### Estimates of the influence of urban highway investment in deindustrialization: office property value impacts in Hong Kong, 2002-2013

**Author(s)**: He, Yiming (何一鳴)

**Citation**: He, Y. (2015). Estimates of the influence of urban highway investment in deindustrialization: Office property value impacts in Hong Kong, 2002-2013 (Outstanding Academic Papers by Students (OAPS)). Retrieved from City University of Hong Kong, CityU Institutional Repository.

**Issue Date**: 2015

**URL**: http://hdl.handle.net/2031/8310

**Rights**: This work is protected by copyright. Reproduction or distribution of the work in any format is prohibited without written permission of the copyright owner. Access is unrestricted.
Estimates of the Influence of Urban Highway Investment in Deindustrialization: Office Property Value Impacts in Hong Kong, 2002-2013

BY
Yiming HE

Submitted in partial fulfilment of the requirements for the degree of Master of Science in Construction Management (Real Estate Project Management)

Department of Architecture and Civil Engineering
City University of Hong Kong

July 2015
Abstract

One of the world’s major trends in recent urban policies is greater public investment in transportation infrastructure for cities’ competitiveness and sustainability. Whereas several studies have shown the increased economic and environmental importance of innovative railway systems along with proactive land use policies in rapidly growing cities, limited empirical research has been conducted to grasp the changing influences of continued highway investments in progressively deindustrializing cities, like Hong Kong. Indeed, policy makers of commercially strong global cities still continue multi-billion dollar capital reinvestments in urban highway systems to meet cities’ mobility needs and mitigate negative impacts from growing traffic in unconventional ways. This study thus investigates the territorial influences of contemporary highway investments in a knowledge- and service-based society by analyzing panel data on Hong Kong’s office property transactions around urban highway interchanges from 2002 to 2013. Empirical results derived from the hedonic price models, adopting log-linear fixed-effect estimators within Hong Kong’s district council boundaries, reveal that traffic volumes are positively associated with office transaction prices in different degrees across Hong Kong Island, Kowloon, and the New Territories. The models estimated also present that the accessibility benefits of urban highway investments are totally cancelled out by the negative externalities of heavy traffic, particularly within 800 meters of highway interchanges in Hong Kong Island, wherein knowledge- and service-based business performances tend to be amenity-sensitive. On the other hand, the price influences of highway proximity on office properties are positive within 800 meters of interchanges in the New Territories, wherein the degree of deindustrialization is relatively moderate due in large part to the recent promotion of industrial parks and cross-border transactions. These empirical findings suggest the wider impacts of on-going major highway projects in the form of office price premiums are to be captured for the government’s growing capital expenditures, accompanied by land use rezoning adaptive to deindustrialization.
Acknowledgements

I would like to express my deepest appreciation to all those who provided me the possibility to complete this thesis. I am thankful to Dr. Murakami for his guidance and support during preparing this thesis and for his comments that greatly improved manuscript. I thank Dr. Wang for his suggestion that refine the thesis.

I would also like to extend my thanks to staffs from Department of Architecture and Civil Engineering for their instructions during my postgraduate study.

Lastly, I express my gratitude toward my classmates for their kind cooperation and encouragement which help me in completion of this thesis.
# Table of Contents

Abstract .................................................................................................................................................. i

Acknowledgements ................................................................................................................................. ii

Table of Contents ................................................................................................................................. iii

List of Tables ........................................................................................................................................ v

List of Figures ....................................................................................................................................... vi

CHAPTER 1: INTRODUCTION ............................................................................................................. 1

1.1 Background ....................................................................................................................................... 1

1.2 Objective ......................................................................................................................................... 2

1.3 Summary ......................................................................................................................................... 3

CHAPTER 2: LITERATURE REVIEW ................................................................................................. 5

2.1 Highway Access and Property Price ............................................................................................... 5

2.2 Hedonic Price Studies in Hong Kong .............................................................................................. 8

CHAPTER 3: METHODOLOGY ........................................................................................................... 12

3.1 Hedonic price model ....................................................................................................................... 12

3.2 Fixed effects model and random effects model ............................................................................. 13

3.3 Model Specification ....................................................................................................................... 14

CHAPTER 4: DATA ............................................................................................................................... 19

4.1 Data Source and Computations ..................................................................................................... 19

4.2 Descriptive Statistics .................................................................................................................... 23
CHAPTER 5: DESCRIPTION OF URBAN HIGHWAY AND OFFICE MARKET IN HONG KONG

5.1 Description of Urban Highway in Hong Kong ........................................... 27
5.2 Office Property Transactions in Hong Kong ............................................. 33

CHAPTER 6: EMPIRICAL RESULTS .................................................................... 36
6.1 Effects of Proximity to Highway Interchanges ......................................... 37
6.2 Effects of Traffic Volume ........................................................................ 40
6.3 Effects of Other Factors .......................................................................... 41

CHAPTER 7: FINDINGS AND DISCUSSIONS ............................................... 50

FINAL CHAPTER: CONCLUSION ................................................................. 56

REFERENCE ................................................................................................. 58
List of Tables

Table 4.1. Variables Descriptions.................................................................22
Table 4.2. Office Property Geographic Distribution Information ................23
Table 4.3. Descriptive Statistics.................................................................25
Table 7.1. Model I for Estimating Office Price in Hong Kong Island..........44
Table 7.2. Model II for Estimating Office Price in Hong Kong Island.........45
Table 7.3. Model I for Estimating Office Price in Kowloon........................46
Table 7.4. Model II for Estimating Office Price in Kowloon....................47
Table 7.3. Model I for Estimating Office Price in New Territories.............48
Table 7.4. Model II for Estimating Office Price in New Territories ..........49
List of Figures

Figure 5.1. Distribution of Highway Interchanges in Hong Kong.........................29
Figure 5.2. Highway Interchanges in Hong Kong Island since 1970s......................30
Figure 5.3. Highway Interchanges in Kowloon since 1970s...............................31
Figure 5.4. Highway Interchanges in New Territories since 1970s.......................32
Figure 5.5. The geographic distribution of office property transactions, 2002-2013......33
Figure 5.6. Annual Office Transaction Price the latest monthly CPI (in December 2014), 2002-2013.................................................................................................35
Figure 6.1. Estimated Unit Price and Distance from Highway Interchanges..........39
Figure 6.2. Price Elasticity Effects of Proximity to Highway Interchanges..............40
Figure 6.3. Price Elasticity Effects of Traffic Flow..............................................41
Figure 7.1. Industrial Structure in the Three Areas, in 2002 and 2013....................52
Figure 7.2. Central-Wan Chai Bypass and Island Eastern Corridor Link Project.......54
Figure 7.3. Widening of Tolo Highway Project..................................................55
CHAPTER 1: INTRODUCTION

1.1 Background

Investment in transportation infrastructure to provide better mobility within cities, such as railway and urban highway, has largely improved cities’ competitiveness and sustainability. Several studies have shown the increased economic and environmental importance of innovative railway systems along with proactive land use policies in rapidly growing cities, particularly the cities in rapid deindustrialization. But there is limited empirical research has been conducted to grasp the changing influences of continued highway investments in progressively deindustrializing cities, like Hong Kong.

Urban highway creates accessibility by connecting serval locations and increases the regional business productivity by providing better mobility for citizens to arrive their destination with lower travel time and cost. But at the same time, the urban highway has negative externalities such as noisy, fume, pollution or fail to meet the transport demand because of congestion. The development of urban highway comes to a dilemma due to the expectation of efficient high-speed mobility but the resistance of negative externalities brought by urban highway. Indeed, policy makers of commercially strong global cities still continue multi-billion dollar capital reinvestments in urban highway systems to meet cities’ mobility needs and mitigate negative impacts from growing traffic in unconventional ways.

Many studies discussed the accessibility benefits of urban highway by examining the measuring land use impacts near highway, as the monocentric urban model predicts a close relationship between transportation improvements and land use (Boarnet, Marlon, 1995). From the literature review in next chapter, previous studies mainly focused on how proximity to highway impacts residential property value that reflects residents’ demand of better living quality, but very few studies explored the relationship between accessibility impacts of highway and non-residential property value that is close related
to land productivity. From economic perspective, urban highway creates accessibility and provides good mobility to local industry which increases local business productivity, thus reflecting into the appreciation of nearby office property value. On the other hand, the negative effects also adversely affect nearby office property price and business productivity.

From economic and business perspectives, the position of urban highway in cities, particularly the deindustrializing cities is still unclear and worthy to be well understood.

1.2 Objective

The study wants to investigate the territorial influences of contemporary highway investments in a knowledge- and service-based society by analyzing panel data on Hong Kong’s office property transactions around urban highway interchanges from 2002 to 2013. Office property price is used as an indirect evidence to reflect land productivity, which assumes that higher office property price should be in the places with more business productivity, due to lack of direct business productivity public data in Hong Kong. And the accessibility impacts of urban highway also can be captured by measure nearby office property price because it has been proved there is close relationship between transportation improvements and land use.

The study examines how access benefits and negative effects of highway influence office property value, as well as the relationship between traffic volume of highway and office price, in order to explain the relationship between urban highway and business productivity in a deindustrialization economy.

The study takes Hong Kong as an empirical example to explore the impacts of urban highway, because Hong Kong government has invested and is investing huge capital into urban highway construction, although the highway network of Hong Kong is relative prefect. For instance, an under-construction highway bypass project in Hong Kong Island costs HK$ 36 billion (around US$ 4.64 billion), and in Kowloon, the Route 6- Central
Kowloon Route is under planning (a 4.7 km long dual 3-lane trunk including 3.9 km long tunnel) which will link the west Kowloon reclamation and the proposed Kai Tak Development. There are some under-going highway improvement project in New Territories to improve the traffic capacity: widening of Tolo Highway / Fanling Highway (HK$ 4.32 Billion estimated projects cost); improvement of Tuen Mun Road (HK$ 6.8 Billion estimated projects cost); etc. On the other hand, Hong Kong is also known as a world-class finance and business center dominated by the service-oriented sector, especially the information-based/ knowledge-based industry, as the result of industrial restructure since mid-1980s due to “open door policy” of China, which led that local manufacturing sector was almost moved to southern part of Mainland China and the rest manufacturing industry was mainly concentrated on New Territories.

Hong Kong, a well-developed city and representative deindustrializing economy with world-class urban highway system and prefect public transport system, is a good case to understand the link between highway and business productivity, in order to offer reference to other cities that is going or will go through similar stages.

1.3 Summary

Next chapter provides the literature review to summarize previous studies of the relationship between urban highway and property value, and existing studies using hedonic price analysis to examine how different attributes affects property price in Hong Kong.

In Chapter 3, the methodology applied to estimate the relationship between urban highway and office property value is provided, which discusses both hedonic price model using OLS regression and fixed effect model that considers time and spatial effect in order to enhance the accuracy of estimation.

Chapter 4 provides an extensive and detail discussion of data used in the study, including the data sources, data management approach, definition of variables as well as descriptive
statistics.

In Chapter 5, the spatial distribution and development process of highway network in Hong Kong including Hong Kong Island, Kowloon and New Territories is introduced, which presents how highway network is gradually constructed and improved since 1970s. And also this chapter introduces office property transaction for period 2002 to 2013 in Hong Kong, as well as office market segmentation and geographic features of Hong Kong.

Chapter 6 presents the empirical results from the both OLS regression model and fixed effects model, and discusses about the regression results especially how proximity to highway interchange and traffic volume of highway interchanges influence on office property price according to fixed effects model with significant intraclass correlation.

Next, chapter 7 presents the different industry structure of Hong Kong Island, Kowloon and New Territories, and discusses how urban highway performs in deindustrializing economy, and analyses two under-construction highway projects in Hong Kong Island and New Territories based on the empirical estimation results.

Final chapter provides the overall concluding comments and limitation of the study.
CHAPTER 2: LITERATURE REVIEW

2.1 Highway Access and Property Price

Past studies have discussed about the relationship between urban highway and residential property price from both positive and negative perspective. The major benefit of highway is the improvement of accessibility that are highly valued by home buyers. Boarnet and Chalermpong (2001) used the Orange County toll-road network as the empirical analysis to present that the new highway network improved accessibility and home buyers are willing to pay for the increased access the new roads provided by using hedonic analysis and multiple sale techniques, and this willingness to pay for increased access influenced both development patterns and induced traffic. Mikelbank (2004) also reported that house price will decrease with increased distance from a highway exit, while the location of site within 0.25 miles from a highway has a significant negative impact on property value as the result of negative externalities. The major negative impacts brought by urban highway is the noisy, fumes, pollution. Some studies indicated that residential property price appreciated with the increase of the distance from highway interchange (Bowes, et al, 2001). Especially traffic noise, Kim, Park and Kweon (2007) examined that traffic noise has a negative impact on the values of the residential properties near highway, and the result presents a 1% increase in traffic noise is associated with a 1.3% decline in land price. High level of traffic and each additional car on street has significant negative impacts on residential property price (Hughes, William, and Sirmans, 1992) and home buyer are more sensitive to truck traffic that discounts property price greatly but not care about total traffic (Li, Wei, and Saphores, 2012).

Urban highway benefits home buyer because of increased accessibility but such benefit is offset by the negative externalities if the property is too close to highway, so the net benefit of proximity to highway is just like an inverse-U shape consistent (Seo, Golub and Kuby, 2014). Seo, et al (2014) measured the effect of nodes and links of roads and rail infrastructure on residential property price, specifically, for highway exits, benefits
are moderate at close distance but highest for the residents who live about 1200m from highway exit and decrease from there, while highway links have negative but insignificant impacts on property values. Kilpatrick, et al (2007) confirmed the finding by exploring that the negative impact on house prices of nearby superhighway (one with both access benefits and negatives) and tunnels (one without the access benefit) when access points are distant. They found that the transportation infrastructure (nearby highway) raises the property values by granting accessibility but lowers them via negative externalities such as noisy and pollution, and the result indicated that the distance from tunnel has positive effect on the property price because proximity to the transit corridor alone without direct access induces a negative impact on nearby housing price.

Property value impacts vary across different types of properties by distance from the highway. Carey and Semmens (2003) found that freeway has an adverse effect on single-family residences but has a positive impact on multifamily residential and commercial property. Ryan and Sherry (2005) explored the different influence of transport access on industrial and office land rents in San Diego, and they found that office properties with more direct access to highway command higher rent than that farther away whereas the industrial firms is not sensitive to highway access.

The impacts of highway on property price and development pattern also vary by different time scale. Generally, the benefit of urban highway appear after construction completion and the under-construction project will bring huge negative impacts on property price. Ten Siethoff and Kockelman (2002) examined commercial property responses to a major capacity expansion of a roadway facility in Austin. They found that there is a negative value impacts during the project construction as the disamenity of construction project, but the negative impacts was removed with the construction completion since the increased accessibility. They also revealed dramatic value gradients falling off from the highway frontage roads and specific value to parcels that benefited from a corner location. Mikelbank (2004) also explored the disaggregate impacts of investments in transportation infrastructure on house price and indicated that the proximity effects can be a significant
depressive force on a local housing neighborhood from the day of the announcement until the day the investment is completed. Chernobai, Reibel and Carney (2011) examined the time-varying effect of distance from the highway extension on property values by using residential property transaction records from a period 11 years centered on the completion of a new highway extension in Los Angeles. The result shows that the maximum home price appreciation caused by the new highway extension occurs at moderate distance from the highway after completion, and in the closer or further place to highway, the increasing rate of price is lower.

The development of urban highway faces a dilemma, as people need better mobility but also desire better living environment. Some city leaders decided to construct new highway underground that requires huger initial capital investment, or demolish highway and replace them by urban park in order to eliminate the negative impacts brought by urban highway. For example, the Big Dig project, a highway-to-green park project, in Boston, Taijima (2003) concluded that “the demolition of the highway should result in $732 million increase in property values and the new parks should increase property values by at least $252 million”. Cervero, Kang and Shively (2009) analyzed price effects resulting from the demolition of the Embarcadero and Central freeways in San Francisco and the conversion from freeway to surface boulevards which still carry large volumes of traffic. The authors estimated that the housing price in the year the Octavia Boulevard opened increased by $116,000, reflecting an amenity effect from the boulevard. The CGC project (replace the Cheong Gye Cheon freeway by an urban stream and linear park) in Korea is also confirmed to benefit nearby residential and non-residential property (Kang, Cervero, 2009).

Most of previous studies focus on how urban highway positive or negative affects quality of living by examining the relationship between urban highway and residential property value but very few studies explore the relationship between urban highway and non-residential property value and how urban highway is related to regional business productivity. Therefore, the study wants to discuss the relationship between urban
highway and office property price in Hong Kong, in order to explain how urban highway influences business productivity.

2.2 Hedonic Price Studies in Hong Kong

The hedonic price model is widely used as a technique to explain the property prices, mainly residential property price, in terms of various attributes, which includes the structure characteristics of the property, the locational characteristics of the property (accessibility to business center or transportation facilities), the environment characteristics of the neighborhood, including the views, the level of noisy, air quality, schools, clubhouse, etc., the building management, and so on. In last two decades, the studies about Hong Kong real estate market by using hedonic price analysis mainly focused on the relationship between residential property and different attributes, which shows that the homes buyers are rational and willing to pay for some desirable housing attributes (Mok, Chan, and Cho, 1995). There is very few studies exploring Hong Kong office property market.

Hedonic price analysis can be applied to estimate the impact of structure characteristics of properties for instance size, age and floor level, to housing prices. Generally, the gross floor area of property and the floor level have positive influence to residential property price while the age of building has negative effects on housing price. Chan, So and Tang (2008) explored how different attributes of housing space affect residential housing property, which the home buyers are more willing to pay for the net floor area rather than the GFA of the property. Besides, they also concluded the negative relationship between the shared space and housing price, which means that the higher is the amount of shared space, the lower will be the housing price, ceteris paribus. However, Tang and Yiu (2010) concluded that home buyer are willing to pay more for a large housing flat and a larger share of neighborhood space within the housing development because the home buyers aware that they do not pay for the individual unit only but pay for sharing space that is often related to the clubhouse, better view, and so on which commands higher market
values. Chau, Wong and Yiu (2004) reported that the high-rise residential property with a balcony is valuated higher by home buyer considering the view outside and examined the effect of balconies on security concerns on low floors which shows that there are no security problems with balcony on lower floor. Choy, Mak and Ho (2007) discussed about how Feng Shui, in term of lucky or unlucky number, influences the housing price and the result shows that unlucky number has significant negative effect on housing price whereas the lucky number is positive but not important associated with housing price.

The locational characteristics is vital determinant for housing price. As regards location attributes, the accessibility to central business district (CBD), transportation facilities, such as MTR station and minibus station, are generally considered importation factors. The travel time from apartment to CBD is negatively correlated with housing price (Mok, Chan, and Cho, 1995; Hui, et al. 2007; Tang and Yiu 2010). According to the previous studies, it often reach a consequence that the accessibility to MTR station, mainly walking time within 10 minutes, has significant positive influence on housing price and consumers are willing to pay extra money for it (So, Tse and Ganesan 1997; Raymond, Y. C. 2002; Choy, Mak, Ho. 2007; Hui, Chau and Pun 2007; Jim and Chen 2009; Hastings, Wong, Walters 2009). However, there are some studies holding different opinion. Chau and Ng (1998) examined the change in the transaction prices of residential properties near two stations, namely Sha Tin and Tai Po and the results show that the improvement in public transportation has a negative effect on price gradient along the railway line. So, et al. (1997) considered the minibuses station has the most influential in determining housing price, based on the sample of a large residential area of the middle-income class in Hong Kong because minibuses are used to pick up commuter and connect to other transport modes, besides, they also confirmed that the availability of MTR station produces significant positive price effects on property price. Yiu and Wong (2005) explored the effect of expected and actual improvements in transport on housing price using the Western Harbor Tunnel as the case study, and the result shows that there was positive price expectation effects before the completion of the tunnel. However, there are also very
few studies that explore the relationship between urban highway and housing price in Hong Kong.

Some studies discussed about the relationship between housing price and environment attributes for instance the natural landscapes, green area, air pollution, noisy level, and so on. Generally, it seems that a property with good view is always valuated higher by consumer, while many studies has already show that property price and elements of view are not always significant positive correlated. The previous studies reach the conclusion that the Hong Kong residents are willing to pay more for sea view but the mountain view have significant negative effect on housing price (Raymond 2002; Hui, Chau and Pun 2007; Jim and Chen 2009). Jim and Chen (2009) also reported that the neighborhood parks in the high-rise private residential units were highly valued by Hong Kong residential, whereas building and street view has negative influence on property price, which means that people would be willing to pay for quiet ambience and better air quality. Chan, So and Tang (2008) also reported that park is a strong impacts evaluated by residents since the basic elements of good quality of living space. However, according the finding of Hui, et al, (2007), the noisy level has a positive influence on housing price, which means that the residents can sacrifice serenity for convenience of access to shopping and dining facilities near homes. Hui, et al (2007) also reported that Hong Kong people are more willing to pay for better air, while, interestingly, the greenbelt is not a significant attribute on property price. Chau, et al (2006) confirmed that there is negative impact of air pollution on property prices, but such impact is not linear while increases as the level of pollution increases as well. Besides, Tse and Love (2000) reported that the property with cemetery view tends to have a lower price. Therefore, according to existing studies, noisy level can be considered as a debatable attribute to housing price in Hong Kong.

Neighborhood effect, such as clubhouse, school zone and sport facility, also influences on the residential property price. The availability of clubhouse, swimming pool and other sport and entertainment facilities increase the sale price of residential property (Mok,
Chan, and Cho, 1995; So, Tse and Ganesan 1997; Raymond, 2002; Hui, Chau and Pun 2007; Jim and Chen 2009). In addition, home buyer are willing to pay extra money to buy the property in school zone (Mok, Chan, and Cho, 1995); the car park has significant positive effect on the property price (So, Tse and Ganesan 1997; Tse and Love 2000).

There are some studies that explore the relationship between residential property and urban redevelopment, building management and other attributes in Hong Kong by using hedonic price analysis. Lai, Chau and Yiu (2007) and Yau and Yung(2010) took Sheung Wan district redevelopment project and the Argyle street/ Shanghai street redevelopment project as case study respectively, and the results show that comprehensive redevelopment area (CDA) zoning does not change the property price as expectation. Chau, et al (2003) reported that the refurbishments of housing increase price level by around 9.8%. Hastings, Wong and Walters (2006) found that appointing professional building management agents would increase the multiple-ownership property price by 15%. Yau and Ho (2009) examined that relationship between housing price and building management, and found that some practices such as keeping architectural drawings and incident records, taking out property-all-risk insurance for common areas, setting out emergency plans and conducting regular fire drills added value to properties.

After reviewing the literature about hedonic analysis in Hong Kong, it indicates that almost all studies discussed the residential property with different housing attributes while very few study was conducted to understand office property markets. The previous studies also gave very little discussion of the relationship between house price and proximity to highway system. The study aims to explore how proximity to highway influences office property price and discuss how highway system affects business productivity in Hong Kong. This study will be helpful to city leader to make a decision in a dilemma of urban highway, and also provide information and understanding about office market to private and public investors in Hong Kong.
CHAPTER 3: METHODOLOGY

3.1 Hedonic price model

The study aims to examine how office property value is influenced by proximity to urban highway to reflect the relationship between proximity to urban highway and business productivity.

Rosen (1974) reported that hedonic prices is defined as the implicit price of characteristics embodied in each product. The relationship between observed product price and observed characteristics can be explained by the differences of products price characteristics that is equalizing on the differences of embedded characteristics. The price differences are marginal rather than average.

Hedonic price modeling, based on utility theory (Rosen, 1974), is widely employed to decompose one property value into multiple - owners’ collective willingness-to-pay for a bundle of internal and external attributes, externality benefit such as proximity to subway station or highway. This technique has then been widely used in urban economics to investigate different aspects of housing problems, for instance, improvement of transportation, amenities, and so on.

Hedonic price model by ordinary least squares (OLS) can be utilized to model the relationship between the property or land price and various attributes that yield utility or satisfaction to housing buyers., such as internal attributes (e.g. floor level, building age, net floor area, etc.), external attributes (e.g. distance from CBD, subway station, highway, etc.) and other attributes.

The formula of hedonic price model has three kinds of functional forms - linear, semi-log and double-log (ln-ln). Generally, the appropriate form is decided according to the principle of highest adjusted R square.
3.2 Fixed effects model and random effects model

Time-series data is widely applied to control for individual-specific unobservable effects which may be correlated with other explanatory variable (Hausman and Taylor, 1981). It is also applied in hierarchical modeling to considering variables at different levels.

Fixed effects model and random effects model are popular techniques to analysis time-series data which analysis variables that change over time or change across different groups. Each group has its own individual characteristics that might or might not influence dependent variables, such as individuals, countries, districts, schools, etc. Specifically, in the region of urban economics, the hedonic prices is also influenced by the housing market segmentation which might be attributes to spatial difference in structural attributes, neighborhood attributes and others (Goodman and Thibodeau, 1998). Many studies examined the relationship between housing price and various attributes within zip code districts or school zones (Goodman and Thibodeau, 2002).

The difference between fixed effect model and random effect model is whether it allow the influence of the differences across group is correlated with dependent variable. Fixed effects model explores the relationship between dependent variable and independent variables within a group that assumes the correlation between group’s error term and predictor variables. Random effects model assumes that difference across groups have influence on the dependent variables, and also it allows for time-invariant variables in the model.

Hausman test is one of approach to decide the preferred model between fixed effect model and random effect model, which basically tests whether the unique errors are correlated with the regressors. When Hausman test does not work, F-test and Breusch-Pagan Lagrange multiplier (LM test) can be used to make a decision across fixed effects model, random effects model and OLS regression, which the former helps to decide between an OLS regression and a fixed effects regression; the latter helps to decide between an OLS regression and a random effects regression.
From statistic perspective, intraclass correlation (rho) can present the percentage of variance explained by the differences across groups, which is also regarded as a justification to compare the three model: if there is no spatially effects in the dependent variables, intraclass correlation become zero or lower than 0.05 by convention, so the assumption of spatial effects will be rejected to a standard OLS regression.

3.3 Model Specification

To estimate the economic and environmental influences of urban highway systems in a drastic deindustrializing economy, this empirical research applies hedonic price analysis whose regression attempts to explain Hong Kong’s office property prices around highway interchanges as a function of highway proximity (in both straight distance and dummy variable), traffic volumes, and other control attributes for the study period of 2002-2013.

In the study, office property price is used as an indirect evidence to reflect land productivity that assumes higher office property price that represent property owners’ willingness to pay for productivity or profitability of office space should be in the places with more business productivity. Although using office property transaction price to represent business productivity is relative indirect compared with using actual labor productivity data, the major advantage of office transaction data is its micro geographic scale based on street-level address, which could provide more precise estimation of economic and environmental influence of urban highway systems. Therefore, considering availability and geographic scale of data, office property transaction data is a better alternative to explain regional business productivity.

Firstly, hedonic price model by ordinal least square (OLS) is used to examine office buyers’ willingness-to-pay for proximity to urban highway, traffic volume and other controlled attributes. The three kinds of functional forms of hedonic price model - linear, semi-log and double-log (ln-ln) are tested one by one in the study. Based on model fitness and appropriateness of parameters for independent variables incorporated, the double-log form is selected in the study. Additionally, there are two advantage of using double-log
form: first, parameters in double-log form represent elasticity that reflects the sensitivity of office property price to different variables in the same scale; and secondly, non-linear influences on property price can be also presented as elasticity by using double-log form.

The following equations of hedonic price model in log-log form is taken, in two models. Model I contains structural variables, location variables, traffic variables and year dummy variables, and it aims to explore overall relationship between the office property price and both distance to highway interchange from each office property and traffic volume of highway interchanges. However, the benefit of proximity to highway interchange might be offset by negative externalities like air pollution and noisy (Mikelbank, 2004; Chernobai, Reibel and Carney, 2011; Kilpatrick, John, et al, 2007; Seo, Golub and Kuby, 2014). Therefore, in Model II, the dummy variables of distance from nearest highway interchange to each property is used to replace the variable of straight-line distance from highway interchange in order to capture the marginal benefit of proximity to highway interchange.

Model I:

\[
\ln(P) = \beta_0 + \beta_1 \ln(S) + \beta_2 \ln(L) + \beta_3 \ln(D_1) + \beta_4 \ln(T) + \delta t + \varepsilon
\]

P: Transaction price per net floor area adjusted by monthly CPI (HK$ per sq. ft.);
S: Structural variables, such as floor level, net floor area and office property age;
L: Location variables, distance to CBD, nearest MTR/KCR station or nearest LRT station;
D_1: Proximity variable, distance from CBD, nearest MTR/KCR station or nearest LRT station;
T: Traffic variable of nearest highway interchange;
t: Year dummy variables, office property transaction year, from 2003 to 2013;
\beta_0: Constant;
\beta_1, \beta_2, \beta_3, \beta_4, \delta: Parameters;
\varepsilon: Error term.
Model II:

\[ \ln(P) = \beta_0 + \beta_1 \ln(S) + \beta_2 \ln(L) + \beta_3 D_2 + \beta_4 \ln(T) + \delta t + \epsilon \]

P: Transaction price per net floor area adjusted by monthly CPI (HK$ per sq. ft.);
S: Structural variables, such as floor level, net floor area and office property age;
L: Location variables, distance to CBD, nearest MTR/KCR station or nearest LRT station;
D_2: Dummy variables of distance from highway interchange;
T: Traffic variable of nearest highway interchange;
t: Year dummy variables, office property transaction year, from 2003 to 2013;
\( \beta_0 \): Constant;
\( \beta_1, \beta_2, \beta_3, \beta_4, \delta \): Parameters;
\( \epsilon \): Error term.

However, the hedonic price model using ordinal least square (OLS) do not consider the housing submarket segmentation that buyers may demand particular locations and/or particular type of property at particular location (Goodman and Thibodeau, 1998), which will influence the accuracy of estimate result. One approach is to add spatial fixed effects dummy variables (e.g. zip codes, school districts) to the hedonic price function, which assumes that properties located within a spatially concentrated area have similar neighborhood characteristic (Goodman and Thibodeau, 1998&2003; Kuminoff, 2010; Espinet, Saez and Coenders, 2003; Kang and Cervero, 2009).

The office transaction data used in the study shows two important characteristics: longitudinal period from 2002 to 2013 and micro geographic scale based on street-level address, which allows to estimates marginal influence of highway interchanges under yearly changing condition and submarket segmentation.

Next, two panel data regression techniques- fixed effect model and random effect model are used to estimate the impacts of proximity to highway interchanges considering both time effects and spatial concentration of data.
Office transaction samples are geographically clustered within DC districts, so the DC districts code is used to explain the variation of office price across the different groups in the study. Each office property are assigned to their DC districts in Hong Kong and the DC districts dummy variables are added to the regression model.

Both fixed effects model and random effect model with time and spatial fixed effects are estimated and Hausman test is also employed to decide the preferred model for the study. After testing, in the study, it is estimated and reported the result by using fixed effect model using time and spatial fixed effects with significant intraclass correlation rather than random effects model. Because intraclass correlation equals zero under the assumption of random effects model, and the result of Hausman test also approves this result.

Similar with the hedonic price model using OLS regression, equations of fixed effect model in double-log form are employed to estimate the impact of proximity to highway interchanges in the forms of both Model I and Model II, based on the principle of highest model fitness and appropriateness of parameters for independent variables incorporated.

The major difference between Model I and Model II is identical with that in the OLS regression.

**Model I:**

\[
\ln(P_{ij}) = \beta_0 + \beta_1 \ln(S_{ij}) + \beta_2 \ln(L_{ij}) + \beta_3 \ln(D1_{ij}) + \beta_4 \ln(T_{ij}) + \delta t_i + \zeta_j + \epsilon_{ij}
\]

- \(P_{ij}\): Transaction price per net floor area adjusted by monthly CPI (HK$ per sq. ft.);
- \(i\): year;
- \(j\): DC districts;
- \(S_{ij}\): Structural variables, floor level, net floor area, gap area and property age;
- \(L_{ij}\): Location variables, distance to CBD, nearest MTR station or nearest LRT station;
- \(D1_{ij}\): Proximity variables, distance to nearest highway interchange;
- \(T_{ij}\): Traffic variable of nearest highway interchange;
- \(t_j\): Year dummy variables, office property transaction year, from 2003 to 2013;
\( \beta_0 \): Constant;
\( \beta_1, \beta_2, \beta_3, \delta \): Parameters;
\( \zeta_j \): DC (j)’s specific (unobserved) effects
\( \epsilon_{ij} \): Error term.

**Model II:**

\[
\ln(P_{ij}) = \beta_0 + \beta_1 \ln(S_{ij}) + \beta_2 \ln(L_{ij}) + \beta_3 D2_{ij} + \beta_4 \ln(T_{ij}) + \delta t_i + \zeta_j + \epsilon_{ij}
\]

\( P_{ij} \): Transaction Price per net floor area adjusted by monthly CPI (HK$ per sq. ft.);
\( i \): time;
\( j \): DC districts;
\( S_{ij} \): Structural variables, floor level, net floor area, gap area and property age;
\( L_{ij} \): Location variables, distance to CBD, nearest MTR station or nearest LRT station;
\( D2_{ij} \): Proximity variables (dummy), distance range to nearest highway interchange;
\( T_{ij} \): Traffic variable of nearest highway interchange;
\( t_j \): Year dummy variables, office property transaction year, from 2003 to 2013;
\( \beta_0 \): Constant;
\( \beta_1, \beta_2, \beta_3, \beta_4, \delta \): Parameters;
\( \zeta_j \): DC (j)’s specific (unobserved) effects
\( \epsilon_{ij} \): Error term.
CHAPTER 4: DATA

4.1 Data Source and Computations

The whole Hong Kong’s office property transaction records were extracted from EPRC Ltd for the study period 2002 to 2013. After several incomplete records were excluded, total 13,670 transaction cases became available for hedonic price analysis, of which 5,536 transaction cases are found in Hong Kong Island, 7,053 transaction cases in Kowloon, and 1,081 transaction cases in the New Territories. As the number of transactions suggests, it is very likely that the feature and trend of office property markets are quite different across the three major territories, thus the database for analysis was divided into Hong Kong Island, Kowloon, and the New Territories. The descriptive statistics for office property transactions are also shown in Table 4.1 and Table 4.3 across the three territorial divisions respectively.

The original office property records contain information on the following attributes: street-level address, name of building, floor level, gross floor area, net floor area, date of sales, open year of building, and transaction price. Essentially, transaction price per net floor area was calculated as a dependent variable of hedonic price models, which could hypothetically indicate office floor owners’ willingness to pay for having office space, in other words, expected business productivity of office space. Because this empirical study applies panel datasets for hedonic price analysis, all transaction values from January 2002 to December 2013 were adjusted by the whole Hong Kong’s latest monthly CPI in December 2014. In this study, the age of office building was counted from the sales year of new building (as the first year) so that every office transaction could have a “positive” age in a relative manner. This age counting is technically important because new properties can be sold in one year before the completion of building construction in Hong Kong’s practices, which would confuse regression estimates with “negative” ages. Additionally, transaction price per “net” floor area can be influenced by the situation of “gross” floor area. To control for such an internal effect, the difference between the gross
floor area and net floor area was also computed as one of the structural independent variables “gap_area”.

These property transaction datasets with street-level address are both spatially and temporarily associated with highway interchanges and other external attributes on a geographic information system (GIS). The geographic information on highway entrance/exist points and interchanges’ center lines were generated using an online satellite imaginary technique (Monkkonen, 2008), and then those multiple segments of points and lines were spatially merged by individual highway interchanges, which includes the completion time of each highway section and interchange obtained from the Highways Department of Hong Kong SAR. The spatial proximity between office properties and highway interchanges were measured in two ways: (1) straight-line distances and (2) dummy variables for five distance ranges - within 100m, from 100m to 200m, from 200m to 400m, from 400m to 600m, from 600m to 800m, which enables us to test both linear and non-linear influences on property prices near highway interchanges.

This study also expects that changes in office prices are likely to be a function of changes in traffic volumes to and from highway interchanges over the study period. Therefore, the annual average daily traffic volume of highway interchange data at counting stations were collected from the Hong Kong SAR Transport Department’s annual traffic census from Year 2002 to 2013 (TTSD Publication). In the original census data, multiple counting stations can be seen around each highway interchange, so, for this empirical study, the annual average daily traffic of each highway interchange is redefined as the mean value of traffic volumes observed by the multiple counting stations. In the end, the annual traffic volumes averaged for each highway interchange were geographically related to individual office transaction cases, wherein one of highway interchanges was identified as the closest one.

Certainly, urban highway is not the only transportation infrastructure that has significantly influenced office transaction prices in Hong Kong’s real estate markets. In a general sense,
rail transit systems have long been even stronger determinants of property values on and around stations. To control for the accessibility and agglomeration impacts of other transit modes, straight distances to CBD, nearest MTR station, and LRT station within 500 meters dummy were additionally measured in similar ways.

It is notable that seasonal or macroeconomic influences on office transaction prices can be sizable but usually unobservable. Thereafter, 11 year dummy variables were also incorporated to capture the year effects from 2003 to 2013 when the transaction prices in 2002 were treated as base year cases. It is also very likely that unobservable characteristics of office property transactions have been geographically clustered in certain economic units or jurisdictional boundaries. For the issue of spatial data clustering, the unique identification codes of (1) Tertiary Planning Units (TPUs) and (2) District Councils (DC) were given to all transaction cases organized on the GIS database. In this case study, DCs may be more an appropriate spatial identification than TPUs because of distinctive business climate and reasonable sample size in each district boundary (Table 4.2).

In addition, the average employment density within 800 meters of each highway interchange for the period of 2002-2013 was computed from the HKSAR Census and Statistics Department’s “Number of establishments and persons engaged (other than those in the Civil Service) analyzed by industry section and Tertiary Planning Unit”, because employment density can be considered one of key endogenous independent variables to explain agglomeration benefits or exogenous instrument variables for two stage least square (2SLS) estimation through traffic volumes in hedonic price models.
### Table 4.1. Variables Descriptions

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Variables Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>Transaction Price per net floor area adjusted by monthly CPI (HK$ per sq. ft.)</td>
</tr>
<tr>
<td><strong>Structural Variable</strong></td>
<td></td>
</tr>
<tr>
<td>floor</td>
<td>Floor Level of Office Property</td>
</tr>
<tr>
<td>gap_area</td>
<td>Gap between Gross and Net Floor Area (sq. ft.)</td>
</tr>
<tr>
<td>area</td>
<td>Net Floor Area (sq. ft.)</td>
</tr>
<tr>
<td>age</td>
<td>Age of Office Property in Transaction Year (Sales Year of Newly Completed Property = 1st year)</td>
</tr>
<tr>
<td><strong>Location Variables</strong></td>
<td></td>
</tr>
<tr>
<td>DCBD</td>
<td>Straight distance to Central Business District (m)</td>
</tr>
<tr>
<td>DMTR</td>
<td>Distance to Nearest MTR/KCR Station (m)</td>
</tr>
<tr>
<td>lrt_500m</td>
<td>1 if &lt;500m from LRT, 0 otherwise</td>
</tr>
<tr>
<td>DIC</td>
<td>Straight-line distance to nearest highway interchange (m)</td>
</tr>
<tr>
<td><strong>Distance Dummy Variables</strong></td>
<td></td>
</tr>
<tr>
<td>DIC_100m</td>
<td>1 if &lt;100m to nearest highway interchange, otherwise 0</td>
</tr>
<tr>
<td>DIC_200m*</td>
<td>1 if 100-200m to nearest highway interchange, otherwise 0</td>
</tr>
<tr>
<td>DIC_400m</td>
<td>1 if 200-400m to nearest highway interchange, otherwise 0</td>
</tr>
<tr>
<td>DIC_600m</td>
<td>1 if 400-600m to nearest highway interchange, otherwise 0</td>
</tr>
<tr>
<td>DIC_800m</td>
<td>1 if 600-800m to nearest highway interchange, otherwise 0</td>
</tr>
<tr>
<td><strong>Traffic Variables</strong></td>
<td></td>
</tr>
<tr>
<td>traffic</td>
<td>Average daily traffic volume of nearest highway interchange from office property in its transaction year</td>
</tr>
<tr>
<td><strong>Neighborhood Economic Variables</strong></td>
<td></td>
</tr>
<tr>
<td>density</td>
<td>Working population density around nearest highway interchange (person/sq. km)</td>
</tr>
<tr>
<td><strong>Year Dummy Variables</strong></td>
<td></td>
</tr>
<tr>
<td>year_2003</td>
<td>1 if transaction time is in 2003, otherwise 0</td>
</tr>
<tr>
<td>year_2004</td>
<td>1 if transaction time is in 2004, otherwise 0</td>
</tr>
<tr>
<td>year_2005</td>
<td>1 if transaction time is in 2005, otherwise 0</td>
</tr>
<tr>
<td>year_2006</td>
<td>1 if transaction time is in 2006, otherwise 0</td>
</tr>
<tr>
<td>year_2007</td>
<td>1 if transaction time is in 2007, otherwise 0</td>
</tr>
<tr>
<td>year_2008</td>
<td>1 if transaction time is in 2008, otherwise 0</td>
</tr>
<tr>
<td>year_2009</td>
<td>1 if transaction time is in 2009, otherwise 0</td>
</tr>
<tr>
<td>year_2010</td>
<td>1 if transaction time is in 2010, otherwise 0</td>
</tr>
<tr>
<td>year_2011</td>
<td>1 if transaction time is in 2011, otherwise 0</td>
</tr>
<tr>
<td>year_2012</td>
<td>1 if transaction time is in 2012, otherwise 0</td>
</tr>
<tr>
<td>year_2013</td>
<td>1 if transaction time is in 2013, otherwise 0</td>
</tr>
</tbody>
</table>

*Note: Variable “DIC_200m” in New Territories equals 1 if <200m to highway interchange from each transaction cases, equals 0 otherwise. Because only one transaction case locates within 100m from its nearest highway interchange.*
Table 4.2. Office Property Geographic Distribution Information

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hong Kong Island</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central &amp; Western</td>
<td>2208</td>
<td>16.2</td>
</tr>
<tr>
<td>Wan Chai</td>
<td>1737</td>
<td>12.7</td>
</tr>
<tr>
<td>Eastern</td>
<td>1131</td>
<td>8.3</td>
</tr>
<tr>
<td>Southern</td>
<td>460</td>
<td>3.4</td>
</tr>
<tr>
<td><strong>Kowloon</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yau Tsim Mong</td>
<td>5496</td>
<td>40.2</td>
</tr>
<tr>
<td>Kowloon City</td>
<td>356</td>
<td>2.6</td>
</tr>
<tr>
<td>Sham Shui Po</td>
<td>188</td>
<td>1.4</td>
</tr>
<tr>
<td>Wong Tai Sin</td>
<td>16</td>
<td>0.1</td>
</tr>
<tr>
<td>Kwun Tong</td>
<td>997</td>
<td>7.3</td>
</tr>
<tr>
<td><strong>New Territories</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kwai Tsing</td>
<td>491</td>
<td>3.6</td>
</tr>
<tr>
<td>Tsuen Wan</td>
<td>217</td>
<td>1.6</td>
</tr>
<tr>
<td>Tuen Mun</td>
<td>264</td>
<td>1.9</td>
</tr>
<tr>
<td>Sha Tin</td>
<td>62</td>
<td>0.5</td>
</tr>
<tr>
<td>Yuen Long</td>
<td>46</td>
<td>0.3</td>
</tr>
<tr>
<td>Tai Po</td>
<td>1</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>13670</td>
<td>100.0</td>
</tr>
</tbody>
</table>

4.2 Descriptive Statistics

According to the descriptive statistic in Table 4.4, mean values of transaction price are 7683, 7686 and 5770 HK$ per sq. ft. in Hong Kong Island, Kowloon and New Territories respectively. For floor level, means are 13.448, 12.28 and 19.19 in the three areas, which indicates the average floor level of transaction cases in New Territories is higher than that in Hong Kong Island and Kowloon. As to age of office property, mean values of age are 20.206, 19.59 and 13.66 in the three areas respectively, which shows that transaction cases in Hong Kong Island and New Territories are general older than that in New Territories, mainly because the development of office property market in Hong Kong Island and Kowloon is much ahead of that in New Territories. For rest structural variables, there is no apparent difference across the three areas.
For the distance to CBD, as the central business district locates in Hong Kong Island, the means of this variable is 2360.5m, 4058.9m and 13641.45m in Hong Kong Island, Kowloon and New Territories. The means of distance to nearest MTR/KCR station is 550.61m, 286.67m and 709.19m in three areas. It shows that offices in New Territories are more distant from CBD and MTR/KCR station averagely. In addition, there is light railway transit (LRT) in New Territories, and 28 percent offices in New Territories locate within 500m to nearest LRT station.

The means of straight-line distance to highway interchanges are 277.61m, 630.93m, 894.47m in Hong Kong Island, Kowloon and New Territories respectively, and also, most of office properties (81 percent) in Hong Kong Island locate within 400m, while office properties in Kowloon and New Territories mainly locates in the distance interval 400-800m, 63 percent and 56 percent respectively. It indicates the different accessibility to highway interchanges in the three areas, and because of the close proximity to highway interchanges in Hong Kong Island where users of 81 percent office could enjoy good access to highway, office price is likely more adverse influenced by the negative effect brought by highway interchanges.

Average daily traffic flow of nearest highway interchange from each office in its transaction year is another key variable in the study, and the mean values of this variable are 47217, 43633 and 52364 in Hong Kong Island, Kowloon and New Territories respectively. The highest mean value is in New Territories, which likely reflects that active business communication more depends on highway transport compared with other two areas.

As to the neighborhood economic variables- job density around nearest highway interchange from office property in its transaction year, the mean values of this variables is 66573.60 person/ sq.km, 26901.59 person/ sq. km and 12489.56 person/ sq.km in Hong Kong Island, Kowloon and New Territories respectively. It shows high working population density in Hong Kong Island, and farther to CBD lower job density.
Table 4.3. Descriptive Statistics

<table>
<thead>
<tr>
<th>Variables</th>
<th>Hong Kong Island</th>
<th>Kowloon</th>
<th>New Territories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Mean</td>
<td>S.D</td>
<td>Min</td>
</tr>
<tr>
<td>Price</td>
<td>7683</td>
<td>5056</td>
<td>258</td>
</tr>
<tr>
<td>Structural Variables</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>floor</td>
<td>13.488</td>
<td>7.493</td>
<td>0.5</td>
</tr>
<tr>
<td>gap_area</td>
<td>344.73</td>
<td>404.78</td>
<td>1</td>
</tr>
<tr>
<td>area</td>
<td>895.65</td>
<td>1352.1</td>
<td>121</td>
</tr>
<tr>
<td>Age</td>
<td>20.21</td>
<td>7.143</td>
<td>1</td>
</tr>
<tr>
<td>Location Variables</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DCBD</td>
<td>2360.5</td>
<td>1534.9</td>
<td>35</td>
</tr>
<tr>
<td>DMTR</td>
<td>550.61</td>
<td>887.54</td>
<td>1.97</td>
</tr>
<tr>
<td>lrt_500m</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DIC</td>
<td>277.61</td>
<td>228.34</td>
<td>1</td>
</tr>
<tr>
<td>Distance Dummy Variables</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DIC_100m</td>
<td>0.19</td>
<td>0.393</td>
<td>0</td>
</tr>
<tr>
<td>DIC_200m</td>
<td>0.24</td>
<td>0.428</td>
<td>0</td>
</tr>
<tr>
<td>DIC_400m</td>
<td>0.38</td>
<td>0.485</td>
<td>0</td>
</tr>
<tr>
<td>DIC_600m</td>
<td>0.1</td>
<td>0.299</td>
<td>0</td>
</tr>
<tr>
<td>DIC_800m</td>
<td>0.05</td>
<td>0.221</td>
<td>0</td>
</tr>
</tbody>
</table>
Table 4.3. Descriptive Statistics (Continues)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Hong Kong Island</th>
<th>Kowloon</th>
<th>New Territories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Mean</td>
<td>S.D</td>
<td>Min</td>
</tr>
<tr>
<td>Traffic Variables</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>traffic</td>
<td>47217</td>
<td>15448.8</td>
<td>14203</td>
</tr>
<tr>
<td>Neighborhood Economic Variable</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>density</td>
<td>66574</td>
<td>36573.67</td>
<td>4858</td>
</tr>
<tr>
<td>Year Variables</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>year_2003</td>
<td>0.05</td>
<td>0.222</td>
<td>0</td>
</tr>
<tr>
<td>year_2004</td>
<td>0.09</td>
<td>0.293</td>
<td>0</td>
</tr>
<tr>
<td>year_2005</td>
<td>0.05</td>
<td>0.221</td>
<td>0</td>
</tr>
<tr>
<td>year_2006</td>
<td>0.08</td>
<td>0.266</td>
<td>0</td>
</tr>
<tr>
<td>year_2007</td>
<td>0.13</td>
<td>0.337</td>
<td>0</td>
</tr>
<tr>
<td>year_2008</td>
<td>0.08</td>
<td>0.274</td>
<td>0</td>
</tr>
<tr>
<td>year_2009</td>
<td>0.09</td>
<td>0.28</td>
<td>0</td>
</tr>
<tr>
<td>year_2010</td>
<td>0.12</td>
<td>0.323</td>
<td>0</td>
</tr>
<tr>
<td>year_2011</td>
<td>0.09</td>
<td>0.284</td>
<td>0</td>
</tr>
<tr>
<td>year_2012</td>
<td>0.1</td>
<td>0.304</td>
<td>0</td>
</tr>
<tr>
<td>year_2013</td>
<td>0.07</td>
<td>0.249</td>
<td>0</td>
</tr>
</tbody>
</table>
5.1 Description of Urban Highway in Hong Kong

Highway network is heavily used and improve the accessibility to amenities in Hong Kong. According to the statistics information from Highway Department of Hong Kong Special Administrative Region (SAR), by December 2014, there were over 699000 vehicles on 2099 kilometers of roads with 442km in Hong Kong Island, 465km in Kowloon and 1192km in the New Territories. There are 9 existing major highways and 1 proposed highway project in Hong Kong, from Route 1 to Route 10, and Route 6 is still under planning. Under this circumstances, Hong Kong Government is still constructing and planning new highway projects, such as Central-Wan Chai Bypass and Island Eastern Corridor Link, Central Kowloon Route.

The study discusses the impact of highway network by focusing on highway interchanges that are the key linkage between two or more surface roads with huger negative externalities such as noisy and air pollution. Figure 5.1 shows the overall spatial distribution of highway interchanges in Hong Kong, with total 62 interchanges since 1970s- 14 in Hong Kong Island, 15 in Kowloon and 33 in New Territories.

The extension process of highway interchanges in Hong Kong Island, shown in Figure 5.2, accompanies with the construction of three cross harbor tunnel between Hong Kong Island and Kowloon Peninsula- Cross Harbor Tunnel, Eastern Harbor Crossing and Western Harbor Crossing. The major construction project of highway system were concentrated in Central and Wan Chai before 2000, while with the completion of improvement works of the Island Eastern Corridor from North Point to Sai Wan Ho in 2003, the service area of highway system gradually fanned outwards to the eastern area. The service area in the southern part of Hong Kong Island is quite limited. At present, the government invested HK$ 36 billion to construct the Central-Wan Chai Bypass and Island
Eastern Corridor Link (a 4.5 km long dual three-lane trunk road with a 3.7 km long tunnel) in order to solve the traffic congestion along the existing road between Sheung Wan and North Point. Overall, highway system in Hong Kong Island mainly serves for the western, central and eastern area that has high population density and job density.

Figure 5.3 presents the development stages of highway interchanges in Kowloon, the prosperous construction of highway interchanges was in the period for 1990 to 2000. In this decade, the improvement of Route 7 and completion of the West Kowloon Corridor provided a more direct and shorter links to Kwai Tsing Container Terminals at Kwai Chung near West Kowloon from North Kowloon and Tsim Sha Tsui respectively; the Kwun Tong Bypass linked the Tseung Kwan O, Kwun Tong, Kai Tai which provided more direct and efficient linkage between Tsim Sha Tsui and Tseung Kwan O Industrial Estate. The government is planning to construct the Central Kowloon Route (a 4.7 km long dual 3-lane trunk road including a 3.9km long tunnel) which will link West Kowloon reclamation and the proposed Kai Tak Development Area. The developing tendency of highway network in Kowloon was centered on Tsim Sha Tsui connected with Hong Kong Island and gradually fanned outwards to Tseung Kwan O and Kwai Chung as the result of rapid growth of industry.

The highway network was improved rapidly since 1990 with the completion of the New Territories Circular Road, the Shenzhen Bay Bridge and Route 8 (also known as Airport Access) in New Territories, shown in Fig. 5.4, providing more effective intra-area transport, especially in Tuen Mun, Yuen Long, Sha Tin where the three large-scale industrial estate locate in, and Kwai Tsing (Kwai Tsing Container Terminals site), and better connecting with Shenzhen and Lantao Island (Hong Kong International Airport site). At present, the improvement of highway network, including widening traffic lanes and adding new vehicular bridges, is under-going, in order to improve the traffic capacity in New Territories.
Figure 5.1. Distribution of Highway Interchanges in Hong Kong
Figure 5.2. Highway Interchanges in Hong Kong Island since 1970s
Figure 5.3. Highway Interchanges in Kowloon since 1970s
Figure 5.4. Highway Interchanges in New Territories since 1970s
5.2 Office Property Transactions in Hong Kong

To estimates how highway interchanges influence office property price, all office transaction samples in Hong Kong, from 2002 to 2013, are collected. Figure 5.5 shows the geographic area of the study and the distribution of office property, which presents that higher density area of office property transaction samples locates along the coast in Hong Kong Island and Kowloon and is also close associated with the spatial distribution of highway interchanges.

Figures 5.6 presents the appreciation trend of annual average office property unit price (per net floor area adjusted by monthly CPI in December 2014) in Hong Kong and three areas from 2002 to 2013, which shows similar stable increasing trend but different level of office property price across the three areas. The average office transaction price in Hong Kong Island is highest across the three, and is close to that in Kowloon, while the average office price in New Territories is much lower than average level.

In addition, there is huge different geographic feature across Hong Kong Island, Kowloon and New Territories as well. The area of Hong Kong Island is 80.31 km$^2$, including 6.98 km$^2$ of land reclaimed since 1887, with population density of 15824.63/ km$^2$ in 2011 and job density of 10944.31/ km$^2$ in 2014; the area of Kowloon is 54.64 km$^2$ with population density of 38553.82/ km$^2$ in 2011 and job density of 19025.27/ km$^2$ in 2014; and the area of New Territories is 988.69 km$^2$ with population density of 3735.11/ km$^2$ in 2011 and job density of 772.63/ km$^2$ in 2014, which are all obtain from Census and Statistics Department of Hong Kong SAR.

In terms of annual average office property price and geographic features, the demand of buyers across the three areas might show different characteristics, and the impacts of highway on office price should vary across the three area. Therefore, in the study, one hypothesis is that the proximity to highway interchange influence the office property price while the impacts differ across the Hong Kong Island, Kowloon and New Territories.
Hong Kong can be also defined by total 18 district council (DC) districts (shown in Fig. 5.5) - Central & Western, Wan Chai, Eastern and Southern in Hong Kong Island, Yau Tsim Mong, Shau Shui Po, Kowloon City, Wong Tai Sin and Kwun Tong in Kowloon, and Tsuen Wan, Tuen Mun, Yuen Long, North, Tai Po, Sai Kung, Sha Tin, Kwai Tsing and Islands in the New Territories. It shows the concentration of office property transactions across DC districts that most of office properties are clustered in some DC districts, like Central & Western, Wan Chai, East, Yau Tsim Mong. Each DC district has its own special neighborhood attributes like different amenities, industry structure, population density and job density, so the office properties in a spatially concentrated area would share similar amenities which also has influence on property price, based on the submarket segmentation theory. Therefore, the spatial cluster is considered in the estimation.

Figure 5.5. The geographic distribution of office property transactions, 2002-2013
Figure 5.6. Annual Office Transaction Price the latest monthly CPI (in December 2014), 2002-2013
CHAPTER 6: EMPIRICAL RESULTS

Table 6.1 to Table 6.6 show the estimated results of observation samples in the forms of Model I and Model by using OLS regression and fixed effects model in Hong Kong Island, Kowloon and New Territories respectively. All models offer quite close prediction of observations and most of the independent variables are highly significant at the 0.001 level except the specific year dummy variables and some distance to highway interchange variables.

Comparing the estimated result of OLS regression and fixed effects model, the intraclass correlation (rho) is quite high for the case in Kowloon (0.365 for Model I and 0.327 for Model II) and New Territories (0.924 for Model I and 0.790 for Model II), which means the high share of variation of property value is explained by between-group variation across the DC districts, so the fixed effects model can explain the observation data more accurately compared with OLS regression. For the case in Hong Kong Island, although the intraclass correlation is relative small (0.047 for Model I and 0.056 for Model II) because the characteristics of office (or business) markets in Hong Kong Island can be diverse and segmented across the given boundaries. However, the value of rho, presenting the proportion of variation explained by groups, is still acceptable by convention, and also the F-value of fixed effects model (591.69 for Model I and 507.66 for Model II) is higher than that of OLS regression (584.772 for Model I and 499.342 for Model II), so I still think the fixed effects model is more appropriate to explain the property value. Therefore, the following discussion is presented based on the estimated result of fixed effects model with significant intraclass correlation.

The key coefficients of the hedonic analysis are the proximity to highway interchange variables and traffic variable. As expected, it shows that significant relationship between office price and distance to highway interchanges, and there are different impacts of proximity to highway interchange on office property value across the three areas, and the traffic flow has significant positive impacts on office price in the three areas while the
sensitivity to the traffic flow is quite different across the three areas.

6.1 Effects of Proximity to Highway Interchanges

Generally, Model I explains the relationship between office property value and distance to highway interchanges by using straight-line distance variables, which presents the overall relations across the three areas, and Model II uses the distance dummy variables to capture the marginal proximity effects of highway interchanges.

As expected, proximity to highway interchange has significant impacts on office transaction price or business productivity but the economic influences are different across Hong Kong Island, Kowloon and New Territories. According to the estimation results from Model I, the price elasticity of straight-line distance to highway interchange variable indicates that the 10 percent increase of distance to highway interchange is associated with 0.1 percent increase of office transaction price in Hong Kong Island at around 0.1 significant level and 0.28 percent decline of office transaction price in Kowloon at 0.001 significant level but 4.3 percent decrease of transaction price in the New Territories at 0.001 significant level.

Therefore, the preliminary finding is that distance to highway interchange is a slightly positive sign in Hong Kong Island but a negative sign in Kowloon and New Territories. Compared with other control variables in Model I, distance to highway interchange has very limited impacts on office price in Hong Kong Island and Kowloon because of low elasticity coefficient and t-value, but highway interchange is regarded as a vital facility for mobility and highly valued by office buyers in the New Territories. Figure 6.1 provides estimated unit price at the mean relation to distance to highway interchange, assuming all other variables are constant at the sample means, which illustrates that office property price is very sensitive to distance to highway interchange in New Territories but insensitive to that in Hong Kong Island and Kowloon.

Model II uses dummy variables for five distance intervals to test non-linear influence on
office property price near highway interchanges in order to capture net benefit of proximity or accessibility to highway interchanges, and the price elasticity effects estimated in the three models are summarized in Figure 6.2.

In Hong Kong Island, locating within 800m to highway interchange decrease office property price by 30.3 to 44.8 percent compared with office locating in more than 800m to highway interchange. Benefit of proximity to highway interchange is totally offset by nuisance effects and the lowest negative impact on office property value appears in distance interval of 200m to 400m where office property was provided good mobility and influenced less by negative effects.

In Kowloon, proximity benefit to highway interchange is very weak for the office property locating within 100m (p = 0.846) as the result of the adverse impacts of externalities, then peaks to highest in distance interval of 100m to 200m where office property is worth 11.5 percent more than the office lying in beyond 800m to highway interchanges, then decreases steadily from there. The transaction price of office lying in 400m to 800m is discounted by 13.3 to 18.9 percent compared with the office lying beyond 800m to highway interchanges. Office properties gain the maximum proximity effects at the moderate distance to highway interchanges where office users can enjoy good mobility with lower negative influence, and both adverse externalities and poor mobility would adversely affect office price.

For the case of New Territories, the estimated result from Model II presents that proximity to highway interchange (within 800 meter) greatly increase office property value by 14.4 to 65.7 percent at 0.001 significant level than the office locating in beyond 800m to highway interchanges. Specifically, the office property locating within 200m and in 200m to 400m is worth 55.2 percent and 65.7 percent more than the office lying beyond 800m respectively, then proximity benefit declines greatly with the increase of distance from highway interchanges, which indicates that local office buyers highly value close distance to highway interchange in order to enjoy better mobility brought by highways and
negative impacts of highway also reduce proximity benefits.

Overall, the results confirms the hypotheses that office property price is significant influenced by distance to highway interchanges while the impacts of proximity to highway interchanges vary across different areas and the net proximity effect is the combination of both positive and negative impact. Similar with the previous finding about the relationship between proximity to highways and residential property value, the accessibility benefit are somewhat offset by the negative externalities associated with close proximity like noisy, dust, fume. The net benefit peaks at modest distances to highway interchanges as the declining speed of negative effects is faster than that of accessibility benefit. Office property price is regarded as an indirect evidence to reflect business productivity, so the relationship between proximity to highway and office price indicates how urban highway affects local business productivity and the different impacts across three areas is likely resulted by their different industrial structure, which will be discussed in next section.

Figure 6.1. Estimated Unit Price and Distance from Highway Interchanges
Figure 6.2. Price Elasticity Effects of Proximity to Highway Interchanges

6.2 Effects of Traffic Volume

Besides the distance to highway interchanges, traffic volume of highway also affects property price. Different with the previous findings that additional traffic volume significantly discounts residential property price, as to office property, additional traffic volume of nearest highway interchange is significant positive associated with office property value in varying degree across three areas, which is summarized in Figure 6.3. Traffic volume enhances the nearby business productivity as it brings more active business communication, thus increasing nearby office property price. But the appreciation degree differs across Hong Kong Island, Kowloon and New Territories. The value of office in New Territories is quite sensitive to traffic volume that 1 percent increase of traffic volume is associated with 0.265 to 0.406 percent increase of office price, whereas in Hong Kong Island, the impacts is much weaker that 1 percent increase of traffic volumes rises office price by 0.085 to 0.088 percent only, and for the office locating in Kowloon, its price is influenced by traffic volume moderately that office is worth more 0.208 to 0.24 percent if traffic volume increases 1 percent.
Figure 6.3. Price Elasticity Effects of Traffic Flow

It presents similar changing tendency of benefit of additional traffic volume with that of proximity benefit across three areas. Office properties in New Territories enjoy more benefit brought by higher traffic volume of highway which indicates that more frequent communication by land transport stimulates its local business productivity. Whereas in other two areas, especially in Hong Kong Island, increase of traffic volume has weaker influences on office property, which presents that active land transportation has limited motivation to local industrial development. As previous introduction of the relationship between office property price and business productivity, the different impacts of land transport flow of highway interchanges also can be explained by the different local industrial structure.

6.3 Effects of Other Factors

The influence of structural features on office property price is similar in Hong Kong Island and Kowloon but is different from that in New Territories, which is likely related with different office market maturation and consumer demand. Floor level is positive and significant associated with office price, especially highly
valued by office buyers in Hong Kong Island and Kowloon that office property value increases by around 1.3 percent and 1.1 percent respectively when floor level increase 10 percent, whereas office buyers in New Territories do not very care about higher floor level that 10 percent increase of floor level is associate with around 0.6 percent only. For office property age, it is negative and significant related with office price as the depreciation of property. Office property price in Hong Kong Island and Kowloon is adversely affected by office age that 10 percent increase of office age is associated with approximate 1.2 percent decline of office price, and in New Territories 10 percent increase of office age discounts property price by 0.64 to 1.55 percent. Net floor area (NFA) is significant positive associated with office price in Hong Kong Island and Kowloon that buyers are willing to pay approximate 0.7 percent and 0.8 percent more for the extra 10 percent net floor area respectively. But in New Territories, NFA is significant negative related with office price that office property price decreases by 0.95 to 1.41 percent with 10 percent increase of NFA, and also 10 percent increase of gap between gross floor area and net floor area rises office price by 1.0 to 1.39 percent. The office buyer in New Territories prefer smaller office.

Turning to other location features, similar with the structural attributes, the preference of office buyers in Hong Kong Island and Kowloon is similar but different from that in New Territories. Distance to CBD is highly valued by buyer in Hong Kong Island and Kowloon that office property is discounted by 2.4 to 2.5 percent and 1.3 to 3.1 percent respectively as distance to CBD becomes 10 percent far, but in New Territories, office buyer do not care about it as all properties are geographical distant to CBD, so both Model I and Model II for New Territories exclude this variable. Distance to MTR station is an important negative sign for office property, especially in Hong Kong Island and Kowloon. If the distance to nearest MTR station increases 10 percent, office property price would reduce by 0.65 to 0.72 percent in Hong Kong Island, 1.37 to 3.14 percent in Kowloon and 0.53 to 1.55 percent in New Territories. But for the case of New Territories, distance to MTR station is less significant (t = 5.85, p = 0.000 in Model I and t = 2.73, p = 0.006 in Model II) because the service area of MTR system in New Territories is lower than that in Hong
Kong Island and Kowloon so people’s dependence on MTR for travel in New Territories is less than that in other two areas.

LRT network is another important transport infrastructure in the northwestern of New Territories. The estimated result from both Model I and Model II indicates office properties within 500 meters of LRT stations have 59.4 to 74.5 percent lower transaction prices than those beyond 500 meters of LRT stations in the New Territories. One possible reason for adverse impacts of proximity to LRT station on office price is that service areas of LRT system – Tuen Mun and Yuen Long takes locational disadvantage to office property – lower employment density and business development, compared other office cluster areas in New Territories – Sha Tin and Kwai Tsing, which employment in Tuen Mun, Yuen Long, Sha Tin and Kwai Tsing accounts for 8.6 percent, 9.8 percent, 17.1 percent and 22.0 percent of all employment in New Territories respectively in 2013. Therefore, proximity to LRT station indicating office’s disadvantageous location discounts office property price greatly compared with office locating beyond 500m of LRT station.

Lastly, the study includes time effects to consider seasonal or macroeconomic influence on office property price and these year dummy variables show the time pattern of property price in Hong Kong. In 2003, as the influence of SRAS in Hong Kong, office price appreciated very slowly and even lost its value, and since 2004 office price started to appreciate rapidly, which the properties sold in 2013 are worth 155.55 to 171.6 percent more than that in 2002 in all three territorial areas even if all office transactions price is adjusted by Hong Kong’s monthly CPI in December 2013. It indicates the rapid recovery and development speed of Hong Kong’s office property market after 2003.
Table 6.1. Model I for Estimating Office Price in Hong Kong Island

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>OLS Coefficient</th>
<th>t-value</th>
<th>p-value</th>
<th>Fixed Effects Coefficient</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural Variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>floor</td>
<td>0.136</td>
<td>18.295</td>
<td>.000</td>
<td>0.137</td>
<td>18.63</td>
<td>.000</td>
</tr>
<tr>
<td>area</td>
<td>0.076</td>
<td>11.339</td>
<td>.000</td>
<td>0.071</td>
<td>10.71</td>
<td>.000</td>
</tr>
<tr>
<td>age</td>
<td>-0.108</td>
<td>-8.952</td>
<td>.000</td>
<td>-0.121</td>
<td>-9.75</td>
<td>.000</td>
</tr>
<tr>
<td>Location Variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DCBD</td>
<td>-0.155</td>
<td>-16.674</td>
<td>.000</td>
<td>-0.250</td>
<td>-14.48</td>
<td>.000</td>
</tr>
<tr>
<td>DMTR</td>
<td>-0.095</td>
<td>-20.026</td>
<td>.000</td>
<td>-0.072</td>
<td>-11.33</td>
<td>.000</td>
</tr>
<tr>
<td>Proximity Variable</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DIC</td>
<td>0.014</td>
<td>2.353</td>
<td>.015</td>
<td>0.010</td>
<td>1.42</td>
<td>.156</td>
</tr>
<tr>
<td>Traffic Variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>traffic</td>
<td>0.139</td>
<td>8.475</td>
<td>.000</td>
<td>0.085</td>
<td>4.93</td>
<td>.000</td>
</tr>
<tr>
<td>Year Dummy Variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>year_2003</td>
<td>-0.094</td>
<td>-2.900</td>
<td>.004</td>
<td>-0.105</td>
<td>-3.27</td>
<td>.001</td>
</tr>
<tr>
<td>year_2004</td>
<td>0.273</td>
<td>9.474</td>
<td>.000</td>
<td>0.260</td>
<td>9.10</td>
<td>.000</td>
</tr>
<tr>
<td>year_2005</td>
<td>0.542</td>
<td>16.573</td>
<td>.000</td>
<td>0.530</td>
<td>16.34</td>
<td>.000</td>
</tr>
<tr>
<td>year_2006</td>
<td>0.694</td>
<td>23.026</td>
<td>.000</td>
<td>0.687</td>
<td>22.98</td>
<td>.000</td>
</tr>
<tr>
<td>year_2007</td>
<td>0.886</td>
<td>32.192</td>
<td>.000</td>
<td>0.878</td>
<td>32.15</td>
<td>.000</td>
</tr>
<tr>
<td>year_2008</td>
<td>1.042</td>
<td>34.915</td>
<td>.000</td>
<td>1.037</td>
<td>35.03</td>
<td>.000</td>
</tr>
<tr>
<td>year_2009</td>
<td>1.059</td>
<td>35.758</td>
<td>.000</td>
<td>1.060</td>
<td>36.10</td>
<td>.000</td>
</tr>
<tr>
<td>year_2010</td>
<td>1.276</td>
<td>45.195</td>
<td>.000</td>
<td>1.277</td>
<td>45.52</td>
<td>.000</td>
</tr>
<tr>
<td>year_2011</td>
<td>1.447</td>
<td>49.152</td>
<td>.000</td>
<td>1.453</td>
<td>49.77</td>
<td>.000</td>
</tr>
<tr>
<td>year_2012</td>
<td>1.576</td>
<td>54.958</td>
<td>.000</td>
<td>1.580</td>
<td>55.34</td>
<td>.000</td>
</tr>
<tr>
<td>year_2013</td>
<td>1.661</td>
<td>53.900</td>
<td>.000</td>
<td>1.661</td>
<td>54.31</td>
<td>.000</td>
</tr>
<tr>
<td>constant</td>
<td>7.436</td>
<td>32.872</td>
<td>.000</td>
<td>8.695</td>
<td>34.32</td>
<td>.000</td>
</tr>
<tr>
<td>R square- overall</td>
<td>0.651</td>
<td></td>
<td></td>
<td>0.650</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- within</td>
<td></td>
<td></td>
<td>0.659</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- between</td>
<td></td>
<td></td>
<td>0.621</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>564.77</td>
<td></td>
<td></td>
<td>591.68</td>
<td></td>
<td></td>
</tr>
<tr>
<td>rho</td>
<td>-</td>
<td></td>
<td></td>
<td>0.047</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Groups</td>
<td>-</td>
<td></td>
<td></td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Observations</td>
<td>5536</td>
<td></td>
<td></td>
<td>5536</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 6.2. Model II for Estimating Office Price in Hong Kong Island

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>OLS Coefficient</th>
<th>OLS t-value</th>
<th>OLS p-value</th>
<th>Fixed Effects Coefficient</th>
<th>Fixed Effects t-value</th>
<th>Fixed Effects p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>t-value</td>
<td>p-value</td>
<td>Coefficient</td>
<td>t-value</td>
<td>p-value</td>
</tr>
<tr>
<td></td>
<td>floor</td>
<td>0.130</td>
<td>17.598</td>
<td>0.000</td>
<td>0.132</td>
<td>18.11</td>
</tr>
<tr>
<td></td>
<td>area</td>
<td>0.072</td>
<td>10.748</td>
<td>0.000</td>
<td>0.079</td>
<td>10.39</td>
</tr>
<tr>
<td></td>
<td>age</td>
<td>-0.111</td>
<td>-9.146</td>
<td>0.000</td>
<td>-0.120</td>
<td>-9.63</td>
</tr>
<tr>
<td>Structural Variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>floor</td>
<td>0.130</td>
<td>17.598</td>
<td>0.000</td>
<td>0.132</td>
<td>18.11</td>
</tr>
<tr>
<td></td>
<td>area</td>
<td>0.072</td>
<td>10.748</td>
<td>0.000</td>
<td>0.079</td>
<td>10.39</td>
</tr>
<tr>
<td></td>
<td>age</td>
<td>-0.111</td>
<td>-9.146</td>
<td>0.000</td>
<td>-0.120</td>
<td>-9.63</td>
</tr>
<tr>
<td>Location Variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>DCBD</td>
<td>-0.140</td>
<td>-15.044</td>
<td>0.000</td>
<td>-0.242</td>
<td>-13.40</td>
</tr>
<tr>
<td></td>
<td>DMTR</td>
<td>-0.092</td>
<td>-19.088</td>
<td>0.000</td>
<td>-0.065</td>
<td>-9.86</td>
</tr>
<tr>
<td>Distance Dummy Variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>DIC_100m</td>
<td>-0.331</td>
<td>-10.692</td>
<td>0.000</td>
<td>-0.328</td>
<td>-9.92</td>
</tr>
<tr>
<td></td>
<td>DIC_200m</td>
<td>-0.371</td>
<td>-12.284</td>
<td>0.000</td>
<td>-0.343</td>
<td>-11.04</td>
</tr>
<tr>
<td></td>
<td>DIC_400m</td>
<td>-0.333</td>
<td>-11.370</td>
<td>0.000</td>
<td>-0.303</td>
<td>-10.02</td>
</tr>
<tr>
<td></td>
<td>DIC_600m</td>
<td>-0.349</td>
<td>-10.750</td>
<td>0.000</td>
<td>-0.359</td>
<td>-11.03</td>
</tr>
<tr>
<td></td>
<td>DIC_800m</td>
<td>-0.409</td>
<td>-11.422</td>
<td>0.000</td>
<td>-0.448</td>
<td>-12.61</td>
</tr>
<tr>
<td>Traffic Variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>traffic</td>
<td>0.149</td>
<td>9.175</td>
<td>0.000</td>
<td>0.088</td>
<td>5.14</td>
</tr>
<tr>
<td>Year Dummy Variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>year_2003</td>
<td>-0.054</td>
<td>-1.690</td>
<td>0.091</td>
<td>-0.067</td>
<td>-2.12</td>
</tr>
<tr>
<td></td>
<td>year_2004</td>
<td>0.313</td>
<td>10.943</td>
<td>0.000</td>
<td>0.297</td>
<td>10.51</td>
</tr>
<tr>
<td></td>
<td>year_2005</td>
<td>0.595</td>
<td>18.265</td>
<td>0.000</td>
<td>0.578</td>
<td>17.92</td>
</tr>
<tr>
<td></td>
<td>year_2006</td>
<td>0.735</td>
<td>24.560</td>
<td>0.000</td>
<td>0.725</td>
<td>24.46</td>
</tr>
<tr>
<td></td>
<td>year_2007</td>
<td>0.930</td>
<td>33.924</td>
<td>0.000</td>
<td>0.916</td>
<td>33.71</td>
</tr>
<tr>
<td></td>
<td>year_2008</td>
<td>1.083</td>
<td>36.512</td>
<td>0.000</td>
<td>1.071</td>
<td>36.48</td>
</tr>
<tr>
<td></td>
<td>year_2009</td>
<td>1.111</td>
<td>37.605</td>
<td>0.000</td>
<td>1.106</td>
<td>37.83</td>
</tr>
<tr>
<td></td>
<td>year_2010</td>
<td>1.323</td>
<td>46.978</td>
<td>0.000</td>
<td>1.318</td>
<td>47.18</td>
</tr>
<tr>
<td></td>
<td>year_2011</td>
<td>1.497</td>
<td>50.985</td>
<td>0.000</td>
<td>1.496</td>
<td>51.53</td>
</tr>
<tr>
<td></td>
<td>year_2012</td>
<td>1.627</td>
<td>56.868</td>
<td>0.000</td>
<td>1.627</td>
<td>56.24</td>
</tr>
<tr>
<td></td>
<td>year_2013</td>
<td>1.718</td>
<td>55.864</td>
<td>0.000</td>
<td>1.716</td>
<td>35.80</td>
</tr>
<tr>
<td></td>
<td>constant</td>
<td>7.616</td>
<td>33.636</td>
<td>0.000</td>
<td>8.915</td>
<td>34.51</td>
</tr>
<tr>
<td></td>
<td>R square- overall</td>
<td>0.665</td>
<td>0.657</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- within</td>
<td>-</td>
<td>0.670</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- between</td>
<td>-</td>
<td>0.568</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>499.34</td>
<td>507.66</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>rho</td>
<td>-</td>
<td>0.056</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Number of Groups</td>
<td>-</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Number of Observations</td>
<td>5536</td>
<td>5536</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable Name</td>
<td>OLS Coefficient</td>
<td>OLS t-value</td>
<td>OLS p-value</td>
<td>Fixed Effects Coefficient</td>
<td>Fixed Effects t-value</td>
<td>Fixed Effects p-value</td>
</tr>
<tr>
<td>-------------------</td>
<td>-----------------</td>
<td>-------------</td>
<td>-------------</td>
<td>---------------------------</td>
<td>-----------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td><strong>Structural Variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>floor</td>
<td>0.126</td>
<td>19.231</td>
<td>.000</td>
<td>0.112</td>
<td>17.48</td>
<td>.000</td>
</tr>
<tr>
<td>area</td>
<td>0.061</td>
<td>10.661</td>
<td>.000</td>
<td>0.088</td>
<td>15.11</td>
<td>.000</td>
</tr>
<tr>
<td>age</td>
<td>-0.105</td>
<td>-13.379</td>
<td>.000</td>
<td>-0.126</td>
<td>-15.80</td>
<td>.000</td>
</tr>
<tr>
<td><strong>Location Variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DCBD</td>
<td>-0.380</td>
<td>-20.602</td>
<td>.000</td>
<td>-0.137</td>
<td>-4.62</td>
<td>.000</td>
</tr>
<tr>
<td>DMTR</td>
<td>-0.106</td>
<td>-16.518</td>
<td>.000</td>
<td>-0.081</td>
<td>-11.93</td>
<td>.000</td>
</tr>
<tr>
<td><strong>Proximity Variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DIC</td>
<td>-0.040</td>
<td>-4.290</td>
<td>.000</td>
<td>-0.028</td>
<td>-2.76</td>
<td>.006</td>
</tr>
<tr>
<td><strong>Traffic Variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>traffic</td>
<td>0.158</td>
<td>16.242</td>
<td>.000</td>
<td>0.240</td>
<td>21.37</td>
<td>.000</td>
</tr>
<tr>
<td><strong>Year Dummy Variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>year_2003</td>
<td>-0.002</td>
<td>-0.066</td>
<td>.948</td>
<td>0.004</td>
<td>0.13</td>
<td>.893</td>
</tr>
<tr>
<td>year_2004</td>
<td>0.382</td>
<td>9.300</td>
<td>.000</td>
<td>0.396</td>
<td>9.93</td>
<td>.000</td>
</tr>
<tr>
<td>year_2005</td>
<td>0.528</td>
<td>22.454</td>
<td>.000</td>
<td>0.532</td>
<td>23.29</td>
<td>.000</td>
</tr>
<tr>
<td>year_2006</td>
<td>0.607</td>
<td>23.407</td>
<td>.000</td>
<td>0.621</td>
<td>24.59</td>
<td>.000</td>
</tr>
<tr>
<td>year_2007</td>
<td>0.815</td>
<td>33.910</td>
<td>.000</td>
<td>0.815</td>
<td>34.89</td>
<td>.000</td>
</tr>
<tr>
<td>year_2008</td>
<td>0.904</td>
<td>34.750</td>
<td>.000</td>
<td>0.913</td>
<td>36.09</td>
<td>.000</td>
</tr>
<tr>
<td>year_2009</td>
<td>0.914</td>
<td>35.996</td>
<td>.000</td>
<td>0.922</td>
<td>37.36</td>
<td>.000</td>
</tr>
<tr>
<td>year_2010</td>
<td>1.119</td>
<td>47.328</td>
<td>.000</td>
<td>1.123</td>
<td>48.93</td>
<td>.000</td>
</tr>
<tr>
<td>year_2011</td>
<td>1.258</td>
<td>51.519</td>
<td>.000</td>
<td>1.260</td>
<td>53.06</td>
<td>.000</td>
</tr>
<tr>
<td>year_2012</td>
<td>1.456</td>
<td>62.324</td>
<td>.000</td>
<td>1.467</td>
<td>64.43</td>
<td>.000</td>
</tr>
<tr>
<td>year_2013</td>
<td>1.573</td>
<td>62.442</td>
<td>.000</td>
<td>1.600</td>
<td>64.94</td>
<td>.000</td>
</tr>
<tr>
<td>constant</td>
<td>9.763</td>
<td>44.524</td>
<td>.000</td>
<td>6.598</td>
<td>20.63</td>
<td>.000</td>
</tr>
</tbody>
</table>

| R square- overall | 0.655 | 0.627 |
| - within          |       | 0.654 |
| - between         |       | 0.372 |
| F                 | 744.31| 739.63|
| rho               |       | 0.365 |
| Number of Groups  |       | 5     |
| Number of Observations | 7053 | 7053 |
### Table 6.4. Model II for Estimating Office Price in Kowloon

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>OLS Coefficient</th>
<th>OLS t-value</th>
<th>OLS p-value</th>
<th>Fixed Effects Coefficient</th>
<th>Fixed Effects t-value</th>
<th>Fixed Effects p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Structural Variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>floor</td>
<td>0.113</td>
<td>17.657</td>
<td>.000</td>
<td>0.101</td>
<td>16.08</td>
<td>.000</td>
</tr>
<tr>
<td>area</td>
<td>0.064</td>
<td>11.458</td>
<td>.000</td>
<td>0.081</td>
<td>14.13</td>
<td>.000</td>
</tr>
<tr>
<td>age</td>
<td>-0.095</td>
<td>-11.958</td>
<td>.000</td>
<td>-0.118</td>
<td>-14.46</td>
<td>.000</td>
</tr>
<tr>
<td><strong>Location Variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DCBD</td>
<td>-0.506</td>
<td>-26.608</td>
<td>.000</td>
<td>-0.314</td>
<td>-10.15</td>
<td>.000</td>
</tr>
<tr>
<td>DMTR</td>
<td>-0.115</td>
<td>-17.785</td>
<td>.000</td>
<td>-0.099</td>
<td>-14.24</td>
<td>.000</td>
</tr>
<tr>
<td><strong>Distance Dummy Variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DIC_100m</td>
<td>-0.004</td>
<td>-0.073</td>
<td>.942</td>
<td>0.011</td>
<td>0.19</td>
<td>.846</td>
</tr>
<tr>
<td>DIC_200m</td>
<td>0.171</td>
<td>6.506</td>
<td>.000</td>
<td>0.115</td>
<td>3.99</td>
<td>.000</td>
</tr>
<tr>
<td>DIC_400m</td>
<td>0.047</td>
<td>3.167</td>
<td>.002</td>
<td>0.037</td>
<td>2.40</td>
<td>.002</td>
</tr>
<tr>
<td>DIC_600m</td>
<td>-0.209</td>
<td>-17.151</td>
<td>.000</td>
<td>-0.189</td>
<td>-15.22</td>
<td>.000</td>
</tr>
<tr>
<td>DIC_800m</td>
<td>-0.153</td>
<td>-11.248</td>
<td>.000</td>
<td>-0.133</td>
<td>-9.52</td>
<td>.000</td>
</tr>
<tr>
<td><strong>Traffic Variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>traffic</td>
<td>0.148</td>
<td>14.488</td>
<td>.000</td>
<td>0.208</td>
<td>18.22</td>
<td>.000</td>
</tr>
<tr>
<td><strong>Year Dummy Variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>year_2003</td>
<td>-0.001</td>
<td>-0.031</td>
<td>.975</td>
<td>0.006</td>
<td>0.24</td>
<td>.810</td>
</tr>
<tr>
<td>year_2004</td>
<td>0.394</td>
<td>9.941</td>
<td>.000</td>
<td>0.404</td>
<td>10.39</td>
<td>.000</td>
</tr>
<tr>
<td>year_2005</td>
<td>0.539</td>
<td>23.716</td>
<td>.000</td>
<td>0.542</td>
<td>24.33</td>
<td>.000</td>
</tr>
<tr>
<td>year_2006</td>
<td>0.634</td>
<td>25.257</td>
<td>.000</td>
<td>0.640</td>
<td>25.98</td>
<td>.000</td>
</tr>
<tr>
<td>year_2007</td>
<td>0.825</td>
<td>35.518</td>
<td>.000</td>
<td>0.825</td>
<td>36.22</td>
<td>.000</td>
</tr>
<tr>
<td>year_2008</td>
<td>0.917</td>
<td>36.516</td>
<td>.000</td>
<td>0.923</td>
<td>37.46</td>
<td>.000</td>
</tr>
<tr>
<td>year_2009</td>
<td>0.925</td>
<td>37.678</td>
<td>.000</td>
<td>0.029</td>
<td>38.56</td>
<td>.000</td>
</tr>
<tr>
<td>year_2010</td>
<td>1.136</td>
<td>49.691</td>
<td>.000</td>
<td>1.137</td>
<td>50.62</td>
<td>.000</td>
</tr>
<tr>
<td>year_2011</td>
<td>1.263</td>
<td>53.428</td>
<td>.000</td>
<td>1.267</td>
<td>54.58</td>
<td>.000</td>
</tr>
<tr>
<td>year_2012</td>
<td>1.458</td>
<td>64.268</td>
<td>.000</td>
<td>1.470</td>
<td>65.91</td>
<td>.000</td>
</tr>
<tr>
<td>year_2013</td>
<td>1.584</td>
<td>64.735</td>
<td>.000</td>
<td>1.616</td>
<td>66.81</td>
<td>.000</td>
</tr>
<tr>
<td>constant</td>
<td>10.734</td>
<td>51.487</td>
<td>.000</td>
<td>8.406</td>
<td>24.69</td>
<td>.000</td>
</tr>
<tr>
<td><strong>R square- overall</strong></td>
<td>0.679</td>
<td>0.664</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- within</td>
<td>-</td>
<td>0.673</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- between</td>
<td>-</td>
<td>0.488</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>F</strong></td>
<td>678.294</td>
<td>655.90</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>rho</strong></td>
<td>-</td>
<td>0.327</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Groups</td>
<td>-</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Observations</td>
<td>7053</td>
<td>7053</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 6.5. Model I for Estimating Office Price in New Territories

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>OLS Coefficient</th>
<th>OLS t-value</th>
<th>OLS p-value</th>
<th>Fixed Effects Coefficient</th>
<th>Fixed Effects t-value</th>
<th>Fixed Effects p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Structural Variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>floor</td>
<td>0.072</td>
<td>5.449</td>
<td>0.000</td>
<td>0.060</td>
<td>5.15</td>
<td>0.000</td>
</tr>
<tr>
<td>gap_area</td>
<td>0.083</td>
<td>2.247</td>
<td>0.025</td>
<td>0.100</td>
<td>3.10</td>
<td>0.000</td>
</tr>
<tr>
<td>area</td>
<td>-0.064</td>
<td>-1.730</td>
<td>0.084</td>
<td>-0.095</td>
<td>-2.81</td>
<td>0.001</td>
</tr>
<tr>
<td>age</td>
<td>-0.013</td>
<td>-0.455</td>
<td>0.649</td>
<td>-0.155</td>
<td>-5.61</td>
<td>0.000</td>
</tr>
<tr>
<td><strong>Location Variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DCBD</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>DMTR</td>
<td>-0.187</td>
<td>-10.718</td>
<td>0.000</td>
<td>-0.101</td>
<td>-5.85</td>
<td>0.000</td>
</tr>
<tr>
<td>lrt_500m</td>
<td>-0.164</td>
<td>-6.336</td>
<td>0.000</td>
<td>-0.745</td>
<td>-6.22</td>
<td>0.000</td>
</tr>
<tr>
<td><strong>Proximity Variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DIC</td>
<td>-0.178</td>
<td>-8.438</td>
<td>0.000</td>
<td>-0.434</td>
<td>-18.84</td>
<td>0.000</td>
</tr>
<tr>
<td><strong>Traffic Variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>traffic</td>
<td>0.172</td>
<td>5.675</td>
<td>0.000</td>
<td>0.406</td>
<td>5.52</td>
<td>0.000</td>
</tr>
<tr>
<td><strong>Year Dummy Variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>year_2003</td>
<td>-0.188</td>
<td>-2.703</td>
<td>0.007</td>
<td>-0.124</td>
<td>-2.07</td>
<td>0.039</td>
</tr>
<tr>
<td>year_2004</td>
<td>-0.049</td>
<td>-0.754</td>
<td>0.451</td>
<td>0.056</td>
<td>0.99</td>
<td>0.321</td>
</tr>
<tr>
<td>year_2005</td>
<td>0.407</td>
<td>6.185</td>
<td>0.000</td>
<td>0.475</td>
<td>8.27</td>
<td>0.000</td>
</tr>
<tr>
<td>year_2006</td>
<td>0.469</td>
<td>7.217</td>
<td>0.000</td>
<td>0.586</td>
<td>10.34</td>
<td>0.000</td>
</tr>
<tr>
<td>year_2007</td>
<td>0.491</td>
<td>7.804</td>
<td>0.000</td>
<td>0.679</td>
<td>12.15</td>
<td>0.000</td>
</tr>
<tr>
<td>year_2008</td>
<td>0.666</td>
<td>9.441</td>
<td>0.000</td>
<td>0.778</td>
<td>12.64</td>
<td>0.000</td>
</tr>
<tr>
<td>year_2009</td>
<td>0.723</td>
<td>12.345</td>
<td>0.000</td>
<td>0.900</td>
<td>17.31</td>
<td>0.000</td>
</tr>
<tr>
<td>year_2010</td>
<td>0.732</td>
<td>13.993</td>
<td>0.000</td>
<td>0.945</td>
<td>20.02</td>
<td>0.000</td>
</tr>
<tr>
<td>year_2011</td>
<td>0.941</td>
<td>16.907</td>
<td>0.000</td>
<td>1.170</td>
<td>23.59</td>
<td>0.000</td>
</tr>
<tr>
<td>year_2012</td>
<td>1.267</td>
<td>21.428</td>
<td>0.000</td>
<td>1.467</td>
<td>27.89</td>
<td>0.000</td>
</tr>
<tr>
<td>year_2013</td>
<td>1.314</td>
<td>24.960</td>
<td>0.000</td>
<td>1.592</td>
<td>32.75</td>
<td>0.000</td>
</tr>
<tr>
<td>constant</td>
<td>7.981</td>
<td>21.477</td>
<td>0.000</td>
<td>7.042</td>
<td>9.00</td>
<td>0.000</td>
</tr>
<tr>
<td><strong>Fixed Effects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R square- overall</td>
<td>0.744</td>
<td></td>
<td></td>
<td>0.654</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- within</td>
<td>-</td>
<td></td>
<td></td>
<td>0.751</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- between</td>
<td>-</td>
<td></td>
<td></td>
<td>0.096</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>165.81</td>
<td></td>
<td></td>
<td>167.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>rho</td>
<td>-</td>
<td></td>
<td></td>
<td>0.924</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Groups</td>
<td>-</td>
<td></td>
<td></td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Observations</td>
<td>1081</td>
<td></td>
<td></td>
<td>1081</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 6.6. Model II for Estimating Office Price in New Territories

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>OLS Coefficient</th>
<th>OLS t-value</th>
<th>OLS p-value</th>
<th>Fixed Effects Coefficient</th>
<th>Fixed Effects t-value</th>
<th>Fixed Effects p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Structural Variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>floor</td>
<td>0.065</td>
<td>5.221</td>
<td>.000</td>
<td>0.057</td>
<td>5.14</td>
<td>.000</td>
</tr>
<tr>
<td>gap_area</td>
<td>0.156</td>
<td>4.427</td>
<td>.000</td>
<td>0.139</td>
<td>4.41</td>
<td>.000</td>
</tr>
<tr>
<td>area</td>
<td>-0.167</td>
<td>-4.518</td>
<td>.000</td>
<td>-0.141</td>
<td>-4.28</td>
<td>.000</td>
</tr>
<tr>
<td>age</td>
<td>0.097</td>
<td>3.213</td>
<td>.001</td>
<td>-0.064</td>
<td>-1.97</td>
<td>.049</td>
</tr>
<tr>
<td><strong>Location Variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DCBD</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>DMTR</td>
<td>-0.093</td>
<td>-5.037</td>
<td>.000</td>
<td>-0.053</td>
<td>-2.73</td>
<td>.006</td>
</tr>
<tr>
<td>lrt_500m</td>
<td>-0.248</td>
<td>-7.567</td>
<td>.000</td>
<td>-0.594</td>
<td>-5.03</td>
<td>.000</td>
</tr>
<tr>
<td><strong>Distance Dummy Variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DIC_200m</td>
<td>0.170</td>
<td>2.144</td>
<td>.032</td>
<td>0.552</td>
<td>6.76</td>
<td>.000</td>
</tr>
<tr>
<td>DIC_400m</td>
<td>0.261</td>
<td>8.524</td>
<td>.000</td>
<td>0.657</td>
<td>18.54</td>
<td>.000</td>
</tr>
<tr>
<td>DIC_600m</td>
<td>-0.082</td>
<td>-1.720</td>
<td>.086</td>
<td>0.235</td>
<td>3.04</td>
<td>.002</td>
</tr>
<tr>
<td>DIC_800m</td>
<td>-0.237</td>
<td>-6.817</td>
<td>.000</td>
<td>0.144</td>
<td>3.76</td>
<td>.000</td>
</tr>
<tr>
<td><strong>Traffic Variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>traffic</td>
<td>0.087</td>
<td>2.061</td>
<td>.000</td>
<td>0.265</td>
<td>3.37</td>
<td>.000</td>
</tr>
<tr>
<td><strong>Year Dummy Variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>year_2003</td>
<td>-0.114</td>
<td>-1.754</td>
<td>.080</td>
<td>-0.078</td>
<td>-1.35</td>
<td>.178</td>
</tr>
<tr>
<td>year_2004</td>
<td>0.041</td>
<td>0.669</td>
<td>.503</td>
<td>0.109</td>
<td>2.01</td>
<td>.047</td>
</tr>
<tr>
<td>year_2005</td>
<td>0.460</td>
<td>7.485</td>
<td>.000</td>
<td>0.510</td>
<td>9.25</td>
<td>.000</td>
</tr>
<tr>
<td>year_2006</td>
<td>0.500</td>
<td>8.096</td>
<td>.000</td>
<td>0.563</td>
<td>10.18</td>
<td>.000</td>
</tr>
<tr>
<td>year_2007</td>
<td>0.573</td>
<td>9.703</td>
<td>.000</td>
<td>0.700</td>
<td>13.10</td>
<td>.000</td>
</tr>
<tr>
<td>year_2008</td>
<td>0.755</td>
<td>11.421</td>
<td>.000</td>
<td>0.837</td>
<td>14.18</td>
<td>.000</td>
</tr>
<tr>
<td>year_2009</td>
<td>0.772</td>
<td>14.057</td>
<td>.000</td>
<td>0.903</td>
<td>18.24</td>
<td>.000</td>
</tr>
<tr>
<td>year_2010</td>
<td>0.838</td>
<td>16.823</td>
<td>.000</td>
<td>0.992</td>
<td>21.86</td>
<td>.000</td>
</tr>
<tr>
<td>year_2011</td>
<td>1.033</td>
<td>19.672</td>
<td>.000</td>
<td>1.200</td>
<td>25.31</td>
<td>.000</td>
</tr>
<tr>
<td>year_2012</td>
<td>1.374</td>
<td>24.510</td>
<td>.000</td>
<td>1.501</td>
<td>29.64</td>
<td>.000</td>
</tr>
<tr>
<td>year_2013</td>
<td>1.285</td>
<td>26.049</td>
<td>.000</td>
<td>1.555</td>
<td>33.65</td>
<td>.000</td>
</tr>
<tr>
<td>constant</td>
<td>7.099</td>
<td>14.152</td>
<td>.000</td>
<td>4.991</td>
<td>6.26</td>
<td>.000</td>
</tr>
</tbody>
</table>

R square- overall    0.778       0.722  
- within          -          0.774  
- between         -          0.416  
F                172.70     163.55  
rho              -          0.790  
Number of Groups  -          6  
Number of Observations  1081       1081  

- 49 -
CHAPTER 7: FINDINGS AND DISCUSSIONS

The empirical findings derived from the hedonic price analysis on micro-level office transaction data across Hong Kong Island, Kowloon, and the New Territories from 2002 to 2013 are basically consistent with the suggestions of urban economic theories and previous empirical studies but rather comprehensive and insightful to consider the changing roles of highway investment in the critical time period of a rapidly deindustrializing economy – Hong Kong.

One of the strong inferences of this empirical research is that the impacts of highway proximity on office prices or business productivity essentially depends on the spatial divisions of business clusters within a city or region that have been formed through both state interventions and market responses.

In the case of Hong Kong’s office property markets, the demands for urban mobility and amenity are distinctive by business locations within one city. In Hong Kong Island, proximity to highway substantially discounts office prices, even though additional traffic volumes are statistically associated with changes in office transaction prices. In Kowloon, however, proximity to highway interchanges can be seen as a locational advantage, accompanied by more frequent face-to-face business interactions or heavier port-related throughputs. In the New Territories, highway interchanges can be regarded as a vital facility for the business benefits of mobility beyond the disamenity costs of proximity, which can be associated with the recent promotions of science parks and cross-border flows.

Also, these distinctive influences across the three geographic sections within Hong Kong can be endorsed by the industrial restructuring trends in Hong Kong Island, Kowloon, and the New Territories. The industrial composition of Hong Kong and its three territorial areas in 2002 and 2013 are summarized in Figure 7.1, according to the number of persons engaged. There are originally over ten industrial categories set by Hong Kong SAR
Census and Statistics Department, but these industries are further aggregated into five major categories: manufacturing, transportation, trade, knowledge-based industry (including information, finance, real estate and professional and business service) and others (including electricity, accommodation, and social service).

Apparently, Hong Kong is dominated by trade and knowledge-based industries, and the share of manufacturing sector was decreasing from 2002 to 2013 as the result of industrial restructure.

Notably, this is extreme in Hong Kong Island that knowledge-based industry offers half of jobs and the percentage keeps increasing, and very few and declining number of people engaged in manufacturing and transportation industry with only 3.09 percent and 3.88 percent in 2002 and 1.60 percent and 3.01 percent in 2013 respectively.

In Kowloon, trade industry attracted most of working population about 42.34 percent in 2002 and 37.06 percent in 2013 and the proportion of knowledge-based industry kept increasing trend from 18.44 percent to 24.52 percent since 2002, and also the number of people who engage in manufacturing was very limited and presented a declining trend for the period from 2002 to 2013 that declined from 6.95 percent to 2.78 percent.

As to New Territories, it is also based on trade industry but agglomerates most of manufacturing and transportation industry. Trade industry occupied 35.09 percent and 33.41 percent in 2002 and 2013. The share of manufacturing and transportation industry was 14.88 percent and 9.80 percent in 2002 and 8.19 percent and 11.11 percent in 2013. Because Hong Kong government encourages to develop three large-scale industry estate- Tai Po Industrial Estate, Yueng Long Industrial Estate and Hong Kong Science Park in order to motivate local manufacturing industry development in New Territories. In addition, there is one of the busiest container port in the world- the Kwai Tsing Container Terminals also supports local transportation and trade industry. Whereas the share of knowledge-based industry was much lower than that in Hong Kong Island and Kowloon, which indicates that degree of deindustrialization is moderate in New Territories.
Overall, the industry structure in Hong Kong Island is obviously dominated by knowledge-based industry; and in Kowloon, trade industry is in the leading position and knowledge-based industry gradually plays more important role in this area. In New Territories, its industry is also dominated by trade industry, whereas manufacturing and transportation industries shows stronger influence on the local industry compared with knowledge-based industry.

![Industrial Structure in the Three Areas, in 2002 and 2013](Sources: Census and Statistics Department of Hong Kong SAR)

Office property price is regarded as a reflection of business productivity, which office property with higher value must locate in the place with higher business productivity. Associating urban highway impacts with local industry structure, in knowledge-based industry dominated region like Hong Kong Island, both proximity benefit and active land transport have very weak impacts on office property price, which indicates that urban highway shows very limited positive impacts on promoting local business productivity, and even likely hinder the development of its leading industry - knowledge-based industry as the results of nuisance effects. Whereas highway is a vital positive factor to improve local business productivity in the area with higher share of manufacturing and
transportation industry just like New Territories that is identical with the empirical analysis of office property price. In Kowloon that have highest proportion of trade industry and relative lower share of manufacturing, transportation and knowledge-based industry, both positive and negative effects on business productive brought by urban highway is relative moderate but significant. The research concludes that urban highway have close relationship with regional business productivity but impacts is decided by local industrial structure. Manufacturing and transportation industry can gain maximum benefit from urban highway compared with other kinds of industry and knowledge-based industry is likely adversely affected by negative externalities of urban highways.

Therefore, city managers should also consider local industry structure when decides the development strategy of urban highway system. From economics perspectives, if the secondary industry like manufacturing or transportation still have strong influence on local industry, construction of urban highway would greatly stimulus local industry productivity, while if the city is or will be gradually developing tertiary industry especially knowledge-based or information-based industry as its dominant industry, mass investment in urban highway perhaps do not motivate or even decrease its industry productivity but the investment in railway likely bring more positive impacts on local industry.

Therefore, when justify the policy implication of urban highway, investment or dis-investment, not only the quality of living but also the business productivity should be considered. For example, a highway bypass project in Hong Kong Island is under construction that is estimated to cost HK$ 36 billion (around US$ 4.64 billion), to alleviate the traffic congestion along the existing roads, shown in Figure 7.2. This project includes construction of a 4.5 km long dual three-lane trunk road with a 3.7 km long tunnel. This project chooses long underground tunnel that required higher construction cost and schedule rather than cheaper surface roads, which looks like a time and money wasting decision. However, based on the empirical estimation, in Hong Kong Island, proximity to surface highway interchanges and additional traffic flow of highway do not
influence much on office price and local business productivity even decrease them because of adverse negative effects. Therefore, considering the long-term development, diverting existing traffic to underground from surface and eliminating nuisance effects brought by surface road is likely more helpful to increase office property nearby the project and enhance its knowledge-based industry productivity, although it requires more initial capital investment.

**Figure 7.2.** Central-Wan Chai Bypass and Island Eastern Corridor Link Project  
(Sources: Highway Department of Hong Kong SAR)

Different with development strategy of urban highway in Hong Kong Island, in New Territories, there are lots of under-construction and under-planning improvement or reconstruction projects, including widening or construction traffic lane, installation of noise barriers, in order to alleviate the traffic congestion and improve the traffic capacity of surface highway. For instance, an improvement project of partial Tolo highway (shown in Figure 7.3), with HK$ 4.49 billion estimated project cost, is under construction in order to improve traffic capacity by widening traffic lane and construction new vehicular
bridges and also eliminate traffic noisy of highway by installing noise barriers. According to the previous analysis, it indicates that in New Territories, urban highway is significant positive associated with both office property price and local business productivity. Additional, these project also reduce some negative effects brought by highway, especially traffic noisy. Therefore, such improvement project of highway benefits nearby office owners and local business activity.

Figure 7.3. Widening of Tolo Highway Project
(Sources: Highway Department of Hong Kong SAR)
FINAL CHAPTER: CONCLUSION

Overall, the study uses hedonic price analysis on office transaction data across Hong Kong Island, Kowloon and New Territories for 2002 to 2013 to examine the relationship between office property price representing business productivity and urban highway from both proximity impacts and traffic volume in a rapidly deindustrializing economy – Hong Kong.

Firstly, the empirical results present the close relationship between urban highway and office property price or business productivity. Whereas the impacts of highway proximity differ across the three territorial areas of Hong Kong that have various economical and geographical characteristics. In Hong Kong Island, proximity benefits to highway are totally offset by negative externalities of heavy traffic, especially within 800m meters of highway interchanges and additional traffic volume of highway interchange slightly increases office price but influences are relative weak. In Kowloon, lying in relative close distance (within 400m) from highway interchanges increases office price and additional traffic volume is significant positive associated with office price, which means nearby office and business could gain benefits from better mobility provided by highway. In New Territories, highway can be regarded as a vitally important facility for mobility as both proximity to highway interchanges and more traffic volume are highly valued by local buyers compared other structural or locational features.

Secondly, the impacts of highway proximity on office prices or business productivity essentially depends on the spatial divisions of business clusters within a city or region that have been formed through both state interventions and market responses. Hong Kong has been going through economic restructure since 1980s that leads to rapidly deindustrialization in the city. This is extreme in Hong Kong Island that is obviously dominated by knowledge-based industry. In Kowloon, trade industry is in the leading position and knowledge-based industry gradually plays more important role in this area but the manufacturing industry is shrinking rapidly. Whereas in New Territories, its
industry is also dominated by trade industry but its manufacturing and transportation industries shows stronger influence on the local industry, which indicates that the degree of decentralization is relatively moderate due in large part to the recent promotion of industrial parks and cross-border transactions.

The study concludes that the different impacts of highway proximity is close related with regional industrial structure. In knowledge-based industry dominate area with rapid deindustrialization, just like Hong Kong Island, the proximity benefits of urban highway have very limited influence on office property price and business productivity as knowledge- and service-based business performances tend to be amenity-sensitive. In the area where the manufacturing and transportation industries still have strong influence on its local industry, such as the New Territories, office property price or business productivity gain maximum benefit of better mobility and more active business interaction brought by urban highway.

Thirdly, these empirical findings suggest that justifying the policy implication of urban highways – investment or dis-investment, the impacts on business productivity is another vital factor. The study explains these by discussing about two under-going highway construction project in Hong Kong Island and New Territories respectively, which presents two different kinds of investment- construction of underground highway with huge initial capital investment and improvement of traffic capacity of existing surface highway requiring much lower cost. It would be helpful to city managers to make better development strategy of urban highway, especially for the cities under deindustrialization.

Finally, there are two major limitations of this study. Initially, the two-way causality between office price and impacts of additional traffic volume still remain inconclusive. Additionally, the sample size of the case in New Territories is not big enough that likely leads to inaccurate explanation from statistics perspective.
REFERENCE


