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ESTIMATING VALUE UPLIFT FROM TRANSIT INVESTMENTS IN SUBANG JAYA, SELANGOR USING DIFFERENCE-IN-DIFFERENCE METHOD

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Abstract

It is generally believed that public transport investment such as urban rail transit systems can improve accessibility, particularly in larger and denser metropolitan areas. The improved accessibility provided by urban rail transit systems can drive up the value of surrounding land or property due to increased buyer demand. Based on this general belief, the study estimates the impact of the Kelana Jaya LRT line extension on residential property values in Subang Jaya, Selangor. Using Difference-in-Difference (DID) method with transaction-based data of 1,006 terraced properties, it is estimated that a typical terraced unit located within 0.8 km of the nearest LRT station and be sold during the construction phase of the project and after the system became operational would fetch a respective premium of approximately 4.7% and 5.3%, or RM31,490 and RM35,510 on average. It is also estimated that the overall impact on the price of terraced properties located within 0.8 km from the nearest LRT station in Subang Jaya, amounts to nearly RM11.6 million. An interesting accounting implication arising from this potential revenue is that it could provide a significant financial incentive to fully or partially fund urban rail transit projects in the Greater Kuala Lumpur area.

Keywords*:* Light rail transit system, Difference-in-Difference (DID) method, value uplift, land value capture, Subang Jaya, Selangor

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INTRODUCTION

Public transport systems, such as urban rail transit, are expected to improve people's accessibility and mobility, especially in more densely populated metropolitan areas. In addition to improved accessibility and mobility, public transport is also expected to reduce traffic congestion and carbon emission from private transport and bring other economic benefits to cities, such as increased productivity and opportunities for land development. Because of these benefits, there is growing interest among cities to invest in the construction or extension of urban rail transit systems. However, such systems are expensive not only to build or upgrade but also to operate and maintain. For example, the cost of building the STAR LRT, PUTRA LRT (currently known as the Sri Petaling and Kelana Jaya LRT lines), and the Kuala Lumpur Monorail line (or KL Monorail) was US$0.9 billion, US$1.5 billion, and US$0.3 billion, respectively (Kiggundu, 2009; A. Jalil, 2016). Table 1 shows the major sources of funding for urban rail transit systems in the Greater Kuala Lumpur[1] (hereafter, Greater KL). As shown in Table 1, the construction of urban rail transit systems in the Greater KL was financed primarily through domestic borrowing and Federal Government funds. It should be noted that Federal Government funds generally come from consolidated tax revenues. Medda and Modelewska (2011), however, argued that the traditional way of financing the construction, operation and maintenance of public transport is increasingly inadequate due to the critical, diverse, and complex needs of public transport. At the same time, government financial support for public transport is becoming more limited and uncertain (Mathur, 2015; Ubbels & Nijkamp, 2002). In many cases, for example, plans for investment in urban rail transit systems are postponed or even cancelled due to budgetary constraints.

For the above reasons, there is growing interest among policymakers in establishing the land value capture (LVC hereafter) mechanism to fully or partially fund[2] the development of public transport. In other words, to ensure adequate and sustainable transport investments for current and future needs, policymakers need to re-evaluate current transport funding mechanisms and explore alternative revenue sources (Lari et al., 2009). One possible alternative is known as "value capture," which taxes land and property owners who benefit significantly from increased land and property values due to proximity to transport infrastructure. With improved accessibility, land and property near transit stations may receive a higher valuation from buyers compared to similar land and property located at a further distance. Evidently, a 2016 study by the Council for the Preservation of Rural England (CPRE), cited by Pearson et al. (2022), found that landowners profited an estimated £9.3 billion of the £12.3 billion in land value increases generated by infrastructure improvements. According to Hong and Ingram (2012), there is a consensus among scholars that the cost of public investment should be recovered, at least in part, through the financial benefits that the investment generates. This approach is based on David Ricardo's (1817) neoclassical urban economic theory, which states that the unearned increment resulting from public investment should be returned to the public through tax measures, etc. (Amborski, 2012).

To assess whether an LVC mechanism is feasible, information is needed on the increase in land or property values following an investment in nearby public transport infrastructure (Dziauddin, 2019). Using the Difference-in-Difference (DID) method and a sample of over 1,000 transactions of terrace properties between 2013 and 2019 in Subang Jaya, Selangor, the paper aims to estimate the indirect impact of the Kelana Jaya LRT line on residential property values at different points in time. To estimate this indirect impact, the property market at each point in time is assumed to reflect the combined influence of positive and negative externalities associated with the proximity of a nearby rail transit station. Controlling the characteristics of residential property and housing submarkets, the paper estimates a potential price premium one has to pay to live near a rail transit station. It should be emphasised that knowledge of property value appreciation around rail transit stations is important as it helps shed light on future planning and development of sustainable public transport systems such as urban rail systems in Greater Kuala Lumpur and other cities. More importantly, the results of this study are useful to urban and transport planners, and policymakers who are increasingly seeking alternative sources, such as the LVC mechanism, to fund or partially fund urban rail transit systems.

Table 1: *Major sources of financing for urban rail transit systems in Greater KL*

Urban rail transit systems projects	Project costs	Funding methods
Sri Petaling LRT line	US$0.9 billion	10% was funded by the Federal Government, 10% by the soft loans from the Federal Government, 10% from the private equity, and 60% by domestic commercial equity.
Kelana Jaya LRT line	US$1.5 billion	25.6% was financed by government soft loans, 20.4% by private equity, and 54% by domestic commercial dept.
KL Monorail line	US$0.3 billion	78% was financed by government soft loans and 22% by private equity.

Source: Kiggundu, 2009.

The remaining sections of this paper are structured as follows: Section 2 reviews the relevant literature on the impact of urban rail transit on residential property values. Section 3 discusses data and methodology, while Section 4 presents empirical results. Finally, Section 5 reviews the empirical results and discusses policy implications from the perspective of LVC mechanisms.

LITERATURE REVIEW

Traditional urban economic theory or more specifically the land rent theory proposed by Alonso (1964), Muth (1969), Mills (1972), and later refined by Fujita (1989), derived from utility maximisation, suggests a positive relationship between proximity to public transport and property values (usually measured from the property to transit stations) owing to better accessibility to and from desired destinations such as major employment centres, schools and colleges, recreational facilities, and health care. According to Mills and Hamilton (1994), the accessibility benefits of public transport should lead to a locational advantage near transit stations, increasing the demand for properties. As a result, a bid-rent surface might be expected to peak near transit stations (Dziauddin, 2019).

There are extensive empirical studies that have investigated the effect of proximity to urban rail transit on property values. However, the focus of the discussion in this section is on the effect of urban rail transit on residential property values. Based on Table 1, the following conclusions can be drawn:

(1) Although the results of previous studies were mixed (with positive, negative, and non-significant results), variation in statistically positive significant results predominates in most of these investigations.

(2) In estimating the effect of rail transit systems on property values, previous studies have considered both heavy and light rails. Results have shown that residential properties near heavy rail stations received greater benefits than those near light rail stations. This can be attributed to the advantages related to higher train speeds, more frequent train service, and greater geographic coverage of heavy rail. In addition, most studies have found that residential properties near commuter rail stations have a higher value than those near heavy and light rail stations (an increase in value of +2.7% to +20.0%).

(3) Most of the past studies have designated catchment areas as locations within a radial distance of 0.4 km, and up to 1.6 km from the nearest transit station.

(4) In determining the study period most researchers have estimated the effect on residential property values from the onset of train service until decades beyond. However, some studies have estimated the impact several years before the government's official announcement of the project, immediately after the announcement, and during the construction of the project (Dubé et al., 2013; Devaux et al., 2017; Diao et al., 2017; Forouhar & Hasankhani, 2018; Yen et al., 2019; He, 2020).

(5) Regarding estimation methods, most of the early studies (since 1970s) have employed the hedonic pricing models (HPM) for over a decade. However,

in the proceeding years, researchers have adopted newer methods following the development of spatial statistical analysis, such as geographically weighted regression (GWR) and spatial autoregressive models (SAR). In addition, some studies have also adopted a quasi-experimental approach such as trend analysis and DID method when longitudinal data are used in identifying the effect of proximity to rail transit systems on property values.

STUDY AREA, DATA AND METHODOLOGY

Study Area

The city of Subang Jaya was selected as the study area. The city is located in the district of Petaling in the state of Selangor, just 20 km from the city centre of Kuala Lumpur. Subang Jaya covers an area of 161.8 sq. km. with a population of about 968,930 in 2020 (about 16.73% of the total population of Selangor). The population growth rate between 2015 and 2020 was 3.93%. The population is relatively young: 26.1% of the total population is 15 years and younger, while 71.6% is of working age (URBANICE Malaysia, 2021). In terms of land use, about 84% of Subang Jaya is a built-up area consisting mostly of residential and institutional uses complemented by commercial and industrial activities. It is served by two LRT lines, one KTM commuter line, and one bus rapid transit line, facilitating access to

Table 2
Summary of selected empirical studies on the effect of urban rail transit on residential property values

Author	Location	Transit type	Property type	Method	Results
Duncan (2011)	San Diego, California, USA	Light rail transit	Condominium	Multilevel model	Transit facility without the pedestrian environment such as intersection density, increases in people-serving commercial activity or decreases in the steepness of the terrain has an insignificant effect on condominium values.
Nolan et al. (2012)	New Jersey, USA	Heavy and light rail transit	Residential	HPM	A house located within the transit village (catchment areas of 0.25 and 0.5 miles from the nearest transit station) increases in value by +0.6%.
Dubé et al. (2013)	Montreal South Shore, Canada	Commuter rail transit	Single-family house	DID	A single-family house located within the vicinity of the commuter station increases in value ranging from +0.7% to +11% depending on the location, with an average impact of +2.6%.
Dziauddin et al. (2015)	Kuala Lumpur, Malaysia	Light rail transit	Residential	HPM and GWR	A house located within a catchment area of 2 km of the nearest transit station increases in value, but the value varies by geographic area.
Zhong and Li (2016)	Los Angeles, California, USA	Heavy and light rail transit	Single-family and multi-family houses	HPM, spatial Durbin model and GWR	A multi-family house located within the three distance bands of mature stations (0-400 m, 400-800 m and 800-1600 m) are 27-99% (US$283,090 to US$1,030,410) more valuable than their counterparts located beyond 1600 m.
Camins-Esakov and Vandegrift (2017)	Bayonne, New Jersey, USA	Light rail transit	Residential	HPM	The results show that the 8th Street Station had no statistically significant impact on annual house price appreciation.

Table 2
Continued.

Author	Location	Transit type	Property type	Method	Results
Devaux et al. (2017)	Laval, Montréal, Canada	Light rail transit	Single-family house	Trend analysis and DID	A single-family house located within a catchment area 1.6 km of the nearest station and after the rail transit is in operation increases in value as distance decreases ranging from +5.67% up to +24.68%.
Diao et al. (2017)	Singapore	Heavy rail transit	Residential	DID	A house located within 0.6 km from the nearest station increases in value by +7.8%.
Forouhar and Hasankhani (2018)	Tehran, Iran	Heavy rail transit	Residential	DID	A house located within 0.4 km of the nearest transit station experiences an increase in value in low-income neighbourhoods, but a decrease in value in high-income neighbourhoods.
Mulley et al. (2018)	Sydney, Australia	Heavy rail transit	Residential	HPM and GWR	The results from HPM indicate that a house increases in value by just over +0.5% for every 100 m closer to the nearest transit station, while the GWR identifies significant variations in the areas where properties have gained the greatest uplift from the investment.
Yen et al. (2019)	Gold Coast, Queensland, Australia	Light rail transit	Residential	DID	The model results do confirm the increases in property prices because of better accessibility to Gold Coast light rail transit, but the amount of uplift does appear to depend both on the model approach and the method to select catchment and control areas.

Table 2
Continued.

Author	Location	Transit type	Property type	Method	Results
Dziauddin (2019)	Kuala Lumpur, Malaysia	Light rail transit	Residential	HPM and GWR	The results show proximity to the nearest light rail transit station gives positive premiums of up to +8% for the majority of properties located in lower–middle and upper-middle income neighbourhoods such as Wangsa Maju, Setapak, Keramat, Setiawangsa, Ampang and Sentul. In contrast, the impact of proximity to the nearest light rail station was not found to be significant for properties in high-income neighbourhoods such as Petaling Jaya.
He (2020)	Hong Kong, China	Commuter rail transit	Residential	DID	The results show that the network accessibility of rail lines had a statistically significant capitalisation effect on property prices that varied across different submarkets.
Le Boennec et al. (2022)	Nantes, France	Commuter rail transit	Residential	HPM and GWR	A house located within a radius of less than 2.8 km from the nearest station increases its value by 0.17 compared to a similar house outside this distance, while the GWR shows significant variations across geographical areas.
Pearson et al. (2022)	Newcastle, UK	Light rail transit	Residential	HPM	A house located within a radius of 0.8 km of the newly operational station increases in value by +9.76%, while a similar house located within a radius of 0.8 km of the establish station increases in value just by +3.32%.

downtown Kuala Lumpur and other major centres. However, in this study, the Kelana Jaya LRT line which passes through Subang Jaya is used as a case study.

Historically, the Kelana Jaya LRT line (formerly known as PUTRA LRT) was constructed in the mid-1990s and became operational in 1998, in time for the 1998 Commonwealth Games. On completion, the line was 29 km long and had 24 stations running between Subang Depot in Petaling Jaya and Terminal PUTRA in Gombak. The main objective of the Kelana Jaya LRT line was to improve accessibility and connectivity between the western and northeastern suburbs of Kuala Lumpur by passing through downtown Kuala Lumpur at a low cost compared to other modes of transport such as taxis. After more than a decade of operation, and due to the urgent need to improve accessibility and connectivity to other major residential areas such as Subang Jaya, the line was extended in 2010 and completed in 2016. The extended project started at Lembah Subang Kelana Business Centre and passed through Subang, USJ and Alam Megah before reaching Putra Heights. Currently, the total Kelana Jaya LRT line includes 46.4 km of grade-separated tracks, both underground and elevated, and 37 stations. Figure 1 shows the study area along with the distribution of residential samples used in this study.

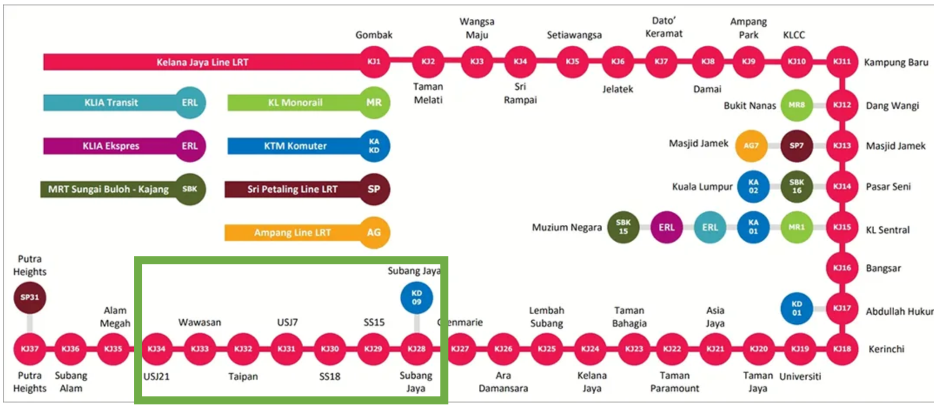

Figure 1: Map of Kelana Jaya LRT line (i.e., the Lembah Subang Extension and study area outlined in green)

Data Descriptions

The residential transaction price data (dependent variable in Malaysian Ringgit) were obtained from Brickz database (https://www.brickz.my) and recorded between I January 2013 and 31 December 2019 for the longitudinal studies. These longitudinal data were intended to reflect two phases of project development, namely during construction (2013-mid 2016) and after it became operational (mid-2016-2019). The Brickz database includes the transaction price, date, property address, building type (terrace, semi-detached, and bungalow houses), sub-building type (corner lot, end lot and intermediate), tenure, and physical characteristics of the property such as a number of stories, lot and floor areas, and a number of bedrooms. Although the database contains transaction records for residential properties for the entire Subang Jaya area, only those within a 2.5 km catchment area along the Kelana Jaya LRT line were selected for the sample. In selecting the sample for the DID method, Tse and Love (2000) pointed out that factors such as similar locational characteristics and income groups with presumably homogeneous tastes should be considered so that the net effects of physical and locational characteristics of the neighbourhood are similar. For this study, property markets with similar locational characteristics and income groups were selected for analysis. In addition, to control for physical characteristics of the property, this study uses similar building and sub-types (terrace house and intermediate) and nearly similar lot and floor areas. Table 3 shows the descriptive statistics of 1,006 terrace property transaction data used as the sample in this study. The mean price of the sample is RM 0.67 million with a standard deviation of 0.14 (20.89% of the mean), while the mean lot area is 1,507.44 and the mean floor area is 1,155.78 with a standard deviation of 303.03 (20.10% of the mean) and 164.74 (14.25% of the mean), respectively. Thus, the differences between price, lot, and floor area are relatively small.

Table 3: *Descriptive statistics (n = 1,006)*

	Mean	**S. D.**	**Max.**	**Min.**
House price (million)	0.67	0.14	1.85	0.10
Lot area (square feet)	1,507.44	303.03	3,886	1,000
Floor area (square feet)	1,155.78	164.74	1399	500

Locational characteristics are meanwhile used to estimate the external influence on residential property values. The characteristics selected for this study include proximity to the nearest LRT station, presence of primary and secondary schools, and distance to the nearest commercial area. All distances to these facilities were calculated using geographic information systems (GIS) and which represent the road network distances for each variable. To capture the effect of these factors on residential property values, dummy variables (1 and 0) are used in the analysis. In this case, the multi-band catchment areas of 0-0.8 km (the treatment zone) and 1.8-2.5 km (the control zone) from the nearest LRT station were employed, both during construction time and after the system was operational. For other locational facilities such as primary and secondary schools and commercial areas, a single-band catchment area was employed. Thus, the binary dummy variable is given a value of 1 if a property unit is within 0-0.6 km of the nearest elementary and secondary school and commercial area; otherwise, the value is 0. The definition of dependent and independent variables is shown in Table 4.

Table 4: *List of variables and their definitions*

Short form	Independent variables (expected sign)	Definition of variables
PRICE	House price (dependent variable)	House price in Malaysian ringgit (RM)
LOT	Lot area (+)	Gross lot area in square feet
FLOOR	Floor area (+)	Gross floor area in square feet
TREAT1	Treatment 1 (+)	1 if it is within a radius of 0.8 km from the nearest LRT station after its operations
CTRL1	Control 1 (+)	1 if it is within a radius of 1.8–2.5 km from the nearest LRT station after its operations
TREAT2	Treatment 2 (+)	1 if it is within a radius of 0.8 km from the nearest LRT station before its operations
CTRL1	Control 2 (+)	1 if it is within a radius of 1.8–2.5 km from the nearest LRT station before its operations
SCH1	Proximity to nearest primary school (+/–)	1 if it is within a radius of 0-0.6 km from the nearest primary school
SCH2	Proximity to nearest secondary school (+/–)	1 if it is within a radius of 0-0.6 km from the nearest secondary school
COM	Proximity to nearest commercial area (+/–)	1 if it is within a radius of 0-0.6 km from the nearest commercial area

Statistical Analysis

In order to estimate the indirect impact of the Kelana Jaya LRT line on residential property values in Subang Jaya, Selangor, while controlling for neighbourhood and physical characteristics, the DID method was used. The DID model in this study can be expressed as follows (Yen et al., 2019: 2):

$$\ln(p_{it}) = \beta_0 + \beta_1 S_{it} + \beta_2 L_{it} + \sum \theta_t LR_{it} \cdot year_{it} + \varepsilon_{it} \qquad (1)$$

where p_{it} represents the transaction price of residential property i at time point t (t = 2013 to mid-2016 and mid-2016 to 2019), which is predicted by a vector of physical and locational characteristics. The physical and locational characteristics include S_{it}, a vector of physical characteristics for property i in year t; Lit, a vector of locational characteristics for property i in year t; the interaction of LR_{it} and $year_{it}$ is the DD estimator capturing change between the treatment area and control area; θ_t is the coefficient of interest; and ε_{it} is the error term of property i in year t. It should be noted that the DD model is typically implemented as an interaction term between treatment group and control group in a regression analysis.

In all regression-based analyses, some of the independent variables are usually multicollinear. To address this problem, correlations among the independent variables were determined using the Pearson correlation coefficient and the variance inflation factor (VIF). According to Neter et al. (1985) and Orford (1999), a Pearson coefficient greater than 0.8 and a VIF greater than 10 indicate harmful collinearity and were therefore used in this study. In addition to multicollinearity, another problem to consider is heteroskedasticity. The presence of heteroscedasticity was determined by conducting the Breusch-Pagan test.

RESULTS

Table 5 shows the results of the DID method using the semi-logarithmic functional form. This allows the parameter estimates to be interpreted as a percentage change in the dependent variable given a unit change in the independent variable. The results show that almost 30% of the variance in the dependent variable is explained by the model. Moreover, the majority of the variables except for SCH1, SCH2, and COM are statistically significant with expected signs. Among all the variables, the coefficient related to the floor size of the property (FLOOR) is highly significant, indicating that it has a strong and statistically significant influence on residential property values. Hence, *ceteris paribus*, with each square foot increase in floor size, the residential property value will increase by approximately 0.4%. This equates to RM670.00, at the mean. As expected, the coefficient on the lot size of the property is also positive and statistically significant. Each square feet increase in lot size, *ceteris paribus*, increases residential property values by 0.02%, at the mean, which equates to RM132.66. Furthermore, the effect of locational characteristics on residential property values is positive but not statistically significant.

It is important to note that the impact of the Kelana Jaya LRT line on residential property values, which is the main focus of this paper, is remarkable. All the dummy variables used to estimate the impact of the line is positive and statistically significant. The coefficients for TREAT1 and TREAT2 show that residential properties located within 0.8 km of the nearest station increased in price by respectively 8.7% and 7.9%, *ceteris paribus*, when the system became operational and during the construction period of the project. This equates to a mean price of RM58,290 and RM52,930, respectively. The results of this study have indeed supported the earlier study by Diao et al. (2016) on the impact of the new Circle Line MRT in Singapore, where they found that the statistically significant effect of the MRT occurs twice, during the construction of the project, which is due to speculation, and after the system was in operation. Interestingly though, the coefficients for CTRL1 and CTRL2 suggest that *ceteris paribus*, residential properties located within 1.8 km to 2.5 km of the nearest station increase in price by 4.7% and 6.7%, at the mean, which equate to RM31,490 and

RM44,890, respectively. This implies that the positive impact of the transit system on residential property values is wider, affecting residential properties up to 2.5 km from the nearest station, at least in the context of Subang Jaya, Selangor. A positive and statistically significant impact of the transit system on residential properties of up to 2.5 km may be viewed with some scepticism. However, it should be kept in mind that Subang Jaya is located quite a distance away (20 km) from the Kuala Lumpur city centre and commuting to and from can be tiresome due to traffic congestion at peak hours. Therefore, having an LRT station in the neighbourhood may influence perceptions of improved accessibility, which in turn reflects the positive impact of LRT on property values more broadly.

Table 5: *Results of DID model: Ordinary least square (OLS)*

	Unstandardized coefficients		**Standardized coefficients**			**Collinearity statistics**
	B	**Std. Error**	**Beta**	**t**	**Sig.**	**VIF**
Constant	12.426	0.055		224.153	0.000***	
LOT	0.000	0.000	0.270	7.483	0.000***	1.832
FLOOR	0.001	0.000	0.404	11.063	0.000***	1.884
SCH1	0.009	0.013	0.020	0.691	0.489n/s	1.137
SCH2	0.002	0.012	0.005	0.183	0.855n/s	1.086
COM	0.009	0.019	0.016	0.482	0.630n/s	1.618
TREAT1	0.087	0.017	0.164	5.152	0.000***	1.437
CTRL1	0.047	0.024	0.060	1.924	0.055*	1.353
TREAT2	0.079	0.021	0.115	3.845	0.000***	1.255
CTRL2	0.067	0.027	0.074	2.457	0.014**	1.294
Adj. R^2	0.288					
SSE	0.187					
F-statistics	46.262					

Notes: *, ** and *** indicate significance at the 0.1, 0.05 and 0.01 levels.

According to Tse and Love (2000), a potential difficulty associated with the hedonic pricing model is the presence of heteroskedasticity. Although this presence does not bias the coefficient estimates, it makes them less accurate and inefficient and, more importantly, it may lead to invalid conclusions (Gujarati & Porter, 2009). To assess the presence of heteroskedasticity in the model, the Breusch-Pagan test was conducted (Breusch & Pagan, 1979). The results indicated the presence of heteroskedasticity in the model. In order to improve the efficiency of the model due to this presence, the weighted least squares (WLS) can be used (Tse & Love, 2000; Gujarati & Porter, 2009). Hence, the regression equation (1) can be run using weighted least squares together with a heteroskedasticity consistent covariance matrix estimator and this can be expressed as follows (Tse & Love, 2000: 372)

$$S(\beta) = \sum w_t^2 (y_t - x_t'\beta)^2 \quad (2)$$

where y_t is a general function of the independent variables x_t, and w_t is the value of the weight series.

Table 6 shows the weighted least squares results. In general, the estimation with the weights shows that the coefficients for most variables are very close to those in model 1, except for the dummy variable for proximity to the nearest transit station. For example, the coefficients for CTRL1 and CTRL2 became insignificant, while the coefficients for TREAT1 and TREAT2 decreased respectively, *ceteris paribus*, from 8.7% (OLS) to 5.3% (WLS) and from 7.9% (OLS) to 4.7% (WLS) when the weights were included. At the mean, this corresponds to RM35,510 and RM31,490, respectively. The results support previous empirical evidence that the impact of the urban transit system on residential property values tends to be concentrated within 0.8 km or 10 minutes walking distance from the nearest station.

CONCLUSION AND POLICY IMPLICATIONS

This study was motivated by the desire to determine the incremental value of urban rail transit investments in Subang Jaya, Selangor. Using the DID method with transaction-based data of terraced properties, this study confirms results found in other areas in terms of value appreciation from urban rail investments such as LRT, where such investments significantly increase the value of residential properties. As shown above, a typical terraced unit located within 0.8 km (TREAT1) of the nearest LRT station and sold during the construction phase of the project and after the system became operational experienced a premium of approximately 4.7% and 5.3%, or RM31,490 and RM35,510 on average, respectively. This is derived after controlling property markets with similar locational characteristics and income groups, as well as physical characteristics of the property.

Table 6: *Results of DID model: Weighted least squares (WLS)*

	Unstandardized coefficients		**Standardized coefficients**			**Collinearity statistics**
	B	**Std. Error**	**Beta**	**t**	**Sig.**	**VIF**
Constant	12.615	0.049		258.965	0.000***	
LOT	0.000	0.000	0.223	5.610	0.000***	2.254
FLOOR	0.000	0.000	0.401	10.114	0.000***	2.243
SCH1	0.002	0.010	0.006	0.192	0.848n/s	1.169
SCH2	0.004	0.010	0.012	0.435	0.664n/s	1.078
COM	0.007	0.016	0.017	0.423	0.672n/s	2.245
TREAT1	0.053	0.014	0.146	3.758	0.000***	2.145

CTRL1	0.014	0.019	0.025	0.746	0.456n/s	1.626
TREAT2	0.047	0.017	0.100	2.858	0.004***	1.759
CTRL2	0.028	0.022	0.041	1.299	0.194n/s	1.421
Adj. R^2	0.295					
SSE	1.495					
F-statistics	47.703					

Notes: *** indicates significance at the 0.01 level.

Moving beyond the statistical results, the findings of this study provide the necessary empirical evidence for the potential implementation of a land value capture mechanism as an alternative revenue source to fund or at least partially fund urban rail transit investments in Malaysia. As noted in the introduction, traditional mechanisms for financing the costs of urban rail construction, operation, and maintenance are becoming increasingly inadequate due to budgetary constraints. With the exception of Hong Kong's Metro and Singapore's MRT, most urban rail transit systems are not self-sustaining since they mainly rely on government support to cover costs. This is further exacerbated by government financial support for public transport becoming increasingly limited and uncertain. Given these challenges, it is crucially important to reflect on the implications of this study for the potential implementation of a land value capture mechanism. To date, many cities in the United States (US), the United Kingdom (UK), Japan, China (especially Hong Kong), Singapore, and Brazil have adopted various mechanisms to capture the land value increases generated by urban rail transit, whether through taxes or fees, such as special assessment districts (known as betterment taxes in the UK), tax increment financing, transport service charges, and development contributions, or through development-based mechanisms such as joint development, transit-oriented development, land sales or leases, and sales of air rights.

Table 7: *Estimation of value increment from the Kelana Jaya LRT line access*

Radius distance	Property area (sq. feet)	Price premium	Value increment (Ringgit Malaysia)
Radius 0.8 km (during construction phase)	246,000	0.053	7,878,170.176
Radius 0.8 km (after operation)	132,190	0.047	3,703,773.070
Total			11,581,943.246
	Simulation of value capture scenarios		57,909.716
	0.5% capture rate		115,819.432
	1.0% capture rate		579,097.162
	5.0% capture rate		

Notes: Property refers to the floor area of terraced units. Value increment is a result of property units*average price*price premium/average floor size of the building. Average prices are RM657,505 (after operation) and RM662,311 (during the construction phase), while average buildings are 1,088 (after operation) and 1,111 (during the construction phase), respectively. *Source*: Adapted from Xu et al. (2016).

Based on the results of this study, we may illustrate land value capture under different mechanisms in the scenarios cited above for Subang Jaya in particular, and Greater Kuala Lumpur in general. One possible method is to impose a direct value capture tax assessment within a 0.8 km radius of the nearest station. Using the data based on 226 (after operation) and 119 (during construction phase) transaction records of terraced properties located within a 0.8 km radius of the nearest LRT station in Subang Jaya, the average price, the price premium created by LRT and divided by the average size of the property, the value increment can be calculated. Table 6 shows the results of value increments accruing from the Kelana Jaya LRT line access. Introducing an urban rail transit value increment tax of 0.5%, 1%, and 5% on terraced units located within a 0.8 km radius of the nearest station would result in revenues of nearly RM58,000, RM116,000 and RM580,000, respectively. These figures are only indicative of the value capture revenue estimated from transaction records of terraced units obtained for this study. An interesting accounting implication arising from these revenues is that they could provide a significant financial incentive to fund urban rail transit projects in Greater Kuala Lumpur.

While the results of this study are believed to be relatively robust, admittedly, there are some limitations that should be considered in tandem with avenues for future studies. It is suggested that future research should use longer periods of longitudinal data spanning at least five years prior to the announcement of the construction of a new LRT line in the area. In addition, additional property and locational characteristics could, for example, include the property's age and ambient noise levels.

In summary, this research has successfully determined value uplift from urban rail transit investments in Subang Jaya, Selangor. More importantly, knowledge of property value appreciation surrounding rail transit stations is important as it helps shed light on future planning and development of sustainable public transport systems such as the urban rail systems in Greater Kuala Lumpur and other cities.

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