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Abstract

Tse and Chan (2003) investigated the relationship between property sales price and value of commuting time. However, property sales price is subject to the inherent limitation that it includes speculative elements. A better measure to be used for such study should be the rent paid by the genuine end-user of the property. This paper examines how equilibrium rents in different locations in the Greater China area are determined by the time value, or the shadow wage, of an individual. Using the rental information, we provide a first estimate of the ratio of the time values of individuals in Hong Kong, Shanghai and Taipei. Our result shows 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.
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1: Introduction

Location is undoubtedly a key factor in determining the price of a property. The price of property 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 commuting time, or the shadow wage, of an individual. The main contribution of this paper to the literature is to deal with the nexus between property value and the shadow wage. Both property value and shadow wages have long been studied in the literature. For example, Stegman (1969) and Henderson (1977) examined environmental quality and location accessibility, as they are deemed to affect property price. Nelson (1978); So, Tse, and Ganesan (1997) examined the effect of transportation on property price. Mahan, Polasky, and Adams (2000) studied the relation of property price to urban air quality and wetlands separately.[3] Heckman (1974) examined 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 attempts to bring the two issues together and provide a new perspective to recover the shadow wage from the property rental value in three major cities in the Greater China area, namely, Hong Kong, Shanghai and Taipei. The rental value of a property depends mainly on two types of variables.

$$price = f(X, t) \tag{1}$$

where X is a vector representing the characteristics of the property such as property age, size, and floor number. Information on the property can be extracted directly

[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).

from the websites of real estate companies. Meanwhile, *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 as a measurement of 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. Finally, Section 5 concludes the paper and suggests future research directions.

2: Data

The residential property rental markets (referred to as the property rental market thereafter) 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 Greater China cities for two reasons: Firstly, they are densely populated; secondly, public transport systems, i.e., the railways and buses, are the major means of travel to the workplace. Since information on traveling time and fare of the railway systems is available on public transportation websites, a precise measurement of commuting time can be obtained easily. An additional reason for using the three Chinese cities is that cultural factors that affect the property market can be controlled for.

The CBDs in Hong Kong, Shanghai, and Taipei are examined in this paper individually.[5] To limit the complexity of this research, one single leading CBD was

[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 but 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 are located in Central such as IFC, while the offices of Hong Kong Monetary Authority and Hong Kong Exchanges and Clearing Limited are located in Central as well. For Shanghai, according to the website of 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

selected in each city (Central in Hong Kong, Lujiazui in Shanghai, and Xinyi in Taipei) based on the government's official recognition and the study of real estate consultants. A variety of the city's landmark buildings located in the selected district serves as a further proof of its leading role as a commercial district.

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

It is reasonable to assume that most people travel to the CBD by public transportation in Hong Kong and Shanghai, since private motor vehicle ownership in these two cities are at a relatively low level due to expensive and limited parking in the CBD, high gasoline taxes and import duties on motor vehicles.[6] In Taipei, private vehicle ownership is relatively high, with one out of four people owning a private car; and one out of two people, a motor cycle. Nevertheless, average daily ridership in the mass transit railway in all three cities is high.[7] Compared with alternative public transports systems, the railway has an advantage to provide more 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 our sample residents are those who are self-selected to live near the railway stations, it is not unreasonable to assume that these people choose to live near the railway stations for easy access to the CBD. Thus, our sample group has a much higher chance of working at CBD compared to others from other

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Tower. The Shanghai headquarters of the People's Bank of China and the office of 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 center of Taipei. (http://www.prweb.com/releases/2007/07/prweb542482.htm).

[6] In Hong Kong, there are 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)

parts of the city. This self-selected sample also eliminates the potential bias of people traveling by private vehicle, since people staying very close to railway stations are more likely to use public transport instead of driving.

As mentioned in Section 1, the information on vector *X* representing the characteristics of the property such as property age, size, and floor number is obtained from the websites of various real estate companies[8], whereas 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 1,086, 1,741, and 893 observations[10] in the property rental markets of Hong Kong, Shanghai, and Taipei are collected respectively.[11] The sample window is January 2011 to March 2011. The observations are classified into three data sets according to property size in order to measure the household situation in different private properties. The first data set, referred to as "all property data set", covers all observations in which private properties of all sizes are included. 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 less than 1,000 sq. ft. This data set is used to measure the situation of small and medium-sized properties in the three cities. In particular, 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 1,000 sq. ft. The "luxury property" set is used to measure the situation of the luxury property

[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/), whereas 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.

market.[12] In the "luxury property", there are 143, 872, and 503 observations for Hong Kong, Shanghai, and Taipei, respectively.

3: Models and Methodology

Two models are employed in the current research: a specific model and a comparative model. Since more information on the Hong Kong property rental market is available, a specific model is constructed for Hong Kong, while a comparative model with fewer parameters specified is used for the markets in Shanghai and Taipei instead of comparing results across the three markets, as less information is published for the Shanghai and Taipei property rental market. For both models, the linear model is adopted; as according to the Handbook on Residential Property Prices Indices (Eurostat, 2013), the linear model has much to recommend it when the property size is included as an explanatory variable.

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

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

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 nonlinear 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 matters because the residential location of students is an important factor in school admissions. Living in districts with famous schools in the vicinity implies a greater chance for the children therein to be accepted into a famous school, thus affecting the price of the property. As a result, the famous school ratio is applied to differentiate districts with more famous 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 the ratios higher than 1/3. The famous school district (*FSD*) equals one if the property is located in one of these four

[13] In Hong Kong, there are three bandings that represent the ranking of secondary schools, with band one schools defined as famous schools.

districts and zero otherwise.

The district median income[14] (*DMI*) denotes the median monthly domestic household income in each district, which covers the households in private properties only. 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.

3.2 Comparative Model

The major regressors remain in the comparative model to compare the property rental markets in Hong Kong, Shanghai, and Taipei; 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 that 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.

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

[15] The eight major property companies refer to 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.

3.3 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 households are willing to pay in order to live closer to the CBD, and thus 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.

[16] The average working days per month of the people in 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 Labor 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.

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

Since the information on the number of family members per household is unavailable, the time value, shadow wage and estimated monthly income calculated from the time coefficients are 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. In order to measure the household shadow wage, which is then calculated on an hourly basis, the household time value is multiplied by 60 as shown in Equation (8):

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

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.

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

The average working hours per day of the people in Hong Kong, Shanghai, and Taipei are 8.6, 8, and 8.2 hours, respectively[18]. The 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.

[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 Labor Affairs in Taiwan, 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. For robustness check, 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.

The coefficients of the travel time required to arrive at the CBD indicate how much, on average, households residing in private properties are willing to pay in order to save a minute of their travel time from their home to the CBD 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, in other words, around HK$2,912 (HK$145.6x20) more to stay in a property which reduces 20 minutes travel to the CBD. 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$2,940 (HK$147x20) and HK$7,848 (HK$392.4x20) respectively for a property that takes 20 minutes less travel from the CBD.

Using the information 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 HK$141 per hour on average. 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 a later period affect the rental price positively, whereas properties built earlier 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 they are 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. For example, similar results can be obtained in the luxury property market in which the household time value, household shadow wage, and the 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 property age effects on the property rental markets in Hong Kong, Shanghai, and Taipei. Only the cases of the Hong Kong and Taipei markets are presented, as 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, 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 compared to the one from the comparative model because more variables are used in the former model. For robustness check, 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 will only use the result of the comparative model for comparison among the three cities.

[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 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 than 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 Hong Kong and Taipei markets are 19.36 and 21.61 years, respectively.

The ratios, as opposed to the absolute numbers, will be the focus in the comparative model. In particular, the estimated coefficient of the comparative model will mainly be 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 finding demonstrates that among these three cities, travel time is valued most in Hong Kong, as more has to be paid for property closer to the CBD; whereas it is valued least in Shanghai. The extent of difference between the households of these two cities is more than double. This ratio also 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.

The household shadow wage ratio among the three cities remains at 2.25: 1: 1.61, as this ratio is obtained by simply 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 and 1.70 times that of Shanghai respectively. In order to verify the validity of this ratio in these three cities, 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, given the same sector, Hong Kong has the highest salary on average, while 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.

[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.

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 the commuting cost. Since the rent that an individual is willing to pay to live near the CBD depends on the value of the time saved from shortening their commute, the distance between property and the CBD is an important factor that determines property rental value. The nearer to the CBD, the higher the rental value of a property. This paper examines how the rental differential between two locations in a metropolitan 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 better information on commuting time for research purposes. Our empirical result indicates that the commuting time to the CBD is an important factor in determining 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 household time value, household shadow wage, and monthly income of the 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 metropolitan is a reflection of the total value of the commuting time differential. For future research along this line, one may include other Asian major 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 if there is a threshold effect above which the impact of travel time to the CBD on the value of a property has 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	0.4
Kowloon City	0.3871
Sha Tin	0.3158
North	0.3
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	0.2
Kwun Tong	0.1935
Sai Kung	0.1905
Wong Tai Sin	0.1818
Islands	0.125
Southern	0.0714

Table 2: Summary statistics of the three data sets in the specific model in Hong Kong between January 2011 and March 2011

Variable	Mean			Std. Dev.			Min			Max		
	All	S & M	Luxury	All	S & M	Luxury	All	S & M	Luxury	All	S & M	Luxury
price	13727.83	12448.86	22161.85	6303.44	4057.42	10577.80	1500	1500	8000	82000	40000	82000
age	14.0460	14.9533	8.0629	10.6078	10.3860	10.1338	1	1	1	36	36	36
age^2	309.7127	331.3563	166.9860	353.6497	348.1050	357.9611	1	1	1	1296	1296	1296
size	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	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	27771.92	27712.62	28162.94	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.

Table 3: Summary statistics of the three data sets in the comparative model in Hong Kong between January 2011 and March 2011

Variable	Mean			Std. Dev.			Min			Max		
	All	S & M	Luxury	All	S & M	Luxury	All	S & M	Luxury	All	S & M	Luxury
price	13727.83	12448.86	22161.85	6303.44	4057.42	10577.80	1500	1500	8000	82000	40000	82000
age	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	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	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.

Table 4: Summary statistics of the three data sets in the comparative model in Shanghai between January 2011 and March 2011

Variable	Mean			Std. Dev.			Min			Max		
	All	S & M	Luxury	All	S & M	Luxury	All	S & M	Luxury	All	S & M	Luxury
price	6152.29	3465.06	8830.27	6453.54	2181.01	8004.74	534.825	534.825	534.825	85572	27335.5	85572
age	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	1044.199	657.624	1429.444	515.342	220.979	429.184	107.64	107.64	1001.052	4929.912	990.288	4929.912
floor	9.8093	7.2670	12.3429	8.0998	6.2522	8.9012	1	1	1	53	45	53
time	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.
For easy comparison, the property rental prices in 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.

Table 5: Summary statistics of the three data sets in the comparative model in Taipei between January 2011 and March 2011

Variable	Mean			Std. Dev.			Min			Max		
	All	S & M	Luxury	All	S & M	Luxury	All	S & M	Luxury	All	S & M	Luxury
price	9251.25	7785.32	10387.86	3564.88	2456.10	3865.60	2147.2	2147.2	3489.2	25498	17446	25498
age	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	1137.512	836.482	1370.915	340.548	116.590	265.6154	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	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. For easy comparison, the property rental prices in 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.

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

	Hong Kong	Shanghai	Taipei
Transportation cost	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 costs in Shanghai and Taipei are converted to Hong Kong dollars by multiplying their average exchange rates from January 2011 to March 2011.

Table 7a: Estimation results of the three data sets in the specific model in Hong Kong between January 2011 and March 2011

	Hong Kong		
VARIABLES	**All property data set**	**Small and mid-size property data set**	**Luxury property data set**
Age	509.6***	353.0***	1,106***
	(40.53)	(30.77)	(218.8)
age^2	-12.22***	-8.566***	-35.80***
	(1.18)	(0.869)	(7.479)
Size	19.15***	16.24***	30.93***
	(0.468)	(0.556)	(2.296)
High	483.8**	404.7**	2,627**
	(226.6)	(160.5)	(1,241)
Medium	577.4**	299.8	3,321**
	(261.2)	(185.2)	(1,452)
Time	-145.6***	-147.0***	-392.4***
	(12.32)	(8.798)	(122.7)
FSD	6,985***	5,296***	-2,511
	(474.4)	(350.2)	(5,999)
DMI	-0.035	-0.0159	-0.690**
	(0.0226)	(0.0156)	(0.312)
Swire	910.0**	791.5**	6,823***
	(458.4)	(340.9)	(2,247)
sunhungkai	738.9**	124.5	-710.5
	(326.7)	(250.4)	(1,753)
Newworld	-1,056*	-46.85	-13,722***
	(579.5)	(437.6)	(3,429)

VARIABLES	Hong Kong		
	All property data set	Small and mid-size property data set	Luxury property data set
hendersonland	3,477**	2,462**	-1,361
	(1,423)	(1,069)	(6,408)
Hutchison	-506.8	-35.95	0
	(665.1)	(448.5)	(0)
Hanglung	1,916***	-99.36	3,492
	(569.7)	(455)	(2,413)
cheungkong	1,076***	659.8***	0
	(306)	(208.8)	(0)
Hopewell	-1,426**	392.6	0
	(722.5)	(534.5)	(0)
Constant	78.06	3,125***	10,241
	(973.5)	(820.2)	(13,804)
Observations	1,086	943	143
R-squared	0.767	0.75	0.787

Standard errors in parentheses

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

Table 7b: Estimation results of the three data sets in the specific model (property company dummy variables are excluded) in Hong Kong between January 2011 and March 2011

	Hong Kong		
VARIABLES	**All property data set**	**Small and mid-size property data set**	**Luxury property data set**
Age	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	18.86***	15.78***	30.98***
	(0.454)	(0.518)	(2.421)
High	479.4**	428.6***	1,442
	(228.9)	(161.1)	(1,253)
Medium	564.3**	294.5	2,541*
	(263.9)	(185.8)	(1,450)
Time	-162.3***	-149.5***	-382.1***
	(11.20)	(7.863)	(112.9)
FSD	6,680***	5,039***	7,718*
	(452.3)	(329.6)	(4,509)
DMI	-0.0367*	-0.0216	0.0184
	(0.0216)	(0.0148)	(0.202)
Constant	1,014	3,872***	-13,011
	(901.2)	(726.1)	(9,434)
Observations	1,086	943	143
R-squared	0.758	0.744	0.745

Standard errors in parentheses

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

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 in 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	-392.4
Household time value	2.3564	2.3844	7.2924
Household shadow wage	141.384	143.064	437.544
Estimated monthly household income	30397.56	30758.76	94071.96

Table 9: Estimation results of the all property data set in the comparative model between January 2011 and March 2011

VARIABLES	Hong Kong	Shanghai	Taipei
age	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	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	-256.1***	-96.31***	-166.0***
	(10.81)	(6.455)	(11.53)
Constant	2,559***	571.9	6,889***
	(711.2)	(520.3)	(441.8)
Observations	1,086	1,741	893
R-squared	0.693	0.595	0.458

Standard errors in parentheses

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

Note: For easy comparison, the property rental prices in 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.

Table 10: Estimation results of the small and mid-size property data set in the comparative model between January 2011 and March 2011

VARIABLES	Hong Kong	Shanghai	Taipei
age	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	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	-205.9***	-63.11***	-132.6***
	(8.018)	(3.723)	(11.86)
Constant	5,469***	3,681***	7,831***
	(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: For easy comparison, the property rental prices in 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.

Table 11: Estimation results of the luxury property data set in the comparative model between January 2011 and March 2011

VARIABLES	Hong Kong	Shanghai	Taipei
age	1,262***	-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	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: 2,451*		
	(1460)		
time	-633.7***	-120.1***	-202.0***
	(48.7)	(10.92)	(19.50)
Constant	-4,486	-4,431***	6,564***
	(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: For easy comparison, the property rental prices in 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.

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 in 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	4.57	2.03	3.27
	Household shadow wage	273.98	121.59	196.02
	Estimated monthly household income	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	3.56	1.26	2.52
	Household shadow wage	213.74	75.80	151.29
	Estimated monthly household income	45954.96	13188.90	27789.18
Luxury property data set	**Coefficient of travel time**	-633.70	-120.10	-202.00
	Household time value	12.12	2.57	4.07
	Household shadow wage	727.10	154.41	244.24
	Estimated monthly household income	156327.36	26866.50	44861.58

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.

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

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