Empirical Modelling of Commercial Property Market Location Submarket using Hedonic Price Model in Malaysia

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Abstract

Modelling commercial property price is limited relative to its housing counterpart. This situation is also applicable in Malaysia with only a handful studies on commercial property market with none focusing on the influence of location submarket. This study therefore modelled the commercial property location submarket using hedonic price model. Using a rich commercial property transactions data with 11,460 observations, OLS models were estimated. The first model was a market wide model without the location submarket and the second model accounted for location submarket. The study found that modelling location submarkets improves model's fit, reduces error, and eliminates heteroskedasticty thereby improving the accuracy of the price modelling. The findings of this study have implication to commercial property investors, financial institutions, public tax institutions, and appraisers.

Keywords
Commercial Property, Location, Submarkets, Hedonic Price Model, OLS

1. Introduction

The global economy functions within the midst of different property land uses – residential, commercial, industrial and agricultural land uses. These uses combined with human interfaces shape the urbanisation process and economic activities (Liusman et al. 2017). While other uses provide shelter, source of food and products, the commercial use provides the platform for accommodating offices, businesses and their employees and employers thus providing the economic needs of the society (Chiang 2016). The commercial property market is strategically important to the global economy as noted by numerous studies (Jeong and Kim 2011; Raposo and Evangelista 2017; Seo et al. 2019). The commercial property market has strong connection with other economic sectors such as the financial market, construction industry, and other services market. According to Statista (2019), in 2017 the wealth investment into commercial property market globally was estimated to be over $700Billion. In United States, the commercial properties account for over 30 percent of the total assets on the National Balance Sheet as the market assets account for over $16trillion net worth (Geltner and Bakhari 2016).

Property taxes are also levied on commercial properties which account for huge proportion of the tax base (Bujanda and Fullerton Jr. 2018). The contribution of commercial properties to Gross Domestic Product (GDP) of many countries is also huge through the multi-trillion dollars investments (Ab. LahSani 2011; Geltner and Bakhari 2016). The income producing nature of commercial properties through long term revenue streams (Chiang 2016) has made it attractive to both institutional and individual investors such that they include it into their investment portfolio to derive the benefit of investment diversification and risk management (Fuerst et al. 2016). The influence of property market to the economy has been revealed by the various economic recessions and the latest global financial crisis which are partly linked with the activities in the property market (Raposo and Evangelista 2017). The property pricing is expected to reflect the demand and supply equilibrium in the property market. Failure to achieve this in commercial property may pose risk to the health of the economy (Ling et al. 2017). According to EuropeanCommission/ECB (2016), commercial property markets are potential source of risk requiring close monitoring and accurate analysis.

The characteristics of commercial property market are shrouded by imperfection. The market and its assets is characterised by heterogeneity, seldom trade volume, high cost of transaction, relative low liquidity, and high information asymmetry (Chiang 2016; Orr et al. 2003; Wiley 2017). These commercial property market features make it relatively volatile. The more relative volatility of commercial property market over the residential property market is due to its direct link with the economic and production cycles unlike the residential properties whose main motive of ownership is the maximisation of utility based on living need (Chiang 2016; Fuerst et al. 2016). Another distinct characteristics of commercial properties in addition to thinness and heterogeneity is the uniqueness of each property's location (Adair et al. 1996; Chegut et al. 2013; Chiang 2016; Crosby et al. 2016; Lecomte 2019). The uniqueness of each location has made it an important determinant of the commercial property market which needs to be adequately modelled. Location has been regarded as one the most significant determinant of commercial property values (Bhattacharya et al. 2013; Droj and Droj 2015; Özyurt 2013 2014). Thus, the need for accurate commercial property prices that reflects the performance of the commercial real estate and the state of the market is paramount (Corgel et al. 2015). Significant attention is giving to property pricing by various stakeholders such as investors, financial institutions, policy makers and researchers. The outcome of the property market is used by the stakeholders for taxation, investment, and price index construction purposes which are useful for both fiscal and monetary policies (Fuerst et al. 2016; Mayer et al. 2019; Reiss 2009; Unbehaun and Fuerst 2018; Wiley 2017). The major concern is the accuracy of the determined property prices (Feng and Jones 2016; Fuerst et al. 2016; Usman et al., 2020)

Property prices are traditionally determined using conventional cost, income, and market valuation approaches (Aliyu et al. 2018). However, increasing transaction volume, the need for recurring property price determination, time and cost saving necessitated the use of mass appraisal techniques (Abdullahi et al. 2018). The Hedonic Pricing Model (HPM) is used for the estimation of property prices from vast sample of comparable properties. The theoretical foundation of HPM have its root in the seminal work of Rosen (1974). Rosen (1974) shows that price of a commodity is the function of the implicit price of its constituent parts. Relying on the monocentric theory, property is viewed as heterogeneous good whose price is inversely related to the central business district, the hedonic function modelled property price as the summation of the implicit prices of its structural characteristics, neighbourhood features and location (Abidoye and Chan 2017; Baudry and Maslianskaia-pautrel 2015; Fotheringham and Park 2018; Mora-Garcia et al. 2019).

The hedonic function is developed based on "one-price-for-all" and the assumption of spatial equilibrium of supply and demand for the various property characteristics, which are assumed to have constant implicit prices across space (Costa and Cazassa 2018; Costa et al. 2016; Geltner and Van de Minne 2017). However, this basic assumption of equilibrium price for each characteristics and homogeneous market has been criticised especially when modelling with regional data (Dale-Johnson 1982). The use of market wide hedonic model in estimating property prices has been criticised due to some reported problems such as spatial autocorrelation and heteroskedasticity. The discriminate and unobservable location attributes of property make the property value to be dependent on the contagious property values which make the error residuals to be correlated. The presence of spatial autocorrelation makes price estimation in hedonic model inefficient and causes problem in price index construction and mass appraisal (Manganelli et al. 2015; Tu et al. 2007; Wu et al. 2018).

In Malaysia, there are limited studies that modelled commercial property market. These studies include Ab. LahSani (2011), Abdul Rahman (2011), Ahmad (2015), Ahmad (2014), Lizam (2011), Zainuddin and Shafie (2016). These previous studies that modelled commercial property market in Malaysia did not explicitly account for location submarkets in order to discern the impact of the other value determinants. This study aims to model the commercial property market by accounting for location submarkets using hedonic pricing model in Malaysia. The rest of the paper is organised as follows. Literature review is presented in section 2. Section 3 illustrates the methodology while section 4 provides the findings of the study. Section 5 concludes the paper.

2. Literature Review

Property price is required for various purposes such as sales, purchase, taxation, mortgages, leasing, insurance, litigations, compensation, inheritance, balance sheet, inheritance, and investment and financing decision making (Núñez-tabales et al. 2016; Pagourtzi et al. 2003). With the sophistication of technology, the need to determine the price of large number of property, the need for efficiency in price determination, and with supporting theoretical basis, property price modelling are developed and continuously used in property pricing (Abidoye and Chan 2017;

Ahmad et al, 2014; Gnagey and Tans 2018; Gröbel and Thomschke 2018; Raposo and Evangelista 2017; Stamou et al. 2017). Such price modelling is based on hedonic function which modelled property price as the function of the property's composite characteristics.

Commercial property market is traditionally modelled using the Hedonic Pricing Model (HPM). The hedonic pricing model, formalised in real estate modelling by the seminal work of Rosen (1974), considered property price as the composition of its attributes – physical attributes, neighbourhood attributes and location (Ahmad et al., 2014; Barreca et al. 2017; Fitzgerald et al. 2019; Gnagey and Tans 2018; Noh 2019). The physical and neighbourhood attributes are relatively easier to measure and modelled in the hedonic pricing model. The location factor, however, is more difficult to measure and model accurately and objectively (Özyurt 2014). This is despite the importance of location in determining real estate prices. The phrase 'location, location, location' is a popular parlance among real estate practitioners used to denote the significance of location on real estate prices (Heyman and Manum 2016; Orford 2017; Özyurt 2014). The essence of this is driven from the fact that property prices are location specific and vary across space. Property locations are fixed, immobile and unique such that no properties are spatially the same (Wyatt 2010). Such uniqueness of location exert significant influence on property prices with the attendant concerns to all property market stakeholders (Orford 2017). Location is linked to neighbourhood, amenities, social ties, and many environmental factors, with their associated externalities, that cumulatively exert significant influence on real estate price. For instance, specific spatial point of a property influences its access to other land uses, other properties.

The impact of location on property prices is more pronounced in commercial property market that the other property classes. This is because location choice for commercial properties requires consideration of so many factors such as access to market, customers, traffic, employment centres, population density and other factors. However, with the availability of many urban sub centres and improved transportation network, the polycentric nature of many cities has diminished the role of CBD in commercial property market, but increased the suburban centres influence (Ahlfeldt 2011; Ahlfeldt and Wendland 2013; Trujillo 2016). The locational characteristic of commercial property market therefore makes it an important feature to property valuers when modelling real estate market. The major issue of concern is now not on whether location is important but rather on how to incorporate it into commercial property market analysis. The traditional implicit locations modelling in hedonic models mostly come in two ways. Firstly, location dummies are used to control the neighbourhood effect on commercial property prices (Deryol 2019; Fell and Kousky 2015; Raposo and Evangelista 2017). The second method of implicitly modelling location into commercial property market in hedonic model is using the approximate distance between the subject commercial property to other spatial landmarks such as highways, CBDs, airports, rail stations, bus terminals, highway exits and other positive and negative externalities that have impact on property prices (Abdullahi et al. 2018; Bujanda and Fullerton Jr. 2018; Clapp 2003; Pace et al. 1998; Seo et al. 2019). These location modelling methods are used in this study.

3. Methodology

This study used sales data of commercial property transactions obtained from National Property Information Centre (NAPIC) Malaysia. The NAPIC is a government agency under the Malaysia's ministry of finance. The agency keeps record of property transaction information for stamp duty purposes. The data contained information on Kuala-Lumpur and Selangor state in Malaysia. The study is limited to shop-office segment of the commercial property market. The use of this segment is as a result of availability of the data. From the obtained data, nine location submarkets were identified. These are Gombak, Hulu Langat, Hulu Selangor, Kelang, Kuala Langat, Kuala Lumpur, Petaling, Sepang and Putra Jaya. These location submarkets are administrative districts in Kuala-Lumpur and Selangor state all in Malaysia. The data set contains information on commercial property transaction prices, data of the transaction, date of construction, the plot size, the building size, the height of the buildings, number of floors, and other information required for price modelling. From the data, additional variables are constructed using Geographical Information System (GIS). These variables are distance to the Central Business District (CBD) which is Kuala-Lumpur city centre in this case, distance to the nearest suburban centre, and distance to the nearest train station. The variable used in the hedonic equation together with their explanation and sources are provided in table 1.

After data sorting, cleaning and screening for missing entries, wrong entries, linearity, normality and homoscedasticity, 11460 property transactions observations were used for the empirical modelling based on quantitative method (Bawuro et al. 2019) Two models are estimated. The first model is a market wide model without accounting for location submarket while the second model accounts for location submarket using dummies.

Table 1. Models' Variables

Variables	Definition	Measurement	Sources
Ln_Price	Logarithm of sales prices	Dependent, Continuous	(Oni et al. 2020; Seo et al., 2019)
ln_plota	Logarithm of plot area. It is the total area of plot on which the subject building is situated. It is measured in square metres	Continuous	(Das et al. 2017; Geltner and Van de Minne 2017; Lizam 2011)
ln_blda	Logarithm of building area. This is the total area of built floor area. It is measured in square metres	Continuous	(Ahmad 2015; Ke et al. 2017; Raposo and Evangelista 2017)
ln_agen_1	Logarithm of building age. Buidling is is the difference between the dates of sales and construction	Continuous	(Jackson and Yost-Bremm 2018)
age_dummy	The dummy of age. New buildings are coded 1 while otherwise 0.	Dummy	(Fuerst et al. 2016)
h_low	Low height. Low height is defined as buildings with 2 levels which are coded 1 otherwise 0.	Dummy	(Diewert and Shimizu 2017; Lizam 2011)
h_med	Medium height. Medium height is defined as buildings with 2-4 levels which are coded 1 otherwise 0.	Dummy	(Diewert and Shimizu 2017; Lizam 2011)
h_high	High height. High height is defined as buildings with 5 levels and above which are coded 1 otherwise 0.	Dummy	(Diewert and Shimizu 2017; Lizam 2011)
bldg_unit	If the whole building is sold its coded 1 while if only a unit in the building is sold is coded 0.	Dummy	(Lizam 2011; Nappi-Choulet and Maury 2009)
ground_flo	If the level of transaction is at ground floor it is coded 1 otherwise 0	Dummy	(Lizam 2011; Seo 2016)
upper_medi	Upper-medium floors. Transactions between 2nd and 4th floors are coded 1 otherwise 0	Dummy	(Lizam 2011; Seo 2016)
upper_high	Upper-high. Transactions between fifth level and above are coded 1 otherwise 0.	Dummy	(Lizam 2011; Seo 2016)
ln_d_klcc	Logarithm of distance to Kuala lumpur central. This is taken as the overall CBD	Continuous	(Ahmad 2015; Fuerst et al. 2016; Liang et al. 2017)
ln_d_cty_cc	Logarithm of distance to the nearest city centre	Continuous	(Das et al. 2017; Ke et al. 2017; Seo 2016)
ln_d_tstations	Logarithm of the distance to the nearest train station	Continuous	(Seo 2016; Xu et al. 2016; Yu et al. 2017)
Location dummies	Transaction in a particular district is coded 1 otherwise 0	Dummy	(Geurts and Black 2015)
Time dummies	Year of transactions are accounted for by dummy entries	Dummy	(Jackson and Yost-Bremm, 2018; Q. Ke et al. 2017)

Ordinary Least Squares (OLS) using log-log linear model is used to estimate the hedonic equation. The log-log linear model allows for logarithmic transformation of both side of the equation and the use of dummy variable is was shown to be more efficient than linear specification (Soguel et al. 2008). The base hedonic model wide model is estimated using equation 1.

$$lnP_i = \beta_i + \sum_k \beta_{ki} lnX_{ki} + \sum_l \beta_{li} dX_{li} + \sum_n \beta_{ni} Td_{ni} + \boldsymbol{\varepsilon} \quad \textbf{(1)}$$

Where lnP_i is the n x 1 vector of commercial property prices, β_{ki}, β_{li}, β_{ni} are regression coefficients of logarithmically transformed continuous commercial property attributes, dummy commercial property attributes and time dummies, and lnX_{ki}, dX_{li}, *and* Td_{ni} are i x k, i x l and i x n vectors logarithmically transformed continuous commercial property attributes, dummy commercial property attributes and time dummies respectively where i is the number of observations and $\boldsymbol{\varepsilon}$ is the error term which is assumed to be identically and independently distributed (i.i.d.). The location submarkets are modelled by using binary dummy variables representing the commercial property submarkets. This approach, according to Lisi (2019) is a simple methodology to implement. The model is specified in equation 2.

$$lnP_i = \beta_i + \sum_k \beta_{ki} lnX_{ki} + \sum_l \beta_{li} dX_{li} + \sum_n \beta_{ni} Td_{ni} + \sum_j \beta_{ji} Jd + \boldsymbol{\varepsilon} \quad \textbf{(2)}$$

Jd represents commercial property location submarkets dummies.

4. Results

This section presents the result of the empirical analysis using ordinary least squares regression. The descriptive statistics of the variables is presented in table 2. The average transaction price for commercial properties was RM720,452 with minimum and maximum values of RM30,000 and RM9,400,000 respectively. The average plot area over which buildings are situated was 158m^2 within a range of 30m^2 to 2,337m^2. Similarly, the average building floor area was 311.7m2 within a range of 26.01m^2 to 2,476m^2. The average age of the buildings was 10 years. Whether building is sold as new is captured by age dummy. It shows that about 21.8 percent of the buildings were sold new. The result also shows that about 26.5 percent of the buildings were of low height category, 54.2 percent medium height category, and 19.3 high height category. About 70 percent of the buildings were sold as a whole while the remaining 30 percent were only units of a building sold. The level of unit's transaction was captured as ground floor, upper-medium and upper-high floors accounting for about 4.8 percent, 15.2 percent, and 5.6 percent of the whole transactions respectively. The average distance to CBD, suburban centres and nearest train station were 14.8km, 5.2km and 2.9km respectively.

Table 2. Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
ln_price	11460	13.09455 (720452.3)	0.899821 (756399.6)	10.30895 (30000)	16.05622 (9400000)
ln_plota	11460	4.95944 (158.198)	0.430969 (109.993)	3.401197 (30)	7.756623 (2337)
ln_blda	11460	5.478736 (311.6789)	0.773412 (217.982)	3.258481 (26.01)	7.8144 (2476)
ln_agen_1	11460	1.672484 (9.693106)	1.215828 (9.390026)	0 (1)	4.304065 (74)
age_dummy	11460	0.218237	0.413067	0	1
h_low	11460	0.264572	0.441125	0	1
h_med	11460	0.542408	0.49822	0	1
h_high	11460	0.193019	0.394685	0	1
bldg_unit	11460	0.696335	0.45986	0	1
ground_flo	11460	0.048604	0.215048	0	1
upper_medi	11460	0.152356	0.359381	0	1
upper_high	11460	0.055672	0.229297	0	1
ln_d_klcc	11460	9.311753 (14852.49)	0.901115 (9983.998)	4.98307 (145.9217)	11.26619 (78134.62)
ln_d_cty_cc	11460	8.309567 (5210.883)	0.784628 (3413.194)	3.748499 (42.45732)	10.02108 (22495.66)
ln_d_tstations	11460	7.493602 (2892.819)	1.043952 (3137.047)	3.346907 (28.4147)	10.94559 (56703.2)

() entries in parenthesis are values before logarithmic transformation

The two estimated models are presented in table 3. Model (1) is the ordinary least square regression model for the market wide model without accounting for location submarket. Model (2) on the other hand is equally an OLS model but with inclusion of location submarkets.

Table 3: OLS Hedonic Price Models

	(1) ln_price	(2) ln_price
ln_plota	0.0859***	0.0908***
ln_blda	0.803***	0.773***
ln_agen_1	-0.102***	-0.113***
age_dummy	-0.0179	-0.00141
h_low	-0.409***	-0.252***
h_med	-0.318***	-0.218***
bldg_unit	-0.185***	-0.194***
ground_flo	0.172***	0.145***
upper_medi	-0.471***	-0.519***
upper_high	-0.349***	-0.388***
ln_d_klcc	-0.140***	-0.151***
ln_d_cty_cc	-0.0868***	-0.137***
ln_d_tstations	-0.0808***	-0.0452***
by2000	-0.282***	-0.363***
y2000	-0.104	-0.160*
y2002	-0.240***	-0.273***
y2003	0.00473	-0.0610
y2004	0.0591	-0.00337
y2005	0.0644	0.00764
y2006	0.120*	0.0591
y2007	0.235***	0.165**
y2008	0.237***	0.211***
y2009	0.257***	0.239***
y2010	0.292***	0.282***
y2011	0.602***	0.565***
y2012	0.699***	0.656***
gomak		-0.698***
hulu_langa		-0.834***
hulu_selan		-0.963***
kelang		-0.650***
kuala_lang		-0.806***
kuala_lump		-0.454***
petaling		-0.386**
sepang		-0.907***
_cons	11.41***	12.34***
N	11460	11460
R^2	0.628	0.663
adj. R^2	0.627	0.662
AIC	18818.6	17705.3
BIC	19016.9	17962.5
RMSE	0.55933	0.5231
Breusch-Pagan	23.53***	0.80

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The result shows that high height, year 2001 and putra-jaya are affected my multicollinearity which leads to their omission from the model. All the commercial property determinants are significant and have the expected signs in both models. The models have high degree of freedom as a result of sample size of 11,460 observations which is considered large. Model 1 produced an R^2 value of 0.628 and adjusted R^2 value of 0.627. The R^2 produced by the model is within the range of most R^2s reported in commercial property price modelling studies (Seo 2016). The Root Mean Squared Errors (RMSE) was 0.55933 indicating a standard error of 0.3128. The *Breusch-Pagan test* was statistically significant (*Breusch-Pagan* = 23.53) indicating significant heteroskedasticity. The presence of significant heteroskedasticity implied that error terms are spatially correlated which jeopardises the accuracy and reliability of property price estimates (Baudry and Maslianskaia-pautrel 2015; Beracha et al. 2018; Bourassa et al. 2007; Kim and Zhang 2005; Lisi 2019; Watkins 1999).

Model (2) modelled the location submarket which produced an R^2 value of 0.663 which represent about 6 percent improvement in the R^2 relative to model 1. The adjusted R^2 equally shows similar improvement. The RMSE decreased to 0.5231 indicating a standard error of 0.2736. This represents about 6.5 percent decrease in model errors. 5 percent reduction in error shows evidence of significant location submarkets (Dale-Johnson 1982; Xiao et al. 2016). Accounting for the location submarket also reduced model's information loss as indicated by 5.9% and 5.6% reduction in models AIC and BIC respectively. The *Breusch-Pagan test* for the model shows an insignificant value of 0.8. This shows that modelling location submarket eliminated heteroskedasticity in the model. This is in line with the submission of Lisi (2019) that accounting for location submarket helps in eliminating heteroskedasticity. Accounting for the location submarkets improves model's fit, reduces error, and eliminates heteroskedastticty thereby improving the accuracy of the price modelling.

5. Conclusion

Commercial property markets are strategic to global economic and financial systems. This requires accurate pricing of its assets. However, most studies on property market analysis focused more on the housing market. Little attention is devoted to the commercial market. This may be due to the thinness of the market and lack of adequate data for such analysis. This situation is not different in Malaysia. Very few studies modelled the commercial property market with none showing the influence of modelling location submarket on the accuracy of price estimates. This study therefore empirically modelled location submarkets with superimposing the submarkets as dummy variables in the hedonic model function.

Two models were estimated. The first model was a market wide hedonic model without accounting for location submarket. The second model accounts for location submarkets. The result shows that modelling location submarkets improves model fit by about 6 percent, reduces model error by 6.5 percent, reduces model's information loss by about 6 percent and eliminated heteroskedascity. The paper concludes that accounting for location submarkets improves model's fit, reduces error, and eliminates heteroskedastticty thereby improving the accuracy of the price modelling. This paper is limited to only shop-office segment of the commercial property market. Further research should model other commercial property market segment with more resent data. Other methodology such as spatial econometric models should be explored in modelling location submarket. The findings of this study have implication to commercial property investors, financial institutions, public tax institutions, and appraisers.

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