6268	0.0867	-7.2259	0.0000
TIME_1995Q1	-0.8313	0.0892	-9.3211	0.0000
TIME_1995Q2	-0.5971	0.0802	-7.4424	0.0000
TIME_1995Q3	-0.6193	0.0775	-7.9944	0.0000
TIME_1995Q4	-0.6631	0.0754	-8.7894	0.0000
TIME_1996Q1	-0.7384	0.0901	-8.1917	0.0000
TIME_1996Q2	-0.6352	0.0745	-8.5281	0.0000
TIME_1996Q3	-0.6719	0.0767	-8.7611	0.0000
TIME_1996Q4	-0.5548	0.0753	-7.3665	0.0000
TIME_1997Q1	-0.4636	0.0730	-6.3524	0.0000
TIME_1997Q2	-0.3370	0.0734	-4.5915	0.0000
TIME_1997Q3	-0.2374	0.0732	-3.2458	0.0012
TIME_1997Q4	-0.3001	0.0781	-3.8400	0.0001
TIME_1998Q1	-0.3450	0.0741	-4.6566	0.0000
TIME_1998Q2	-0.3015	0.0646	-4.6659	0.0000
TIME_1998Q3	-0.7664	0.1825	-4.1990	0.0000
TIME_1998Q4	-0.5889	0.0595	-9.9057	0.0000
TIME_1999Q1	-0.5073	0.0716	-7.0888	0.0000
TIME_1999Q2	-0.6406	0.1500	-4.2713	0.0000
TIME_1999Q3	-0.5691	0.0614	-9.2735	0.0000
TIME_1999Q4	-0.5191	0.0573	-9.0577	0.0000
TIME_2000Q1	-0.5937	0.0756	-7.8538	0.0000

TIME_2000Q2	-0.6059	0.0527	-11.4904	0.0000
TIME_2000Q3	-0.6024	0.0529	-11.3861	0.0000
TIME_2000Q4	-0.7207	0.0999	-7.2119	0.0000
TIME_2001Q1	-0.5958	0.0460	-12.9502	0.0000
TIME_2001Q2	-0.6829	0.0644	-10.5979	0.0000
TIME_2001Q3	-0.8415	0.0858	-9.8056	0.0000
TIME_2001Q4	-0.7812	0.0487	-16.0369	0.0000
TIME_2002Q1	-0.8480	0.0457	-18.5615	0.0000
TIME_2002Q2	-0.8412	0.0459	-18.3344	0.0000
TIME_2002Q3	-0.8248	0.0425	-19.4107	0.0000
TIME_2002Q4	-0.8229	0.0477	-17.2504	0.0000
TIME_2003Q1	-0.9629	0.1265	-7.6103	0.0000
TIME_2003Q2	-0.9228	0.0546	-16.9047	0.0000
TIME_2003Q3	-0.8813	0.0409	-21.5520	0.0000
TIME_2003Q4	-0.8378	0.0383	-21.8523	0.0000
TIME_2004Q1	-0.7495	0.0417	-17.9794	0.0000
TIME_2004Q2	-0.7290	0.0394	-18.4815	0.0000
TIME_2004Q3	-0.7177	0.0376	-19.1128	0.0000
TIME_2004Q4	-0.6761	0.0343	-19.7373	0.0000
TIME_2005Q1	-0.5725	0.0303	-18.9108	0.0000
TIME_2005Q2	-0.5469	0.0388	-14.0920	0.0000
TIME_2005Q3	-0.5095	0.0323	-15.7522	0.0000
TIME_2005Q4	-0.5513	0.0312	-17.6962	0.0000

TIME_2006Q1	-0.6363	0.0888	-7.1683	0.0000
TIME_2006Q2	-0.4450	0.0368	-12.0926	0.0000
TIME_2006Q3	-0.4717	0.0551	-8.5565	0.0000
TIME_2006Q4	-0.5234	0.0814	-6.4307	0.0000
TIME_2007Q1	-0.3948	0.0337	-11.7120	0.0000
TIME_2007Q2	-0.3242	0.0323	-10.0231	0.0000
TIME_2007Q3	-0.3490	0.0327	-10.6738	0.0000
TIME_2007Q4	-0.2544	0.0356	-7.1520	0.0000
TIME_2008Q1	-0.2465	0.0417	-5.9049	0.0000
TIME_2008Q2	-0.0929	0.0244	-3.8014	0.0002
TIME_2008Q3	-0.0934	0.0380	-2.4607	0.0140
TIME_2008Q4	-0.2361	0.0357	-6.6052	0.0000
TIME_2009Q1	-0.2159	0.0242	-8.9289	0.0000
TIME_2009Q2	-0.0949	0.0232	-4.0930	0.0000
TIME_2009Q3	-0.0281	0.0332	-0.8468	0.3973
C	0.2419	0.1306	1.8517	0.0643

R-squared	0.7735	Mean dependent var	0.4409
Adjusted R-squared	0.7611	S.D. dependent var	0.3738
S.E. of regression	0.1827	Akaike info criterion	-0.5106
Sum squared resid	46.9417	Schwarz criterion	-0.2319
Log likelihood	456.8587	F-statistic	62.3493
Durbin-Watson stat	2.0796	Prob(F-statistic)	0.0000

Appendix II Regression Results of Model A – Sham Tseng and Tsing Yi (Cross-Sectional Inter-Temporal Model)

Dependent Variable: LN_PRICE
Method: Least Squares
Sample: 3 63 68 15747 15749 17126
Included observations: 17119

ST & TY Model A

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GFA	0.0002	0.0000	11.5278	0.0000
AGE	-0.0116	0.0008	-15.4787	0.0000
FLOOR	0.0063	0.0008	7.9528	0.0000
FLOOR2	-0.0001	0.0000	-5.3876	0.0000
SEAVIEW	0.0442	0.0044	10.1547	0.0000
P2_DOC_CPL	0.2499	0.0296	1.9853	0.0919
P3_AFTER_CPL	0.1072	0.0432	2.4826	0.0131
TIME_1991Q2	-0.8696	0.0511	-17.0221	0.0000
TIME_1991Q3	-0.8040	0.0646	-12.4441	0.0000
TIME_1992Q1	-0.2824	0.0533	-5.2938	0.0000
TIME_1992Q3	-0.3909	0.0665	-5.8761	0.0000
TIME_1992Q4	-0.4549	0.0517	-8.7943	0.0000
TIME_1993Q1	-0.4467	0.0489	-9.1412	0.0000
TIME_1993Q2	-0.3886	0.0480	-8.0935	0.0000
TIME_1993Q3	-0.3336	0.0484	-6.8969	0.0000
TIME_1993Q4	-0.3609	0.0488	-7.3883	0.0000
TIME_1994Q1	-0.2013	0.0473	-4.2552	0.0000
TIME_1994Q2	-0.1557	0.0492	-3.1620	0.0016
TIME_1994Q3	-0.1996	0.0429	-4.6491	0.0000
TIME_1994Q4	-0.2097	0.0375	-5.5950	0.0000
TIME_1995Q1	-0.3053	0.0375	-8.1392	0.0000
TIME_1995Q2	-0.2706	0.0380	-7.1140	0.0000
TIME_1995Q3	-0.3555	0.0408	-8.7187	0.0000
TIME_1995Q4	-0.3521	0.0367	-9.5827	0.0000
TIME_1996Q1	-0.2670	0.0387	-6.9055	0.0000
TIME_1996Q2	-0.2172	0.0363	-5.9846	0.0000
TIME_1996Q3	-0.2095	0.0375	-5.5790	0.0000
TIME_1996Q4	-0.0638	0.0367	-1.7398	0.0819
TIME_1997Q1	0.1852	0.0377	4.9145	0.0000
TIME_1997Q2	0.3084	0.0365	8.4533	0.0000
TIME_1997Q3	0.3133	0.0432	7.2567	0.0000
TIME_1997Q4	0.2360	0.0467	5.0545	0.0000
TIME_1998Q1	-0.0313	0.0375	-0.8350	0.4037
TIME_1998Q2	-0.0605	0.0303	-1.9986	0.0457
TIME_1998Q3	-0.1571	0.0259	-6.0652	0.0000
TIME_1998Q4	-0.2142	0.0194	-11.0211	0.0000
TIME_1999Q1	-0.1394	0.0165	-8.4258	0.0000
TIME_1999Q2	-0.1531	0.0171	-8.9715	0.0000
TIME_1999Q3	-0.1820	0.0208	-8.7568	0.0000

TIME_1999Q4	-0.2173	0.0227	-9.5924	0.0000
TIME_2000Q1	-0.2106	0.0184	-11.4482	0.0000
TIME_2000Q2	-0.3283	0.0344	-9.5361	0.0000
TIME_2000Q3	-0.3305	0.0207	-15.9563	0.0000
TIME_2000Q4	-0.3532	0.0225	-15.7015	0.0000
TIME_2001Q1	-0.3740	0.0194	-19.2960	0.0000
TIME_2001Q2	-0.3854	0.0181	-21.2854	0.0000
TIME_2001Q3	-0.4204	0.0197	-21.3560	0.0000
TIME_2001Q4	-0.4642	0.0188	-24.6841	0.0000
TIME_2002Q1	-0.4778	0.0204	-23.4376	0.0000
TIME_2002Q2	-0.4803	0.0189	-25.4409	0.0000
TIME_2002Q3	-0.4917	0.0216	-22.7964	0.0000
TIME_2002Q4	-0.5823	0.0209	-27.8209	0.0000
TIME_2003Q1	-0.6320	0.0208	-30.3718	0.0000
TIME_2003Q2	-0.7103	0.0214	-33.1905	0.0000
TIME_2003Q3	-0.7638	0.0205	-37.3186	0.0000
TIME_2003Q4	-0.6864	0.0187	-36.6427	0.0000
TIME_2004Q1	-0.5667	0.0235	-24.1474	0.0000
TIME_2004Q2	-0.4484	0.0213	-21.0503	0.0000
TIME_2004Q3	-0.4393	0.0229	-19.1883	0.0000
TIME_2004Q4	-0.3984	0.0200	-19.8880	0.0000
TIME_2005Q1	-0.3613	0.0194	-18.6500	0.0000
TIME_2005Q2	-0.2975	0.0181	-16.4220	0.0000
TIME_2005Q3	-0.2876	0.0219	-13.1064	0.0000
TIME_2005Q4	-0.2993	0.0269	-11.1160	0.0000
TIME_2006Q1	-0.3438	0.0225	-15.2702	0.0000
TIME_2006Q2	-0.2748	0.0229	-11.9906	0.0000
TIME_2006Q3	-0.3112	0.0221	-14.1058	0.0000
TIME_2006Q4	-0.3883	0.0261	-14.8761	0.0000
TIME_2007Q1	-0.3367	0.0191	-17.5939	0.0000
TIME_2007Q2	-0.3024	0.0177	-17.0956	0.0000
TIME_2007Q3	-0.2705	0.0201	-13.4648	0.0000
TIME_2007Q4	-0.2245	0.0172	-13.0650	0.0000
TIME_2008Q1	-0.1106	0.0184	-6.0246	0.0000
TIME_2008Q2	-0.0662	0.0181	-3.6501	0.0003
TIME_2008Q3	-0.0681	0.0161	-4.2220	0.0000
TIME_2008Q4	-0.2108	0.0241	-8.7346	0.0000
TIME_2009Q1	-0.1780	0.0161	-11.0375	0.0000
TIME_2009Q2	-0.1351	0.0168	-8.0572	0.0000
TIME_2009Q3	-0.0276	0.0163	-1.6937	0.0903
C	0.7193	0.0500	14.3723	0.0000

R-squared	0.5856	Mean dependent var	0.5752
Adjusted R-squared	0.5837	S.D. dependent var	0.3944
S.E. of regression	0.2545	Akaike info criterion	0.1054
Sum squared resid	1103.3470	Schwarz criterion	0.1416
Log likelihood	-822.0239	F-statistic	304.7979
Durbin-Watson stat	1.938939	Prob(F-statistic)	0.000000

Appendix III **Regression Results of Model B (Inter-Temporal Spatial-Temporal Model)**

Dependent Variable: LN_PRICE

Method: Least Squares

Model B

Sample: 3 65 70 10107 10109 15404 15406 17140 17142 18612

Included observations: 18603

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GFA	0.0004	0.0000	13.3122	0.0000
AGE	-0.0128	0.0008	-16.5195	0.0000
FLOOR	0.0073	0.0008	9.6817	0.0000
FLOOR2	-0.0001	0.0000	-6.8139	0.0000
SEAVIEW	0.0577	0.0042	13.6474	0.0000
INTERACT_TKT_P2	0.1532	0.0358	4.2784	0.0000
INTERACT_TKT_P3	-0.0682	0.0473	-4.6812	0.0000
INTERACT_ST_P1	-0.0231	0.0144	-2.8629	0.0042
INTERACT_ST_P2	0.1150	0.0333	1.1506	0.2499
INTERACT_ST_P3	0.0204	0.0470	4.6338	0.0000
INTERACT_TY_P1	0.1946	0.0139	9.3398	0.0000
INTERACT_TY_P2	0.1811	0.0327	0.8518	0.3943
INTERACT_TY_P3	-0.0645	0.0462	-2.8753	0.0040
TIME_1991Q2	-0.9499	0.0544	-17.4671	0.0000
TIME_1991Q3	-0.8360	0.0554	-15.0894	0.0000
TIME_1992Q1	-0.4165	0.0497	-8.3861	0.0000
TIME_1992Q3	-0.4394	0.0528	-8.3274	0.0000
TIME_1992Q4	-0.4598	0.0502	-9.1577	0.0000
TIME_1993Q1	-0.4724	0.0484	-9.7555	0.0000
TIME_1993Q2	-0.4471	0.0481	-9.3021	0.0000
TIME_1993Q3	-0.3880	0.0481	-8.0737	0.0000
TIME_1993Q4	-0.4051	0.0482	-8.4005	0.0000
TIME_1994Q1	-0.2808	0.0478	-5.8803	0.0000
TIME_1994Q2	-0.1999	0.0485	-4.1203	0.0000
TIME_1994Q3	-0.2254	0.0447	-5.0405	0.0000
TIME_1994Q4	-0.2365	0.0393	-6.0176	0.0000
TIME_1995Q1	-0.3437	0.0389	-8.8293	0.0000
TIME_1995Q2	-0.2793	0.0395	-7.0773	0.0000
TIME_1995Q3	-0.3816	0.0419	-9.1093	0.0000
TIME_1995Q4	-0.3765	0.0379	-9.9229	0.0000
TIME_1996Q1	-0.2915	0.0392	-7.4429	0.0000
TIME_1996Q2	-0.2455	0.0376	-6.5290	0.0000
TIME_1996Q3	-0.2412	0.0383	-6.3007	0.0000
TIME_1996Q4	-0.0914	0.0379	-2.4131	0.0158
TIME_1997Q1	0.1495	0.0387	3.8580	0.0001
TIME_1997Q2	0.2695	0.0377	7.1556	0.0000
TIME_1997Q3	0.2774	0.0428	6.4830	0.0000
TIME_1997Q4	0.1922	0.0447	4.3034	0.0000
TIME_1998Q1	-0.0594	0.0389	-1.5279	0.1266
TIME_1998Q2	-0.0768	0.0295	-2.6079	0.0091
TIME_1998Q3	-0.1939	0.0320	-6.0545	0.0000

TIME_1998Q4	-0.2340	0.0187	-12.4891	0.0000
TIME_1999Q1	-0.1624	0.0164	-9.8929	0.0000
TIME_1999Q2	-0.1836	0.0184	-9.9782	0.0000
TIME_1999Q3	-0.2109	0.0201	-10.5145	0.0000
TIME_1999Q4	-0.2349	0.0222	-10.5560	0.0000
TIME_2000Q1	-0.2312	0.0186	-12.4087	0.0000
TIME_2000Q2	-0.3395	0.0300	-11.3270	0.0000
TIME_2000Q3	-0.3421	0.0200	-17.0630	0.0000
TIME_2000Q4	-0.3808	0.0235	-16.2284	0.0000
TIME_2001Q1	-0.3882	0.0182	-21.2919	0.0000
TIME_2001Q2	-0.4046	0.0172	-23.5650	0.0000
TIME_2001Q3	-0.4431	0.0186	-23.8017	0.0000
TIME_2001Q4	-0.4803	0.0182	-26.4378	0.0000
TIME_2002Q1	-0.4982	0.0200	-24.9238	0.0000
TIME_2002Q2	-0.5106	0.0208	-24.5249	0.0000
TIME_2002Q3	-0.5188	0.0243	-21.3276	0.0000
TIME_2002Q4	-0.5947	0.0205	-29.0499	0.0000
TIME_2003Q1	-0.6684	0.0220	-30.3901	0.0000
TIME_2003Q2	-0.7194	0.0209	-34.4437	0.0000
TIME_2003Q3	-0.7698	0.0201	-38.2655	0.0000
TIME_2003Q4	-0.6950	0.0181	-38.4683	0.0000
TIME_2004Q1	-0.5817	0.0220	-26.4297	0.0000
TIME_2004Q2	-0.4620	0.0215	-21.4523	0.0000
TIME_2004Q3	-0.4539	0.0205	-22.1043	0.0000
TIME_2004Q4	-0.4126	0.0180	-22.9441	0.0000
TIME_2005Q1	-0.3725	0.0189	-19.7157	0.0000
TIME_2005Q2	-0.3137	0.0166	-18.9242	0.0000
TIME_2005Q3	-0.2954	0.0212	-13.9024	0.0000
TIME_2005Q4	-0.3235	0.0251	-12.8901	0.0000
TIME_2006Q1	-0.3698	0.0203	-18.2368	0.0000
TIME_2006Q2	-0.2820	0.0211	-13.3820	0.0000
TIME_2006Q3	-0.3255	0.0197	-16.5340	0.0000
TIME_2006Q4	-0.3970	0.0250	-15.8980	0.0000
TIME_2007Q1	-0.3404	0.0189	-17.9744	0.0000
TIME_2007Q2	-0.3040	0.0181	-16.8392	0.0000
TIME_2007Q3	-0.2729	0.0188	-14.5247	0.0000
TIME_2007Q4	-0.2210	0.0161	-13.7653	0.0000
TIME_2008Q1	-0.1129	0.0174	-6.4747	0.0000
TIME_2008Q2	-0.0627	0.0167	-3.7478	0.0002
TIME_2008Q3	-0.0650	0.0163	-3.9851	0.0001
TIME_2008Q4	-0.2177	0.0234	-9.2876	0.0000
TIME_2009Q1	-0.1836	0.0155	-11.8134	0.0000
TIME_2009Q2	-0.1322	0.0156	-8.4561	0.0000
TIME_2009Q3	-0.0262	0.0153	-1.7095	0.0874
C	0.7049	0.0506	13.9265	0.0000

R-squared	0.5954	Mean dependent var	0.5645
Adjusted R-squared	0.5935	S.D. dependent var	0.3945
S.E. of regression	0.2515	Akaike info criterion	0.0817
Sum squared resid	1171.0710	Schwarz criterion	0.1179
Log likelihood	-674.1103	F-statistic	320.5846
Durbin-Watson stat	1.9848	Prob(F-statistic)	0.0000

Appendix IV **Regression Results of Model C (Price Index and Price Gradient Approach)**

Dependent Variable: LN_PRICE

Method: Least Squares **Model C**

Sample: 3 65 70 10107 10109 15404 15406 17140 17142 18612

Included observations: 18603

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GFA	0.0004	0.0000	12.9489	0.0000
FLOOR	0.0069	0.0007	9.2988	0.0000
FLOOR2	-0.0001	0.0000	-6.4972	0.0000
AGE	-0.0126	0.0008	-16.2340	0.0000
SEAVIEW	0.0570	0.0043	13.3727	0.0000
INTER_ST_1991Q2	-0.8754	0.0264	-33.1678	0.0000
INTER_ST_1991Q3	-0.7865	0.0421	-18.6901	0.0000
INTER_ST_1992Q1	-0.4718	0.0208	-22.6814	0.0000
INTER_ST_1992Q3	-0.4456	0.0204	-21.8670	0.0000
INTER_ST_1992Q4	-0.4696	0.0358	-13.1098	0.0000
INTER_ST_1993Q1	-0.4546	0.0275	-16.5089	0.0000
INTER_ST_1993Q2	-0.3703	0.0255	-14.5192	0.0000
INTER_ST_1993Q3	-0.3662	0.0229	-15.9652	0.0000
INTER_ST_1993Q4	-0.3889	0.0267	-14.5804	0.0000
INTER_ST_1994Q1	-0.2041	0.0252	-8.1006	0.0000
INTER_ST_1994Q2	-0.1667	0.0263	-6.3396	0.0000
INTER_ST_1994Q3	-0.1329	0.0296	-4.4889	0.0000
INTER_ST_1994Q4	-0.1170	0.0274	-4.2687	0.0000
INTER_ST_1995Q1	-0.1526	0.0268	-5.6921	0.0000
INTER_ST_1995Q2	-0.1073	0.0250	-4.2962	0.0000
INTER_ST_1995Q3	-0.2079	0.0363	-5.7300	0.0000
INTER_ST_1995Q4	-0.1731	0.0266	-6.5115	0.0000
INTER_ST_1996Q1	-0.0993	0.0279	-3.5555	0.0004
INTER_ST_1996Q2	-0.0568	0.0234	-2.4283	0.0152
INTER_ST_1996Q3	-0.0247	0.0286	-0.8630	0.3881
INTER_ST_1996Q4	0.1480	0.0223	6.6413	0.0000
INTER_ST_1997Q1	0.3732	0.0288	12.9730	0.0000
INTER_ST_1997Q2	0.5075	0.0254	20.0009	0.0000
INTER_ST_1997Q3	0.4705	0.0376	12.5055	0.0000
INTER_ST_1997Q4	0.4180	0.0377	11.0874	0.0000
INTER_ST_1998Q1	0.1125	0.0275	4.0950	0.0000
INTER_ST_1998Q2	0.0014	0.0387	0.0356	0.9716
INTER_ST_1998Q3	-0.1520	0.0382	-3.9754	0.0001
INTER_ST_1998Q4	-0.2175	0.0252	-8.6177	0.0000
INTER_ST_1999Q1	-0.1283	0.0237	-5.4169	0.0000
INTER_ST_1999Q2	-0.1435	0.0224	-6.4039	0.0000
INTER_ST_1999Q3	-0.1829	0.0239	-7.6499	0.0000
INTER_ST_1999Q4	-0.1931	0.0295	-6.5415	0.0000
INTER_ST_2000Q1	-0.1790	0.0260	-6.8911	0.0000

INTER_ST_2000Q2	-0.3355	0.0397	-8.4551	0.0000
INTER_ST_2000Q3	-0.3034	0.0268	-11.3367	0.0000
INTER_ST_2000Q4	-0.3311	0.0287	-11.5454	0.0000
INTER_ST_2001Q1	-0.3450	0.0241	-14.3267	0.0000
INTER_ST_2001Q2	-0.3565	0.0235	-15.1816	0.0000
INTER_ST_2001Q3	-0.3855	0.0243	-15.8464	0.0000
INTER_ST_2001Q4	-0.4420	0.0252	-17.5320	0.0000
INTER_ST_2002Q1	-0.4355	0.0234	-18.6080	0.0000
INTER_ST_2002Q2	-0.4772	0.0279	-17.0918	0.0000
INTER_ST_2002Q3	-0.4712	0.0390	-12.0681	0.0000
INTER_ST_2002Q4	-0.5674	0.0261	-21.7584	0.0000
INTER_ST_2003Q1	-0.6188	0.0285	-21.7325	0.0000
INTER_ST_2003Q2	-0.6680	0.0233	-28.7145	0.0000
INTER_ST_2003Q3	-0.7252	0.0287	-25.2349	0.0000
INTER_ST_2003Q4	-0.6657	0.0250	-26.5804	0.0000
INTER_ST_2004Q1	-0.5409	0.0291	-18.6117	0.0000
INTER_ST_2004Q2	-0.4339	0.0406	-10.6895	0.0000
INTER_ST_2004Q3	-0.4061	0.0278	-14.5997	0.0000
INTER_ST_2004Q4	-0.3754	0.0281	-13.3768	0.0000
INTER_ST_2005Q1	-0.3137	0.0281	-11.1805	0.0000
INTER_ST_2005Q2	-0.2564	0.0241	-10.6327	0.0000
INTER_ST_2005Q3	-0.2792	0.0313	-8.9260	0.0000
INTER_ST_2005Q4	-0.3073	0.0312	-9.8499	0.0000
INTER_ST_2006Q1	-0.3232	0.0270	-11.9607	0.0000
INTER_ST_2006Q2	-0.2295	0.0310	-7.4061	0.0000
INTER_ST_2006Q3	-0.2820	0.0318	-8.8704	0.0000

INTER_ST_2006Q4	-0.3874	0.0426	-9.0962	0.0000
INTER_ST_2007Q1	-0.2868	0.0297	-9.6443	0.0000
INTER_ST_2007Q2	-0.2624	0.0231	-11.3628	0.0000
INTER_ST_2007Q3	-0.2014	0.0253	-7.9654	0.0000
INTER_ST_2007Q4	-0.1665	0.0238	-6.9847	0.0000
INTER_ST_2008Q1	-0.0543	0.0227	-2.3892	0.0169
INTER_ST_2008Q2	-0.0283	0.0281	-1.0081	0.3134
INTER_ST_2008Q3	-0.0357	0.0226	-1.5820	0.1137
INTER_ST_2008Q4	-0.1800	0.0282	-6.3739	0.0000
INTER_ST_2009Q1	-0.1458	0.0242	-6.0183	0.0000
INTER_ST_2009Q2	-0.0880	0.0228	-3.8557	0.0001
INTER_ST_2009Q3	0.0295	0.0246	1.2012	0.2297
INTER_ST_2009Q4	0.0112	0.0202	0.5530	0.5803
INTER_TKT_1991Q2	-0.4849	0.0216	-22.4470	0.0000
INTER_TKT_1991Q3	-0.6832	0.0214	-31.8515	0.0000
INTER_TKT_1992Q4	-0.2241	0.0316	-7.1001	0.0000
INTER_TKT_1993Q1	-0.2811	0.0261	-10.7495	0.0000
INTER_TKT_1993Q2	-0.2925	0.0331	-8.8343	0.0000
INTER_TKT_1993Q3	-0.1971	0.0335	-5.8805	0.0000
INTER_TKT_1993Q4	-0.1993	0.0394	-5.0598	0.0000
INTER_TKT_1994Q1	-0.2130	0.0314	-6.7834	0.0000
INTER_TKT_1994Q2	-0.0760	0.0389	-1.9522	0.0509
INTER_TKT_1994Q3	-0.2005	0.1002	-2.0010	0.0454
INTER_TKT_1994Q4	-0.0116	0.0908	-0.1281	0.8981
INTER_TKT_1995Q1	-0.3696	0.1304	-2.8346	0.0046
INTER_TKT_1995Q2	-0.0510	0.0392	-1.3012	0.1932

INTER_TKT_1995Q3	-0.1836	0.0889	-2.0647	0.0390
INTER_TKT_1995Q4	-0.1541	0.0589	-2.6141	0.0090
INTER_TKT_1996Q1	-0.1726	0.0673	-2.5660	0.0103
INTER_TKT_1996Q2	-0.1443	0.0403	-3.5779	0.0003
INTER_TKT_1996Q3	-0.2279	0.0435	-5.2424	0.0000
INTER_TKT_1996Q4	-0.0615	0.0346	-1.7777	0.0755
INTER_TKT_1997Q1	-0.0235	0.0357	-0.6578	0.5107
INTER_TKT_1997Q2	0.1307	0.0460	2.8427	0.0045
INTER_TKT_1997Q3	0.2293	0.0383	5.9805	0.0000
INTER_TKT_1997Q4	0.1176	0.0536	2.1930	0.0283
INTER_TKT_1998Q1	0.0795	0.0515	1.5443	0.1225
INTER_TKT_1998Q2	0.1282	0.0417	3.0749	0.0021
INTER_TKT_1998Q3	-0.4412	0.2241	-1.9684	0.0490
INTER_TKT_1998Q4	-0.2779	0.0334	-8.3253	0.0000
INTER_TKT_1999Q1	-0.2236	0.0660	-3.3863	0.0007
INTER_TKT_1999Q2	-0.3448	0.1456	-2.3684	0.0179
INTER_TKT_1999Q3	-0.3141	0.0864	-3.6358	0.0003
INTER_TKT_1999Q4	-0.1723	0.0771	-2.2347	0.0254
INTER_TKT_2000Q1	-0.2978	0.0591	-5.0388	0.0000
INTER_TKT_2000Q2	-0.3008	0.0589	-5.1094	0.0000
INTER_TKT_2000Q3	-0.2954	0.0474	-6.2326	0.0000
INTER_TKT_2000Q4	-0.5035	0.0868	-5.7979	0.0000
INTER_TKT_2001Q1	-0.3702	0.0455	-8.1405	0.0000
INTER_TKT_2001Q2	-0.4566	0.0843	-5.4164	0.0000
INTER_TKT_2001Q3	-0.5857	0.1342	-4.3649	0.0000
INTER_TKT_2001Q4	-0.5297	0.0660	-8.0206	0.0000

INTER_TKT_2002Q1	-0.7335	0.0775	-9.4610	0.0000
INTER_TKT_2002Q2	-0.6848	0.0669	-10.2289	0.0000
INTER_TKT_2002Q3	-0.6494	0.0599	-10.8493	0.0000
INTER_TKT_2002Q4	-0.5468	0.0944	-5.7902	0.0000
INTER_TKT_2003Q1	-0.8398	0.1285	-6.5365	0.0000
INTER_TKT_2003Q2	-0.7111	0.1033	-6.8845	0.0000
INTER_TKT_2003Q3	-0.7192	0.0619	-11.6163	0.0000
INTER_TKT_2003Q4	-0.6987	0.0540	-12.9271	0.0000
INTER_TKT_2004Q1	-0.6415	0.0756	-8.4829	0.0000
INTER_TKT_2004Q2	-0.5523	0.0463	-11.9355	0.0000
INTER_TKT_2004Q3	-0.5181	0.0715	-7.2467	0.0000
INTER_TKT_2004Q4	-0.5168	0.0633	-8.1700	0.0000
INTER_TKT_2005Q1	-0.4892	0.0423	-11.5540	0.0000
INTER_TKT_2005Q2	-0.4531	0.0630	-7.1934	0.0000
INTER_TKT_2005Q3	-0.3208	0.0631	-5.0814	0.0000
INTER_TKT_2005Q4	-0.4499	0.0665	-6.7654	0.0000
INTER_TKT_2006Q1	-0.5893	0.0741	-7.9584	0.0000
INTER_TKT_2006Q2	-0.2846	0.0778	-3.6586	0.0003
INTER_TKT_2006Q3	-0.3892	0.0764	-5.0961	0.0000
INTER_TKT_2006Q4	-0.4348	0.0979	-4.4407	0.0000
INTER_TKT_2007Q1	-0.3623	0.0535	-6.7773	0.0000
INTER_TKT_2007Q2	-0.2092	0.0570	-3.6679	0.0002
INTER_TKT_2007Q3	-0.3149	0.0418	-7.5385	0.0000
INTER_TKT_2007Q4	-0.1596	0.0423	-3.7708	0.0002
INTER_TKT_2008Q1	-0.2108	0.0548	-3.8445	0.0001
INTER_TKT_2008Q2	-0.0557	0.0356	-1.5612	0.1185

INTER_TKT_2008Q3	-0.0010	0.0560	-0.0185	0.9853
INTER_TKT_2008Q4	-0.2347	0.0594	-3.9521	0.0001
INTER_TKT_2009Q1	-0.2153	0.0669	-3.2182	0.0013
INTER_TKT_2009Q2	-0.0834	0.0390	-2.1385	0.0325
INTER_TKT_2009Q3	0.0019	0.0466	0.0402	0.9679
INTER_TKT_2009Q4	-0.0566	0.0513	-1.1028	0.2701
INTER_TY_1991Q2	-0.7529	0.0341	-22.0482	0.0000
INTER_TY_1991Q3	-0.6183	0.0403	-15.3530	0.0000
INTER_TY_1992Q1	-0.1838	0.0241	-7.6401	0.0000
INTER_TY_1992Q3	-0.1649	0.0351	-4.6954	0.0000
INTER_TY_1992Q4	-0.2689	0.0295	-9.1127	0.0000
INTER_TY_1993Q1	-0.2484	0.0319	-7.7897	0.0000
INTER_TY_1993Q2	-0.2459	0.0258	-9.5207	0.0000
INTER_TY_1993Q3	-0.1490	0.0254	-5.8751	0.0000
INTER_TY_1993Q4	-0.1619	0.0274	-5.9034	0.0000
INTER_TY_1994Q1	-0.0677	0.0240	-2.8271	0.0047
INTER_TY_1994Q2	0.0416	0.0304	1.3681	0.1713
INTER_TY_1994Q3	-0.0013	0.0340	-0.0368	0.9707
INTER_TY_1994Q4	0.0051	0.0277	0.1827	0.8550
INTER_TY_1995Q1	-0.1638	0.0407	-4.0211	0.0001
INTER_TY_1995Q2	-0.1533	0.0418	-3.6628	0.0003
INTER_TY_1995Q3	-0.2183	0.0348	-6.2689	0.0000
INTER_TY_1995Q4	-0.2514	0.0251	-9.9997	0.0000
INTER_TY_1996Q1	-0.1505	0.0281	-5.3620	0.0000
INTER_TY_1996Q2	-0.0985	0.0268	-3.6772	0.0002
INTER_TY_1996Q3	-0.1168	0.0265	-4.4098	0.0000

INTER_TY_1996Q4	0.0143	0.0263	0.5429	0.5872
INTER_TY_1997Q1	0.2932	0.0245	11.9627	0.0000
INTER_TY_1997Q2	0.3909	0.0230	16.9895	0.0000
INTER_TY_1997Q3	0.4456	0.0345	12.9002	0.0000
INTER_TY_1997Q4	0.3286	0.0412	7.9713	0.0000
INTER_TY_1998Q1	0.1315	0.0343	3.8378	0.0001
INTER_TY_1998Q2	-0.0032	0.0303	-0.1062	0.9155
INTER_TY_1998Q3	-0.1941	0.0241	-8.0581	0.0000
INTER_TY_1998Q4	-0.2311	0.0291	-7.9523	0.0000
INTER_TY_1999Q1	-0.1831	0.0282	-6.4919	0.0000
INTER_TY_1999Q2	-0.1922	0.0288	-6.6780	0.0000
INTER_TY_1999Q3	-0.1978	0.0397	-4.9864	0.0000
INTER_TY_1999Q4	-0.2903	0.0305	-9.5166	0.0000
INTER_TY_2000Q1	-0.2869	0.0269	-10.6853	0.0000
INTER_TY_2000Q2	-0.3220	0.0378	-8.5208	0.0000
INTER_TY_2000Q3	-0.3910	0.0389	-10.0506	0.0000
INTER_TY_2000Q4	-0.4154	0.0354	-11.7439	0.0000
INTER_TY_2001Q1	-0.4519	0.0350	-12.8941	0.0000
INTER_TY_2001Q2	-0.4573	0.0274	-16.6928	0.0000
INTER_TY_2001Q3	-0.5180	0.0309	-16.7599	0.0000
INTER_TY_2001Q4	-0.5137	0.0306	-16.7828	0.0000
INTER_TY_2002Q1	-0.5503	0.0311	-17.6903	0.0000
INTER_TY_2002Q2	-0.4936	0.0429	-11.5109	0.0000
INTER_TY_2002Q3	-0.5347	0.0284	-18.8353	0.0000
INTER_TY_2002Q4	-0.6338	0.0581	-10.8998	0.0000
INTER_TY_2003Q1	-0.6725	0.0452	-14.8807	0.0000

INTER_TY_2003Q2	-0.7831	0.0373	-20.9716	0.0000
INTER_TY_2003Q3	-0.8402	0.0305	-27.5056	0.0000
INTER_TY_2003Q4	-0.7225	0.0342	-21.1493	0.0000
INTER_TY_2004Q1	-0.6202	0.0358	-17.3398	0.0000
INTER_TY_2004Q2	-0.4731	0.0287	-16.4830	0.0000
INTER_TY_2004Q3	-0.5037	0.0313	-16.0706	0.0000
INTER_TY_2004Q4	-0.4342	0.0259	-16.7626	0.0000
INTER_TY_2005Q1	-0.4342	0.0291	-14.9121	0.0000
INTER_TY_2005Q2	-0.3711	0.0295	-12.5942	0.0000
INTER_TY_2005Q3	-0.2926	0.0355	-8.2363	0.0000
INTER_TY_2005Q4	-0.2743	0.0525	-5.2255	0.0000
INTER_TY_2006Q1	-0.3738	0.0431	-8.6744	0.0000
INTER_TY_2006Q2	-0.3533	0.0393	-8.9938	0.0000
INTER_TY_2006Q3	-0.3668	0.0283	-12.9519	0.0000
INTER_TY_2006Q4	-0.3832	0.0335	-11.4302	0.0000
INTER_TY_2007Q1	-0.4130	0.0332	-12.4436	0.0000
INTER_TY_2007Q2	-0.3782	0.0323	-11.6957	0.0000
INTER_TY_2007Q3	-0.3476	0.0291	-11.9424	0.0000

INTER_TY_2007Q4	-0.2991	0.0266	-11.2664	0.0000
INTER_TY_2008Q1	-0.1699	0.0320	-5.3072	0.0000
INTER_TY_2008Q2	-0.1111	0.0300	-3.6999	0.0002
INTER_TY_2008Q3	-0.1107	0.0237	-4.6712	0.0000
INTER_TY_2008Q4	-0.2579	0.0517	-4.9922	0.0000
INTER_TY_2009Q1	-0.2230	0.0290	-7.6931	0.0000
INTER_TY_2009Q2	-0.2005	0.0237	-8.4647	0.0000
INTER_TY_2009Q3	-0.1055	0.0261	-4.0464	0.0001
C	0.5395	0.0293	18.4073	0.0000

R-squared	0.6031	Mean dependent var	0.5645
Adjusted R-squared	0.5983	S.D. dependent var	0.3945
S.E. of regression	0.2500	Akaike info criterion	0.0771
Sum squared resid	1148.7860	Schwarz criterion	0.1706
Log likelihood	-495.4002	F-statistic	126.3839
Durbin-Watson stat	1.9964	Prob(F-statistic)	0.0000

Appendix V **Table of Price Gradients between Sham Tseng and Tsing Yi over Time Periods**

Quarter	Price Gradient (Coefficient of Tsing Yi - Coefficient of Sham Tseng)
1991Q2	0.1225
1991Q3	0.1682
1992Q1	0.2881
1992Q3	0.2807
1992Q4	0.2006
1993Q1	0.2063
1993Q2	0.1244
1993Q3	0.2172
1993Q4	0.2269
1994Q1	0.1364
1994Q2	0.2083
1994Q3	0.1316
1994Q4	0.1221
1995Q1	-0.0112
1995Q2	-0.0460
1995Q3	-0.0104
1995Q4	-0.0783
1996Q1	-0.0512
1996Q2	-0.0417
1996Q3	-0.0921
1996Q4	-0.1337
1997Q1	-0.0800
1997Q2	-0.1166
1997Q3	-0.0249
1997Q4	-0.0895
1998Q1	0.0189
1998Q2	-0.0046
1998Q3	-0.0421
1998Q4	-0.0136
1999Q1	-0.0548
1999Q2	-0.0487
1999Q3	-0.0149
1999Q4	-0.0972
2000Q1	-0.1079
2000Q2	0.0135
2000Q3	-0.0877
2000Q4	-0.0842
2001Q1	-0.1069
2001Q2	-0.1008
2001Q3	-0.1325
2001Q4	-0.0716
2002Q1	-0.1149
2002Q2	-0.0165
2002Q3	-0.0635
2002Q4	-0.0664
2003Q1	-0.0536
2003Q2	-0.1151
2003Q3	-0.1150
2003Q4	-0.0568
2004Q1	-0.0793
2004Q2	-0.0392
2004Q3	-0.0976
2004Q4	-0.0588
2005Q1	-0.1205
2005Q2	-0.1147
2005Q3	-0.0133
2005Q4	0.0330
2006Q1	-0.0506
2006Q2	-0.1238
2006Q3	-0.0848
2006Q4	0.0042
2007Q1	-0.1261
2007Q2	-0.1158
2007Q3	-0.1462
2007Q4	-0.1326
2008Q1	-0.1156
2008Q2	-0.0827
2008Q3	-0.0750
2008Q4	-0.0779
2009Q1	-0.0772
2009Q2	-0.1126
2009Q3	-0.1350
2009Q4	-0.0112

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