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2014

The Nexus between Labour Wages and Property Rents in the Greater China Area

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25/6/2014

Abstract:

Tse and Chan (2003) investigated the relationship between property sales price and the value of commuting time without accounting for the fact that property sales price is subject to the inherent limitation of containing speculative elements. A better measure to use for such a study would be the rent paid by the genuine end-user of the property. This paper examines how equilibrium rents in different locations within Greater China are determined by the time value, or the shadow wage, of an individual. Using the rental information, we provide a first estimated ratio of time values for individuals in Hong Kong, Shanghai and Taipei. Our results show that the shadow wage ratio of the households in Hong Kong, Shanghai and Taipei is about 2.25: 1: 1.61.

Keywords: Shadow wage; Property rental price; Central business district.

JEL Classifications: J31; R30.

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[1] We would like to thank the editor, an anonymous referee, Charles Leung, Travis Ng and Tommy Leung for their helpful comments. We would also like to thank Min Chen for able research assistance. Any remaining errors are ours. Corresponding author: Terence Tai-Leung Chong, Department of Economics, The Chinese University of Hong Kong, Shatin, N.T., Hong Kong. Email: chong2064@cuhk.edu.hk. Web page: http://www.cuhk.edu.hk/eco/staff/tlchong/tlchong3.htm.

1: Introduction

Location is always a definitive factor in determining the price of a property, where the price of properties in different locations hinges upon the perceived value of traveling time between home and the central business district (CBD), *ceteris paribus*. In particular, property value is negatively related to the distance from the CBD, as predicted in the monocentric city model developed by Alonso (1964), Muth (1969) and Mills (1972).[2] Given the rental differentials across different districts, one should be able to retrieve the time value associated with the commuting time, or the shadow wage, of an individual. This paper builds upon related literature by addressing the nexus between property values and the shadow wage. Both property value and shadow wages have long been studied in the past. For example, Stegman (1969) and Henderson (1977) examine the effect of environmental quality and location accessibility on property price. Nelson (1978), as well as So, Tse and Ganesan (1997), assess the effect of transportation on property price. Mahan, Polasky and Adam (2000) consider the relation of property price to urban air quality and wetlands separately.[3] Heckman (1974) examines the observed wage rate of women and the shadow price of time. However, the relation between shadow wage and property rental price has seldom been examined. This paper brings the two issues together to provide a new perspective on recovering the shadow wage from the property rental value in three major cities in Greater China, namely, Hong Kong, Shanghai and Taipei.

The rental value of a property depends mainly on two types of variables.

$$price = f(X, t) \qquad (1)$$

where X is a vector representing the characteristics of the property such as its age,

[2] According to McMillen (2006), although cities are becoming increasingly polycentric, modern urban areas still tend to be dominated by the traditional CBD. The monocentric model still has predictive value, even though the rate of decline in property values with distance from the CBD has fallen over time.

[3] The hedonic regression method and factor analysis are often applied to estimate the individual factor effect on property price (Kain and Quigley, 1970; Bajari and Kahn, 2008).

size and floor number, and *t* is the time cost variable reflecting the CBD proximity effect on property. Similar to Tse and Chan (2003), traveling time from a property to the CBD, instead of distance, is used in this paper to measure its effect on property price. The estimated coefficient associated with the variable can be used to derive ratios of time values among different cities. The rest of the paper is organized as follows: Section 2 describes the data and provides the details of the measurement methods. Section 3 introduces the models and methodology used in the empirical research. Section 4 reports the results of different models. Section 5 concludes the paper and suggests directions for future research.

2: Data

The residential property rental markets (referred to as the property rental market hereafter) of the Greater China region, including Hong Kong, Shanghai and Taipei, are examined and compared. Unlike McMillen and Singell (1992), who studied seven cities[4] in America, this paper focuses on three cities in Greater China because (1) they are densely populated; (2) the public transport systems (i.e., the railways and buses) are the primary means of commute, and a precise measurement of commuting time is easily obtainable; (3) the cultural factors of these three Chinese cities are similar.

The CBDs in Hong Kong, Shanghai and Taipei are individually examined in this paper.[5] To limit the complexity of this research, a single leading CBD is selected in each city (Central in Hong Kong, Lujiazui in Shanghai and Xinyi in Taipei) based

[4] McMillen and Singell (1992) studied Cleveland, Columbus, Dayton, Detroit, Indianapolis, Philadelphia and Pittsburgh in America.

[5] All the three cities in our sample have a single CBD. Although the Hong Kong government plans to turn Kowloon East into the second CBD, the most important business district will remain in Central (http://www.scmp.com/article/981836/planners-think-big-kowloon-east). In addition, a number of Hong Kong's landmark buildings, such as IFC, are located in Central, while the offices of the Hong Kong Monetary Authority and Hong Kong Exchanges and Clearing Limited are located in Central as well. For Shanghai, according to the website of the Pudong New Area Government, Lujiazui is the only national-level development zone named with finance and trade (http://english.pudong.gov.cn/html/pden/pden_business_dz/Info/Detail_73178.htm). In addition, a number of Shanghai's landmark buildings are located in Lujiazui, such as Shanghai IFC and Jin Mao Tower. The Shanghai headquarter of the People's Bank of China and the office of the Shanghai Stock Exchange are located in Lujiazui as well. For Taipei, Xinyi will contain at least 50% of the total Grade A office stock in Taipei, and will remain as the leading commercial centre of Taipei (http://www.prweb.com/releases/2007/07/prweb542482.htm).

on the official recognition of the district and consensus among real estate consultants. A concentration of the city's landmark buildings in the selected district serves to further support its leading role as a commercial district.

The property market is composed of the rental market and sales market. Property buyers can be either end-users or investors, while tenants are mostly genuine end-users. Unlike Tse and Chan (2003), who focused on the private property sales market and its prices, this paper only uses information from the private property rental market in order to exclude the influences of speculation in the property market.

Most people in Hong Kong and Shanghai travel to the CBD by public transportation, since private motor vehicle ownership in these two cities is relatively low due to expensive and limited parking spaces in the CBD, high gasoline taxes and import duties on motor vehicles.[6] In Taipei, private vehicle ownership is higher, with one out of four people owning a private car and one out of two people a motorcycle. Nevertheless, average daily ridership on the mass transit railway in all three cities is high.[7] Compared with alternative public transport systems, the railway provides the most accurate and reliable information on commuting time. Properties atop or adjacent to the railway stations are sampled for a precise measure of commuting time, whereas those beyond walking distance from the railway stations are excluded from our study due to measurement difficulties. Since residents in our sample are self-selected to live close to the railway stations, it is reasonable to assume that they do so for easy access to the CBD. Thus, our sample group has a much higher chance of working in the CBD than others who live in less convenient area. This self-selected sample also eliminates the potential bias of people traveling by private vehicle, since people living very close to the railway stations are more likely to use public transport instead of driving.

The information on vector X representing the characteristics of the property (i.e.,

[6] In Hong Kong, there were only 63 private cars licensed per 1000 people in 2012. In Shanghai, there were only 51 private cars owned per 1000 people in 2011 (data sources: *Shanghai Statistical Yearbook 2012*, Hong Kong Transport Department).

[7] Average daily ridership per capita in 2012 was around 0.68, 0.36 and 0.67 in Hong Kong, Shanghai and Taipei respectively (data sources: Hong Kong MTR, Xinmin News, Taipei Rapid Transit Corporation).

age, size and floor number) is obtained from the websites of various real estate agencies[8] and the time cost variable or the necessary commuting time is obtained from the websites of the metro systems[9] in the three cities. A total of 1086, 1741 and 893 observations[10] in the property rental markets of Hong Kong, Shanghai and Taipei are collected, respectively.[11] The sample window is from January 2011 to March 2011. The observations are classified into three data sets according to property size. The first data set, referred to as the "all property data set", covers all observations and includes private properties of all sizes. This data set can be used to measure the general conditions of the households under private housing in the three cities. The second data set, the "small and mid-size property", covers the observations of private properties of less than 1000 sq. ft. This data set is used to measure the situation of small and medium-sized properties. Notably, there are 943, 869 and 390 observations in the small and mid-size property data sets in Hong Kong, Shanghai and Taipei, respectively. The third data set, "luxury property", consists of private properties equal to or exceeding 1000 sq. ft. The "luxury property" set is used to measure the situation of the luxury property market.[12] There are 143, 872 and 503 observations for Hong Kong, Shanghai and Taipei, respectively.

3: Models and Methodology

Two linear models are employed in the current research: a specific model and a comparative model. Since more information on the Hong Kong property rental

[8] For the property rental market in Hong Kong, the data sources are Centaline Property (http://web.centanet.com/findproperty/) and Midland Reality (http://www.midland.com.hk/chi/). For the Shanghai property rental market, the data source is Koofang (http://shanghai.koofang.com/), while for the Taipei property rental market, the data sources are Happyrent (http://happyrent.rakuya.com.tw/) and Twhouses (http://www.twhouses.com.tw/).

[9] The metro systems in Hong Kong, Shanghai and Taipei are Mass Transit Railway, Shanghai Metro and Taipei Rapid Transit System, respectively.

[10] In Shanghai and Taipei, since the property information shown on the real estate websites is not well organized, the information on the property estate is always missing, while only the street name and number of the property can be found. Therefore, it is not feasible to identify the property estate information on the observations in these two cities. However, the property estate information can be found on the real estate websites in Hong Kong, and the observations in Hong Kong are obtained from 76 property estates.

[11] In the Shanghai and Taipei property rental markets, only the bid information is available, so the bid price on the property rental is used to estimate the actual property rental price.

[12] High-income people living in luxury property use the metro instead of driving as their basic commuting mode because car parks are limited in CBDs, while traffic jams during peak hours also induce most of the high-income group people to take the metro to work.

market is available, a specific model is constructed for Hong Kong, while a comparative model with fewer specified parameters is used for the markets in Shanghai and Taipei where there is less information.

3.1 Specific Model

The specific model is constructed as follows:

$$\begin{aligned} price_i = {} & \beta_1 + \beta_2 age_i + \beta_3 age_i^2 + \beta_4 size_i + \beta_5 high_i + \beta_6 medium_i + \beta_7 time_i \\ & + \beta_8 FSD_i + \beta_9 DMI_i + \beta_{10} swire_i + \beta_{11} sunhungkai_i + \beta_{12} newworld_i \\ & + \beta_{13} hendersonland_i + \beta_{14} hutchison_i + \beta_{15} hanglung_i + \beta_{16} cheungkong_i \\ & + \beta_{17} hopewell_i + \varepsilon_i \end{aligned} \tag{2}$$

where *price* denotes the property rental price

age denotes the property age

size denotes the property size

high is the dummy variable for high floor

medium is the dummy variable for medium floor

time denotes the travel time from the property to the CBD via the railway systems

FSD is the dummy variable for famous school district

DMI denotes the district median income

swire is the dummy variable for the Swire Group

sunhungkai is the dummy variable for Sun Hung Kai Properties Ltd.

newworld is the dummy variable for New World Development Co. Ltd.

hendersonland is the dummy variable for Henderson Land Development Co. Ltd.

hutchison is the dummy variable for Hutchison Whampoa Ltd.

hanglung is the dummy variable for Hang Lung Holdings Ltd.

cheungkong is the dummy variable for Cheung Kong Holdings Ltd.

hopewell is the dummy variable for Hopewell Holdings Ltd.

The variable age^2 is added to capture the non-linear age effect on the property rental price.

The floor dummy variables, *high* and *medium*, are used to demarcate the general height of the floor instead of using the exact floor number.

The "famous school effect" must be accounted for because the residential location of students is an important factor in school admissions. Living in districts within the vicinity of prestigious schools generates a greater chance for the children therein to be accepted into that school, which affects property price. As a result, the famous school ratio is applied to differentiate districts with more of these schools. The ratio is defined as follows:

$$Famous\ \ school\ \ ratio = \frac{Number\ \ of\ \ band\ one\ \ schools\ \ in\ \ that\ \ district}{Total\ \ number\ of\ \ schools\ \ in\ \ that\ \ district} \quad (3)$$

[13]

Table 1 presents the famous school ratio of all 18 districts in Hong Kong. The top four districts with the highest famous school ratios are Central and Western, Wan Chai, Yau Tsim Mong and Kowloon City, with ratios higher than 1/3. The famous school district (*FSD*) equals one if the property is located in one of these four districts and zero otherwise.

The district median income[14] (*DMI*) denotes the median monthly domestic household income in each district, which only covers the households in private properties. The *DMI* is applied to measure the wealth effect in different districts, as the household income and purchasing power vary among districts.

In this paper, eight dummy variables are used to capture the developer effect.[15] Table 2 presents the summary statistics of the three data sets.

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[13] In Hong Kong, there are three bandings that represent the ranking of secondary schools, with band one schools being the most prestigious and considered to be famous schools.

[14] The 2010 data on the median monthly domestic household income can be obtained from the Hong Kong Census and Statistics Department.

[15] The eight major property companies referred to are the Swire Group, Sun Hung Kai Properties Ltd., New World Development Co. Ltd., Henderson Land Development Co. Ltd., Hutchison Whampoa Ltd., Hang Lung Holdings Ltd., Cheung Kong Holdings Ltd. and Hopewell Holdings Ltd.

3.2 Comparative Model

The major regressors remain in the comparative model to evaluate the property rental markets in those three cities; however, the minor regressors in Shanghai and Taipei markets are removed because of insufficient information. The comparative model is constructed as follows:

$$price_i = \beta_1 + \beta_2 age_i + \beta_3 age_i^2 + \beta_4 size_i + \beta_5 floor_i + \beta_6 time_i + \varepsilon_i \quad (4)$$

Information on the exact property floor number in the Shanghai and Taipei property rental markets is available. The *floor* variable in the above model denotes the corresponding floor number of the rental property. For the property rental market in Hong Kong, floor dummy variables are used instead to measure the effect of the floor on which the property is located.

Tables 3 to 5 show the summary statistics of the three data sets in the comparative models in Hong Kong, Shanghai and Taipei, respectively.

3.3 Estimation of the Household Time Value and the Household Shadow Wage

The regression coefficient for travel time (β_7 in the specific model for Hong Kong or β_6 in the comparative models for Shanghai and Taipei) is estimated. This time coefficient measures the additional property rental price that the households are willing to pay in order to live closer to the CBD, and for every minute saved on travel per month.

For Hong Kong,

$$\frac{\beta_7}{\text{average working days per month} \times 2} = \text{transportation cost} + \text{household time value} \quad (5)$$

whereas for Shanghai and Taipei,

$$\frac{\beta_6}{\text{average working days per month} \times 2} = \text{transportation cost} + \text{household time value} \quad (6)$$

In Equations (5) and (6), the time coefficient is divided by the average working days per month to measure the time coefficient per day instead of per month. Specifically, the average working days per month of the people in Hong Kong, Shanghai and Taipei are 25, 21.75 and 22.4 days, respectively.[16] The coefficient is also divided by two, as the travel time accounts for a round trip. The left-hand side of Equations (5) and (6) indicates how much a household is willing to pay, which comprises the transportation cost and household time value, in order to save a minute of travel time.

In Equation (7), transportation cost[17] is calculated as the mean of the traveling cost divided by the travel time from each station to the CBD.

$$\text{Transportation cost} = \text{mean}\left(\frac{\text{traveling cost}}{\text{travel time}}\right) \quad (7)$$

Since the information on the number of family members per household is unavailable, the time value, shadow wage and estimated monthly income from the time coefficients are calculated on a household basis. The household time value can be obtained by deducting the transportation cost from the left-hand side of Equations (5) and (6). The obtained household time value is calculated on a minute basis. The household time value is multiplied by 60 in order to measure the household shadow wage on an hourly basis, as shown in Equation (8):

$$\text{Household shadow wage} = 60 \times \text{household time value} \quad (8)$$

[16] The average working days for Hong Kong, Shanghai and Taipei are obtained from the Hong Kong Census and Statistics Department, the General Office of the State Council of the People's Republic of China and the Council of Labour Affairs in Taiwan, respectively.

[17] Information on the transportation cost is obtained from the Hong Kong Mass Transit Railway, Shanghai Metro and Taipei Rapid Transit System, respectively.

In Equation (9), the monthly household income can be estimated by multiplying the household shadow wage by the average working days per month and the average working hours per day.

$$\begin{aligned}\text{Estimated monthly household income} = {} & \text{household shadow wage} \\ & \times \text{average working days per month} \\ & \times \text{average working hours per day}\end{aligned} \qquad (9)$$

The average working hours per day of residents from Hong Kong, Shanghai and Taipei are 8.6, 8 and 8.2 hours, respectively.[18] Data on the transportation cost, average working days per month and average working hours per day in the three cities are presented in Table 6.

4: Results

The results of the specific model and the comparative model are shown in Sections 4.1 and 4.2, respectively.

4.1 Results of the Specific Model

Table 7a illustrates the estimation results for all three data sets of the specific model in Hong Kong. To check for robustness, we also estimate a model without the developer dummies in Table 7b. The estimated time coefficients are close to those in Table 7a. The coefficients for the time variables in all three data sets are statistically significant at the 1% level. A negative sign indicates a negative relation between the property rental price and the travel time between the property and the CBD, i.e., the shorter the travel time, the higher the property rental price. This finding confirms the hypothesis made in this paper and the results obtained by Tang (1975), and Tse and Chan (2003). The willingness of households to save travel time to and from the CBD by paying a higher rent to live in a property closer to the CBD is shown in the coefficients.

[18] Information on the average working hours per day in Hong Kong, Shanghai and Taipei is obtained from the Hong Kong Census and Statistics Department, the General Office of the State Council of the People's Republic of China and the Council of Labour Affairs in Taiwan, respectively.

The coefficients of the travel time required to arrive at the CBD indicate how much per month a household residing in private properties is willing to pay in order to save a minute of their travel time per month. From Table 7a, the time coefficients in the all-property data set, small and mid-size property data set, and luxury property data set are -145.6, -147 and -392.4, respectively. This shows that for the all-property data set, households in private properties are willing to pay HK$145.6 each month, on average, in order to save a minute of their travel time, or around HK$2912 (HK$145.6x20) more to stay in a property that reduces travel to the CBD by 20 minutes. Similarly, by using the time coefficients for the small and mid-size property data set and the luxury property data set, it is shown that households are willing to pay an additional sum of HK$2940 (HK$147x20) and HK$7848 (HK$392.4x20), respectively, for a property where it takes 20 minutes less to travel to the CBD.

Given that the average working days per month and the transportation cost per minute in Hong Kong are 25 days and HK$0.5556, respectively, Equation (5) can be used to calculate the time value and the shadow wage of Hong Kong households in the three data sets. Based on the all-property data set in Hong Kong, the household time value is HK$2.36 per minute, so the household shadow wage is on average HK$141 per hour. By multiplying the average working days per month and the average working hours per day, the estimated monthly income of a household living in private property is HK$30,398.

The regressors, *age* and age^2, are added to obtain the quadratic shape of the property age effect on the property rental price. As shown in Table 7a, the values of β_3, which are all significant at the 1% level, are negative in all three data sets. β_3 also shows an inverse U-shape relation between the property rental price and property age. In other words, properties built in an earlier period affect the rental price positively, whereas properties built later have a negative impact on the rental price. One explanation for the inverse U shape is that the usable area of newly constructed properties has declined significantly in recent years and is less preferred by households, while older properties with larger usable areas are favored. As a result, the property rental price increases in relation to increasing property age at an early stage. However, when the property is too old, the quality of the property is perceived to have declined, and the

safety of the property is questioned. The turning point is when the perceived value of property starts to decline, which triggers a rental price downfall. The turning point can be obtained by setting $age = -\frac{\beta_2}{2\beta_3}$. As shown in Table 7 and Equation (11), the turning points of property age in the all-property data set, small and mid-size property data set, and luxury property data set are 20.9 years, 20.6 years and 15.4 years, respectively.

Table 8 displays the travel time coefficient, household time value, household shadow wage and the estimated monthly household income of all three data sets in Hong Kong. Similar results can be obtained in the luxury property market in which the household time value, household shadow wage and estimated monthly household income are HK$7.29 per minute, HK$437.54 per hour and HK$94,072 per month, respectively. The household shadow wage and monthly household income in different data sets can thus be estimated.

4.2 Results of the Comparative Model

Tables 9 to 11 show the estimation results of the comparative models of all three data sets in Hong Kong, Shanghai and Taipei, respectively. Similar to the specific model, the time variables of all three data sets in the comparative models of the three cities are 99% statistically significant.

The relevant coefficients shown in Tables 9 to 11 illustrate the effect of property age on the property rental markets in Hong Kong, Shanghai and Taipei. Only the cases of the Hong Kong and Taipei markets are presented because that of Shanghai is not significant at the 10% level. For Hong Kong, the relation between the property rental price and the property age remains an inverse U shape. However, the turning point appears at 19.36 years rather than 20.9 years in the specific model in Equation (11).[19] The travel time coefficient, household time value, household shadow wage

[19] The property rental market in Taipei exhibits characteristics exactly opposite to those of its Hong Kong counterpart: the former shows a U-shape relation between the property rental price and property age. In other words, the property age affects the property rental price negatively during the early stage

and estimated monthly household income of all three data sets in the comparative model in the three cities are calculated and listed in Table 12.

Note that the coefficient of the time variable for Hong Kong in Table 7a is -145.6 in the specific model and -256.1 in the comparative model. The estimated coefficient of TIME of the specific model should be more precise than the one from the comparative model because more variables are used in the former. To check for robustness, we also estimate a model without the developer dummies in Table 7b. The estimated time coefficients are close to those in Table 7a, suggesting that there is no multicollinearity among the developer dummies and other variables. Since fewer regressors are included in the comparative model, we only use the result of the comparative model for comparison among the three cities. The ratio, as opposed to the absolute number, is the focus in the comparative model. In particular, the estimated coefficient of the comparative model is mainly used to identify the ratio of the time values of citizens in the three places. Taking the whole property data set as an example, the time values are presented in Table 12. The time value ratio of the households in Hong Kong, Shanghai and Taipei is approximately 2.25: 1: 1.61. This ratio indicates that approximately 1.61 and 2.25 times more rent have to be paid in Taipei and Hong Kong than in Shanghai, respectively, for living closer to the CBD. Among these three cities, the value of travel time is highest for people living in Hong Kong, because they are willing to pay more to live closer to the CBD.

The household shadow wage ratio among the three cities remains at 2.25: 1: 1.61, as it is obtained by multiplying the corresponding household time value by a fixed number, 60, for all three cities. Nevertheless, the estimated monthly household income ratio is 2.78: 1: 1.70, as the two key components, the average working days per month and the average working hours per day, vary among the three cities. Therefore, the estimated monthly household income of Hong Kong and Taipei is 2.78

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but positively at a later stage. The negative relation before the turning point in this U-shape pattern can be explained by households who prefer newer flats to other similar-quality properties. The positive relation after the turning point in the U-shape pattern of the Taipei market can be explained by the proximity of the properties constructed during earlier decades to the CBD. Households prefer these earlier-constructed properties due to their location. Consequently, property rental prices start to increase when the property age reaches the turning point. Taking the all-property data set as an example, the turning points of property age in the Hong Kong and Taipei markets are 19.36 and 21.61 years, respectively.

and 1.70 times that of Shanghai, respectively. In order to verify the validity of this ratio, the ratio is then used to compare with different salary indexes of these cities. Table 13 illustrates the average salary levels of various occupational sectors.[20] The salary comparison ratios of the selected occupational sectors in the three cities are then calculated based on the salary information in Table 13 and the resulting ratios are presented in Table 14. Tables 13 and 14 show that among the three cities, when comparing the same sector, Hong Kong has the highest salaries on average and Shanghai has the lowest. The salary comparison ratios are consistent with the estimated monthly household income ratio and reflect the general situations in Hong Kong, Shanghai and Taipei.

5: Conclusion

The central business district (CBD), where most of the commercial offices are located, plays a critical role in the economic development of a city. Most people prefer to live close to the CBD to save on commuting cost and time. Since the rent that an individual is willing to pay depends on the value of the time saved from shortening their commute, the distance between the property and the CBD is an important determinant of property rental rate. The closer a property is to the CBD, the higher its rental value. This paper examines how the rental differential between two locations in a metropolis is determined by the time value of a household. The rental information on properties atop or adjacent to the railway stations in the CBDs of Hong Kong, Shanghai and Taipei is analyzed. Compared with alternative public transportation modes, the railway schedule provides the most accurate information on commuting time for research purposes. Our empirical results support the relationship between commuting time to the CBD and the rent of a residential property. All the time coefficients under the specific model for Hong Kong and the comparative model for Hong Kong, Shanghai and Taipei are found to be statistically significant at the 1% level. The time value, shadow wage and monthly income of the

[20] Occupational sectors consist of university graduate, police, teacher, information technology, logistics and shipping, design, manufacturing, engineering, real estate and property, and food and beverage. The salary information on civil servants such as police is from the corresponding government salary index tables of the three cities. The salary information on the remaining occupational sectors is from Centaline Human Resources Consultants Limited and Classified Post in Hong Kong, Baicai Recruitment Agent in Shanghai and the 1111 Job Bank in Taipei.

households in these three cities can be recovered from our models. It is found that the time value ratio of the households in Hong Kong, Shanghai and Taipei is about 2.25: 1: 1.61. The estimated level of the shadow wage in the three cities and their respective ratios are consistent with the empirical data, which provide evidence that the rental price differential between two locations in a metropolis is a reflection of the total value of the commuting time differential. For future research along this line, one may include other major Asian cities where public transportation is the main mode of commuting and cities with multiple CBDs. Finally, as different income groups perceive time value differently, the threshold model of Hansen (2000) may be used to analyze whether there is an income level above which the coefficient of the time variable will have a substantial increase.

Table 1: Famous school ratios of 18 districts in Hong Kong

Districts	Famous school ratio
Central and Western	0.6364
Wan Chai	0.5385
Yau Tsim Mong	0.4000
Kowloon City	0.3871
Sha Tin	0.3158
North	0.3000
Eastern	0.2903
Sham Shui Po	0.2727
Tsuen Wan	0.2308
Tai Po	0.2273
Kwai Tsing	0.2258
Tuen Mun	0.2162
Yuen Long	0.2000
Kwun Tong	0.1935
Sai Kung	0.1905
Wong Tai Sin	0.1818
Islands	0.1250
Southern	0.0714

Note: Famous school ratio is a ratio between 0 and 1, which is calculated by dividing the number of band one schools in that district by the total number of schools in that district.

Data source: Schooland (http://www.schooland.hk/ss/).

Table 2: Summary statistics of the three data sets in the specific model in Hong Kong

Variable (unit)	Mean			Std. Dev.			Min			Max		
	All	S & M	Luxury	All	S & M	Luxury	All	S & M	Luxury	All	S & M	Luxury
price (HK$)	13727.8	12448.9	22161.9	6303.44	4057.42	10577.8	1500	1500	8000	82000	40000	82000
age (year)	14.0460	14.9533	8.0629	10.6078	10.3860	10.1338	1	1	1	36	36	36
age^2	309.713	331.356	166.986	353.650	348.105	357.961	1	1	1	1296	1296	1296
size (sqft)	741.930	667.674	1231.601	258.847	169.980	205.407	292	292	1007	2416	999	2416
high	0.4742	0.4634	0.5455	0.4996	0.4989	0.4997	0	0	0	1	1	1
medium	0.2459	0.2460	0.2448	0.4308	0.4309	0.4315	0	0	0	1	1	1
time (min)	29.2947	29.4199	28.4685	9.9654	9.9150	10.2887	3	3	3	54	54	50
FSD	0.0783	0.0636	0.1748	0.2687	0.2442	0.3812	0	0	0	1	1	1
DMI	27771.9	27712.6	28162.9	5660.20	5536.05	6427.09	18000	18000	18000	33600	33600	33600
swire	0.0654	0.0594	0.1049	0.2473	0.2365	0.3075	0	0	0	1	1	1
sunhungkai	0.1446	0.1400	0.1748	0.3518	0.3471	0.3812	0	0	0	1	1	1
newworld	0.0359	0.0286	0.0839	0.1862	0.1669	0.2782	0	0	0	1	1	1
hendersonland	0.0046	0.0042	0.0070	0.0677	0.0650	0.0836	0	0	0	1	1	1
hutchison	0.0276	0.0318	0.0000	0.1640	0.1756	0.0000	0	0	0	1	1	0
hanglung	0.0746	0.0742	0.0769	0.2628	0.2623	0.2674	0	0	0	1	1	1
cheungkong	0.1667	0.1919	0.0000	0.3729	0.3940	0.0000	0	0	0	1	1	0
hopewell	0.0414	0.0477	0.0000	0.1994	0.2133	0.0000	0	0	0	1	1	0

Note: "All" refers to the all property data set, "S & M" refers to the small and mid-size property data set, and "Luxury" refers to the luxury property data set. Price denotes the property rental price; Age denotes the property age; Size denotes the property size; High is the dummy variable for high floor; Medium is the dummy variable for medium floor; Time denotes the travel time from the property to the CBD via the railway systems; FSD is the dummy variable for famous school district; DMI denotes the district median income; the remaining variables under DMI are all property company dummy variables; Swire for Swire Group; Sunhungkai for Sun Hung Kai Properties Ltd.; Newworld for New World Development Co. Ltd.; Hendersonland for Henderson Land Development Co. Ltd.; Hutchison for Hutchison Whampoa Ltd.; Hanglung for Hang Lung Holdings Ltd.; Cheungkong for Cheung Kong Holdings Ltd.; Hopewell for Hopewell Holdings Ltd.

Data Sources: Centaline Property (http://web.centanet.com/findproperty/) and Midland Reality (http://www.midland.com.hk/chi/).

Table 3: Summary statistics of the three data sets in the comparative model in Hong Kong

Variable (unit)	Mean			Std. Dev.			Min			Max		
	All	S & M	Luxury	All	S & M	Luxury	All	S & M	Luxury	All	S & M	Luxury
price (HK$)	13727.8	12448.9	22161.9	6303.44	4057.42	10577.8	1500	1500	8000	82000	40000	82000
age (year)	14.0460	14.9533	8.0629	10.6078	10.3860	10.1338	1	1	1	36	36	36
age^2	309.713	331.356	166.986	353.650	348.105	357.961	1	1	1	1296	1296	1296
size (sqft)	741.930	667.674	1231.601	258.847	169.980	205.407	292	292	1007	2416	999	2416
high	0.4733	0.4624	0.5455	0.4995	0.4988	0.4997	0	0	0	1	1	1
medium	0.2477	0.2481	0.2448	0.4319	0.4322	0.4315	0	0	0	1	1	1
time (min)	29.2947	29.4199	28.4685	9.9654	9.9150	10.2887	3	3	3	54	54	50

Note: "All" refers to the all property data set, "S & M" refers to the small and mid-size property data set, and "Luxury" refers to the luxury property data set. Price denotes the property rental price; Age denotes the property age; Size denotes the property size; High is the dummy variable for high floor; Medium is the dummy variable for medium floor; Time denotes the travel time from the property to the CBD via the railway systems.

Data Sources: Centaline Property (http://web.centanet.com/findproperty/) and Midland Reality (http://www.midland.com.hk/chi/).

Table 4: Summary statistics of the three data sets in the comparative model in Shanghai

Variable (unit)	Mean			Std. Dev.			Min			Max		
	All	S & M	Luxury	All	S & M	Luxury	All	S & M	Luxury	All	S & M	Luxury
price (HK$)	6152.29	3465.06	8830.27	6453.54	2181.01	8004.74	534.825	534.825	534.825	85572	27335.5	85572
age (year)	8.7220	10.6306	6.8200	5.7137	6.8503	3.3462	0	0	0	83	83	23
age^2	108.701	159.883	57.696	206.879	277.922	57.507	0	0	0	6889	6889	529
size (sqft)	1044.20	657.624	1429.44	515.342	220.979	429.184	107.64	107.64	1001.05	4929.91	990.288	4929.91
floor	9.8093	7.2670	12.3429	8.0998	6.2522	8.9012	1	1	1	53	45	53
time (min)	29.3510	32.5167	26.1961	18.2652	17.3524	18.6128	0	0	0	81	81	81

Note: "All" refers to the all property data set, "S & M" refers to the small and mid-size property data set, and "Luxury" refers to the luxury property data set.
Price denotes the property rental price; Age denotes the property age; Size denotes the property size; Floor denotes the corresponding floor number of the rental property; Time denotes the travel time from the property to the CBD via the railway systems.
For easy comparison, the property rental prices of the Shanghai market are converted to Hong Kong dollars by multiplying their average exchange rate from January 2011 to March 2011, whereas the size unit of Shanghai properties is converted from square meters to square feet.
Data Source: Koofang (http://shanghai.koofang.com/).

Table 5: Summary statistics of the three data sets in the comparative model in Taipei

Variable (unit)	Mean			Std. Dev.			Min			Max		
	All	S & M	Luxury	All	S & M	Luxury	All	S & M	Luxury	All	S & M	Luxury
price (HK$)	9251.25	7785.32	10387.9	3564.88	2456.10	3865.60	2147.2	2147.2	3489.2	25498	17446	25498
age (year)	14.2231	12.4167	15.6237	9.2206	9.5759	8.6899	1	1	1	50	39	50
age^2	287.220	245.636	319.463	306.089	312.195	297.602	1	1	1	2500	1521	2500
size (sqft)	1137.51	836.482	1370.92	340.548	116.590	265.615	286.654	286.654	1002.222	2489.55	999.377	2489.55
floor	6.2128	7.0462	5.5467	3.8668	4.3288	3.3336	1	1	0	26	26	22
time (min)	12.7503	13.4923	12.1750	7.8851	8.6196	7.2211	0	0	0	45	45	45

Note: "All" refers to the all property data set, "S & M" refers to the small and mid-size property data set, and "Luxury" refers to the luxury property data set.
Price denotes the property rental price; Age denotes the property age; Size denotes the property size; Floor denotes the corresponding floor number of the rental property; Time denotes the travel time from the property to the CBD via the railway systems.
For easy comparison, the property rental prices of the Taipei market are converted to Hong Kong dollars by multiplying their average exchange rate from January 2011 to March 2011, whereas the size unit of Taipei properties is converted from pyeong to square feet.
Data Sources: Happyrent (http://happyrent.rakuya.com.tw/) and Twhouses (http://www.twhouses.com.tw/).

Table 6: Summary of transportation cost, average working days per month, and average working hours per day

	Hong Kong	Shanghai	Taipei
Transportation cost (HK$/min)	0.5556	0.1875	0.4383
Average working days per month	25	21.75	22.4
Average working hours per day	8.6	8	8.2

Note: The transportation cost is calculated as the mean of the traveling cost divided by the travel time from each station to the CBD.
The transportation costs in Shanghai and Taipei are converted to Hong Kong dollars by multiplying their average exchange rates from January 2011 to March 2011.

Data Sources: Transportation cost: Hong Kong Mass Transit Railway, Shanghai Metro and Taipei Rapid Transit System, respectively.
Average working days per month and average working hours per day: Hong Kong Census and Statistics Department, the General Office of the State Council of the People's Republic of China and the Council of Labour Affairs in Taiwan.

Table 7a: Estimation results of the three data sets in the specific model for Hong Kong

Variable (unit)	Hong Kong		
	All property data set	Small and mid-size property data set	Luxury property data set
age (year)	509.6***	353.0***	1106***
	(40.53)	(30.77)	(218.8)
age^2	-12.22***	-8.566***	-35.80***
	(1.18)	(0.869)	(7.479)
size (sqft)	19.15***	16.24***	30.93***
	(0.468)	(0.556)	(2.296)
high	483.8**	404.7**	2627**
	(226.6)	(160.5)	(1,241)
medium	577.4**	299.8	3321**
	(261.2)	(185.2)	(1,452)
time (min)	-145.6***	-147.0***	-392.4***
	(12.32)	(8.798)	(122.7)
FSD	6985***	5296***	-2511
	(474.4)	(350.2)	(5,999)
DMI	-0.035	-0.0159	-0.690**
	(0.0226)	(0.0156)	(0.312)
swire	910.0**	791.5**	6823***
	(458.4)	(340.9)	(2,247)
sunhungkai	738.9**	124.5	-710.5
	(326.7)	(250.4)	(1,753)
newworld	-1056*	-46.85	-13722***
	(579.5)	(437.6)	(3,429)

Variable (unit)	Hong Kong		
	All property data set	Small and mid-size property data set	Luxury property data set
hendersonland	3477**	2462**	-1361
	(1423)	(1069)	(6408)
hutchison	-506.8	-35.95	0
	(665.1)	(448.5)	(0)
hanglung	1916***	-99.36	3492
	(569.7)	(455)	(2413)
cheungkong	1076***	659.8***	0
	(306)	(208.8)	(0)
hopewell	-1426**	392.6	0
	(722.5)	(534.5)	(0)
Constant	78.06	3125***	10241
	(973.5)	(820.2)	(13804)
Observations	1086	943	143
R-squared	0.767	0.75	0.787

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: Age denotes the property age; Size denotes the property size; High is the dummy variable for high floor; Medium is the dummy variable for medium floor; Time denotes the travel time from the property to the CBD via the railway systems; FSD is the dummy variable for famous school district; DMI denotes the district median income; the remaining variables under DMI are all property company dummy variables; Swire for Swire Group; Sunhungkai for Sun Hung Kai Properties Ltd.; Newworld for New World Development Co. Ltd.; Hendersonland for Henderson Land Development Co. Ltd.; Hutchison for Hutchison Whampoa Ltd.; Hanglung for Hang Lung Holdings Ltd.; Cheungkong for Cheung Kong Holdings Ltd.; Hopewell for Hopewell Holdings Ltd.

Data Sources: Centaline Property (http://web.centanet.com/findproperty/) and Midland Reality (http://www.midland.com.hk/chi/).

Table 7b: Estimation results of the three data sets in the specific model (property company dummy variables are excluded) for Hong Kong

	Hong Kong		
Variable (unit)	**All property data set**	**Small and mid-size property data set**	**Luxury property data set**
age (year)	557.1***	361.0***	1,210***
	(38.26)	(29.12)	(167.6)
age^2	-13.62***	-8.908***	-30.73***
	(1.092)	(0.818)	(4.904)
size (sqft)	18.86***	15.78***	30.98***
	(0.454)	(0.518)	(2.421)
high	479.4**	428.6***	1442
	(228.9)	(161.1)	(1253)
medium	564.3**	294.5	2541*
	(263.9)	(185.8)	(1450)
time (min)	-162.3***	-149.5***	-382.1***
	(11.20)	(7.863)	(112.9)
FSD	6680***	5039***	7718*
	(452.3)	(329.6)	(4509)
DMI	-0.0367*	-0.0216	0.0184
	(0.0216)	(0.0148)	(0.202)
Constant	1,014	3872***	-13011
	(901.2)	(726.1)	(9434)
Observations	1086	943	143
R-squared	0.758	0.744	0.745

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: Age denotes the property age; Size denotes the property size; High is the dummy variable for high floor; Medium is the dummy variable for medium floor; Time denotes the travel time from the property to the CBD via the railway systems; FSD is the dummy variable for famous school district; DMI denotes the district median income.

Data Sources: Centaline Property (http://web.centanet.com/findproperty/) and Midland Reality (http://www.midland.com.hk/chi/).

Table 8: Summary of the travel time coefficient, household time value, household shadow wage, and the estimated monthly household income in all three data sets for Hong Kong

	Hong Kong		
	All property data set	**Small and mid-size property data set**	**Luxury property data set**
Coefficient of travel time	-145.6	-147.0	-392.4
Household time value (HK$/min)	2.3564	2.3844	7.2924
Household shadow wage (HK$/hr)	141.4	143.1	437.5
Estimated monthly household income (HK$/month)	30397.56	30758.76	94071.96

Note: The household shadow wage is calculated by multiplying household time value by 60. The monthly household income is estimated by multiplying the household shadow wage by the average working days per month and the average working hours per day.

Table 9: Estimation results of the all property data set in the comparative model

Variable (unit)	Hong Kong	Shanghai	Taipei
age (year)	648.3***	-46.76	-312.6***
	(42.53)	(31.83)	(31.65)
age^2	-16.74***	1.147	7.231***
	(1.208)	(0.808)	(0.946)
size (sqft)	19.40***	7.736***	5.700***
	(0.509)	(0.218)	(0.267)
floor	high: 532.0**	62.38***	58.50**
	(257.5)	(14.53)	(23.68)
	medium: 430.3		
	(296.3)		
time (min)	-256.1***	-96.31***	-166.0***
	(10.81)	(6.455)	(11.53)
Constant	2559***	571.9	6889***
	(711.2)	(520.3)	(441.8)
Observations	1086	1741	893
R-squared	0.693	0.595	0.458

Standard errors in parentheses

***p<0.01, **p<0.05,*p<0.1

Note: Age denotes the property age; Size denotes the property size; High is the dummy variable for high floor; Medium is the dummy variable for medium floor; Time denotes the travel time from the property to the CBD via the railway systems.
For easy comparison, the property rental prices of the Shanghai and Taipei markets are converted to Hong Kong dollars by multiplying their average exchange rates from January 2011 to March 2011, whereas the size unit of Shanghai properties is converted from square meters to square feet, and that of Taipei properties is converted from pyeong to square feet.

Data Sources: Hong Kong: Centaline Property (http://web.centanet.com/findproperty/) and Midland Reality (http://www.midland.com.hk/chi/); Shanghai: Koofang (http://shanghai.koofang.com/); Taipei: Happyrent (http://happyrent.rakuya.com.tw/) and Twhouses (http://www.twhouses.com.tw/).

Table 10: Estimation results of the small and mid-size property data set in the comparative model

Variable (unit)	Hong Kong	Shanghai	Taipei
age (year)	398.7***	-73.36***	-275.0***
	(33.14)	(15.33)	(36.37)
age^2	-10.41***	0.683**	6.303***
	(0.928)	(0.337)	(1.114)
size (sqft)	15.38***	3.074***	4.056***
	(0.591)	(0.264)	(0.871)
floor	high: 454.0**	66.82***	30.72
	(184.2)	(10.09)	(23.94)
	medium: 183.1		
	(211.7)		
time (min)	-205.9***	-63.11***	-132.6***
	(8.018)	(3.723)	(11.86)
Constant	5469***	3681***	7831***
	(660.2)	(321)	(756.8)
Observations	943	869	390
R-squared	0.665	0.451	0.361

Standard errors in parentheses

***p<0.01, **p<0.05,*p<0.1

Note: Age denotes the property age; Size denotes the property size; High is the dummy variable for high floor; Medium is the dummy variable for medium floor; Time denotes the travel time from the property to the CBD via the railway systems.
For easy comparison, the property rental prices of the Shanghai and Taipei markets are converted to Hong Kong dollars by multiplying their average exchange rates from January 2011 to March 2011, whereas the size unit of Shanghai properties is converted from square meters to square feet, and that of Taipei properties is converted from pyeong to square feet.

Data Sources: Hong Kong: Centaline Property (http://web.centanet.com/findproperty/) and Midland Reality (http://www.midland.com.hk/chi/); Shanghai: Koofang (http://shanghai.koofang.com/); Taipei: Happyrent (http://happyrent.rakuya.com.tw/) and Twhouses (http://www.twhouses.com.tw/).

Table 11: Estimation results of the luxury property data set in the comparative model

Variable (unit)	Hong Kong	Shanghai	Taipei
age (year)	1262***	-149.2	-340.8***
	(160.1)	(163.3)	(48.74)
age^2	-35.37***	-4.99	7.844***
	(4.507)	(9.344)	(1.417)
size (sqft)	31.75***	11.84***	6.239***
	(2.448)	(0.41)	(0.513)
floor	high: 1313	63.55***	99.02**
	(1271)	(21.42)	(41.38)
	medium: 2451*		
	(1460)		
time (min)	-633.7***	-120.1***	-202.0***
	(48.7)	(10.92)	(19.50)
Constant	-4486	-4431***	6564***
	(3675)	(1096)	(935.0)
Observations	143	872	503
R-squared	0.731	0.619	0.396

Standard errors in parentheses

***p<0.01, **p<0.05,*p<0.1

Note: Age denotes the property age; Size denotes the property size; High is the dummy variable for high floor; Medium is the dummy variable for medium floor; Time denotes the travel time from the property to the CBD via the railway systems.
For easy comparison, the property rental prices of the Shanghai and Taipei markets are converted to Hong Kong dollars by multiplying their average exchange rates from January 2011 to March 2011, whereas the size unit of Shanghai properties is converted from square meters to square feet, and that of Taipei properties is converted from pyeong to square feet.

Data Sources: Hong Kong: Centaline Property (http://web.centanet.com/findproperty/) and Midland Reality (http://www.midland.com.hk/chi/); Shanghai: Koofang (http://shanghai.koofang.com/); Taipei: Happyrent (http://happyrent.rakuya.com.tw/) and Twhouses (http://www.twhouses.com.tw/).

Table 12: Summary of the travel time coefficient, household time value, household shadow wage, and the estimated monthly household income in all three data sets for Hong Kong, Shanghai, and Taipei

		Hong Kong	Shanghai	Taipei
All property data set	**Coefficient of travel time**	-256.10	-96.31	-166.00
	Household time value (HK$/min)	4.57	2.03	3.27
	Household shadow wage (HK$/hr)	273.98	121.59	196.02
	Estimated monthly household income (HK$/month)	58906.56	21156.90	36005.58
Small and mid-size property data set	**Coefficient of travel time**	-205.90	-63.11	-132.60
	Household time value (HK$/min)	3.56	1.26	2.52
	Household shadow wage (HK$/hr)	213.74	75.80	151.29
	Estimated monthly household income (HK$/month)	45954.96	13188.90	27789.18
Luxury property data set	**Coefficient of travel time**	-633.70	-120.10	-202.00
	Household time value (HK$/min)	12.12	2.57	4.07
	Household shadow wage (HK$/hr)	727.10	154.41	244.24
	Estimated monthly household income (HK$/month)	156327.36	26866.50	44861.58

Note: The household shadow wage is calculated by multiplying household time value by 60. The monthly household income is estimated by multiplying the household shadow wage by the average working days per month and the average working hours per day.

Table 13: Comparison of the salary indexes of the 10 selected occupational sectors in Hong Kong, Shanghai and Taipei in 2010

	Hong Kong	Shanghai	Taipei
University Graduate	14300	3861	5736
Police	17250	4975	13301
Teacher	19945	5437	12092
Information Technology	13000	6708	7630
Logistics and Shipping	15000	4856	7563
Design	17000	7069	9141
Manufacturing	12000	6393	7671
Engineering	18000	7357	9818
Real Estate and Property	18000	8685	9507
Food and Beverage	10000	4982	6348

Note: The salary indexes of Shanghai and Taipei are converted to Hong Kong dollar for easy comparison.

Data Sources: Civil servants of the three cities: the corresponding government salary index tables;
The remaining occupational sectors of the three cities: Hong Kong: Centaline Human Resources Consultants Limited and Classified Post; Shanghai: Baicai Recruitment Agent; Taipei: 1111 Job Bank.

Table 14: Salary comparison ratios of the 10 selected occupational sectors in Hong Kong, Shanghai and Taipei in 2010

	Hong Kong	Shanghai	Taipei
University Graduate	3.70	1	1.49
Police	3.47	1	2.67
Teacher	3.67	1	2.22
Information Technology	1.94	1	1.14
Logistics and Shipping	3.09	1	1.56
Design	2.40	1	1.29
Manufacturing	1.88	1	1.20
Engineering	2.45	1	1.33
Real Estate and Property	2.07	1	1.09
Food and Beverage	2.01	1	1.27

Note: The salary indexes of Shanghai and Taipei are converted to Hong Kong dollar for easy comparison.

Data Sources: Civil servants of the three cities: the corresponding government salary index tables;
The remaining occupational sectors of the three cities: Hong Kong: Centaline Human Resources Consultants Limited and Classified Post; Shanghai: Baicai Recruitment Agent; Taipei: 1111 Job Bank.

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