Shopping Centres and the Price of Proximate Residential Properties.

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Abstract

The paper investigates the relationship between shopping centres (as a whole) and the price of neighbouring residential properties as well as the relative advantage(s), in terms of proximity factor effect, of a modern shopping mall and a conventional town centre. It is found, through hedonic analysis of 8600 transactions from 19 public housing estates, that proximity to shopping centres generally commands a premium. Notwithstanding the negative externalities of shopping centres, residential properties within 100-metre radius of shopping centres command a higher premium than those farther away although the price-distance relationship is not monotonic while the proximity factor varies from housing estate to housing estate. Furthermore, the results of the study show that residential properties near a town centre with a shopping mall command a higher premium than those near a town centre without a shopping mall. These findings will be of interest to investors in public housing and policy makers.

Key Words: *Shopping mall, town centre, public housing, hedonic model, proximity factor, premium*

Introduction

Modern urban theory extends traditional economic theories of market behaviour to space consumption and locational preference. As suggested by Berry and Bednarz (1979), land and property values ultimately result at any point in space from the complex interaction of amenity and location attributes relative to a series of urban goods and services. Therefore, house price should, among other things, reflect the combined influence of positive and negative externalities of various proximate location attributes (see Kauko, 2003). With the increase in the standard of living, residents are also paying more attention to the location of flats which affects the living environment. Thus, externalities that impact property values are of great importance to the owners.

Shopping centre, as an externality, simultaneously exerts both attractive and repulsive effects which can impact a household's location choice. It is attractive when it provides convenience to the residents (i.e. savings in travel time) in close proximity to it. It becomes a negative externality when it generates too much traffic, noise and pollution to disturb the peace and tranquility expected by residents of nearby houses.

In the early development of Singapore, the shopping belt was confined to the central part of Singapore along Scotts Road and Orchard Road. Over time, more shopping centres such as Bugis Junction and Suntec City were built in the fringe areas.

Moreover, with approximately 85% of Singapore's population residing in HDB housing estates (General Household Survey 2005), planned shopping centre is a common feature in all estates as each public housing estate is planned to be a self-sufficient town to meet the day to day needs of the residents. As Singapore developed, the shopping facilities in the town centres slowly evolved from being housed in shophouses to integrated retail developments (shopping malls) offering all sorts of services. Currently, the shopping areas in HDB towns (i.e. neighbourhood shopping centre in planning terms) offer a 'one-stop' shopping experience and have become a focal point for neighbourhoods to enhance community living.

Grether and Mieszkowski (1980) postulate that "land use externalities may be very localized so that they are next door phenomena" to imply that proximity effect is unlikely to extend very far in space. According to Reilly's (1931) retail gravitational theory, the size of a shopping centre is expected to positively influence households' locational choice and preference. Colwell *et al*. (1985), Rosiers *et al*. (1996), Sirpal (1994]) conclude that shopping facilities are positive externalities. Notwithstanding these findings, proximity to shopping centres could be a blessing or a curse to nearby residential properties – A blessing if nearness to a shopping centre turns out to be a positive externality and a curse if the proximity factor is a negative externality. Therefore the paper is aimed at :

a) Assessing the magnitude and direction of the impact of neighbourhood shopping centres on the values of public residential properties located within 500m radius of the town centres.
b) Ascertaining the relative impact of the type of shopping centre on public residential property values.

The paper proceeds as follows. The next section is devoted to literature review. This is followed by data sourcing and management after which the results of the data analyses are presented and discussed. The last section is devoted to concluding remarks.

Literature Review

Residential property value is a bundle of both endogenous and exogenous attributes Each property is not only a composite of structural/physical characteristics; it is also a set of neighbourhood and location characteristics. Structural/physical characteristics refer to the 'make' of the property such as type of house, number of bedrooms, area, floor level and tenure while neighbourhood characteristics include socioeconomic variables such as average household income and predominant land uses such as percentage of land area that is undeveloped or devoted to residential uses (Basu and Thibodeau [1998]). Location characteristics that influence house prices include accessibility and proximity (Basu and Thibodeau [1998]).

Accessibility determinants of house prices include distance to employment centres, transportation networks, recreation facilities and shopping facilities (Basu and Thibodeau [1998]). Similarly, examples of proximity externalities include distance to nearby non-residential uses such as parks, commercial properties, schools, etc. (Basu and Thibodeau [1998]). Tse and Love (2000) suggest that house price accessibility and amenities are strongly connected.

Previous research is mostly limited to evaluating the effect of externalities on residential land uses. Externalities arise when a specific land use affects neighbouring properties and causes a change in their values (Do *et al.*,1994). Galster (1986) uses bid rent theory to explain the discrete short and long-term effects of negative externalities on real property. Holding everything else constant, a property that is subject to any form of undesirability such as inconvenience or nuisance would experience a decline in property value, at least, in the short term.

Blomquist (1974) uses linear distance as a proxy to assess the influence of an electric power plant on selling prices of nearby residential properties. Blomquist (1974) concludes that an electrical power plant is a form of negative externality.

Cheshire and Sheppard (1995) state that amenities can influence land price. Lentz and Wang (1998) conclude that specific local externalities such as proximity to industry and refineries affect property values negatively. Similarly, Delaney and Timmons (1992) state that the market value of residential property is affected by proximity to high voltage power lines. Do *et al.* (1994) report that churches are a negative externality. However, Carroll *et al.* (1996) contradict Do *et al.* (1994) by concluding that churches are a positive externality.

Tideman (1970) finds that property owners beyond some critical distance do not regard the presence of disamenity as having any negative effect on the value of their property. This is supported by Grether and Mieszkowski (1980) who find that non-residential uses such as highways, commercial strips and industrial properties do not show a systematic effect on house values. Their research shows that land use externalities tend to be very localised and thus, proximity effect does not extend very far in space.

Shopping Centre As An Externality

Shopping centre is a building or set of buildings that contain a variety of retail units, with interconnecting walkways enabling visitors to easily walk from unit to unit (www.wikipedia.org). In the modern history of Singapore, shopping centres/malls are planned development, as part of the Government's urban renewal of the city. Besides the key objective to allow convenient 'trading' of goods and services, shopping centres, in particular those in the suburban areas, have evolved to become a focal point for the neighbourhoods. Lifestyle and recreational facilities are now included in the retail space to enhance community living.

Shopping centre as a locational factor is considered as an externality. As with other sources of externalities, it can have negative or positive impact. The repulsive effects would stem from traffic congestion, noise or pollution generated by the facilities. The attraction would be the easy access which can translate into travel cost savings.

A study done in the US by Colwell *et al*. (1985) suggests that the proximity effects of being in the vicinity of a specific land use is not likely to extend very far in space and may vary across locations. The study controls for 'before and after' effects by using sales transactions of a neighbourhood before and after the public announcement of a shopping centre was made. It is found that shopping centre is both a positive and negative externality. At distance closer than 1500 feet, diseconomies appear to dominate. Properties located beyond 1500 feet of the shopping centre were valued more. This suggests that there might be an optimal spatial frequency of these shopping centres.

Sirpal (1994) extends the research further by examining price differences of identical residential properties located around shopping centres of different sizes in Florida. Various models (the linear, the semi-log, the log linear, and the inverse model with and without squared distance) are tested and it is found that the size of a shopping centre is found to have a positive contributory effect on the values of the surrounding residential properties. Based on one of the more reliable models (log-linear) defined in the research, the results indicate that the value of a residential property nearer to a larger shopping centre is higher than that of an otherwise identical residential property located near a smaller shopping centre by 5%. The study also shows that house prices tend to rise with an increase in distance from the nearby shopping centre, reach maximum, and then fall. However, no firm conclusion is drawn about the monotonicity of a rise in house price with distance from a centre in the study.

Following Sirpal's (1994) suggestion to confirm the effects of varying sizes of shopping centres on surrounding residential values, Rosiers *et al*. (1996) conduct a similar investigation in a Canadian urban context to conclude that houses near to the shopping centres command a premium of 5%. It is found that house prices first rise, achieve a maximum within the 200m to 300m buffer and then fall almost constantly afterwards. Although the study shows a price rise within the 500m to 600m buffer, the coefficient of the variable is not significant. Such results suggest that the relationship between house prices and distance to the nearest shopping centre is non-monocentric. The study (Rosier *et al*., 1996) also considers various shopping centre sizes and their impact on house prices to conclude that the larger the retail complex, the greater the optimal distance, i.e. the impact on house value stretches further in distance. Optimal distances are established at 0.215, 0.310 and 0.532 km for neighbourhood, community and regional shopping centres respectively.

On the contrary, Tse and Love (2000) have found that residential properties in Hong Kong exhibit a positive price-distance relationship with shopping centres. Accessibility to a shopping centre is not a favourable attribute for small/medium units in determining prices. That is, house price increases as distance from the shopping centre increases. In view of the above review, the following hypotheses are formulated:

a. **Hypothesis One**
Flats near to shopping centres command a premium.

b. **Hypothesis Two**
Property value decreases with increase in distance to the shopping centre.

c. **Hypothesis Three**
The premium paid for a property at the same distance to a town centre which incorporates a shopping mall is higher than that of an otherwise identical property located at the same distance to a conventional town-centre of shop-houses

Data Sourcing and Management

The above hypotheses are operationalised via the hedonic model. The hedonic price model has been widely employed to explore locational and neighbourhood attributes namely quality of public schools (Haurin and Brasington [1996], Clauretie and Neill [2000]); proximity to shopping complexes (Sirpal [1994], Rosiers *et al*. [1996]); places of worship such as churches (Carroll *et al*.,1996); hospitals (Huh and Kwak [1997]) as well as structural attributes such as floor area or size (Mok *et al*. [1995] and Carroll *et al*. [1996]). Mok *et al*. (1995) and Tse and Love (2000) also use the hedonic price model to estimate the implicit price of sea view and cemetery views respectively.

However, finding the correct specification of the hedonic relationship requires researchers to identify both the correct list of independent variables and the true functional forms (Linneman [1980]). Some studies give primary importance to physical/structural traits such as number of rooms, bathrooms (Linneman [1980]) and age of the building (Kain and Quigley [1970]); some focus on amenities such as churches (Carroll *et al*., 1996) and schools (Clauretie and Neill [2000]) while others emphasize the role of the neighbourhood traits (Goodman and Thibodeau [1998]). Ideally, all housing traits considered in valuing a property should be included in the hedonic model.

Some studies are concerned about the collinearity between housing attributes and thus, omit a large number of housing traits (Constantine [1994]). However, this does not necessarily solve the problem. In fact,

> "…..the omission of variables that should be in the model only confounds the problem because the least square regressor yields consistent and efficient estimates only when the model is correctly specified. The omission of important traits on the basis of multicollinearity insures that both the standard errors and hedonic coefficients of the remaining traits are biased." (Consumer Reports [1996]).

Thus, researchers using the hedonic pricing technique face a tradeoff - including highly correlated variables causes collinearity to reduce the precision of parameter estimates, while omission of variables that should be in the regression model may result in biased estimates. Herein may lie the wisdom in the statement of Taylor and Wilson (1964) that :

> "To seek perfect specification for quantitative analysis of human behaviour is to seek the stars. Earth bound creatures must be content with approximate correct specification."

According to Butler (1982), the intrinsic clustering of characteristic combinations into a relatively small number of configurations leads to considerable multicollinearity in estimates employing a generous selection of the relevant variables. He postulates that it is inevitable for any estimate of a hedonic relationship to be mis-specified as there is a need to omit some of the relevant independent variables. Butler (1982) finds that even severely restricted specification appears to suffer only limited coefficient biases, with a negligible impact on the explanatory and predictive powers of the equation. Similarly, Mok *et al*. (1995) favour using a smaller number of variables as they argue that biases due to missing variables are small. For example, Mok *et al*. (1995) do not include the number of rooms as an independent variable in their study since number of rooms is highly correlated with floor area.

Furthermore, hedonic theory offers very little guidance on the correct functional form. As economic theory is ambiguous about the appropriate form, using linear and logarithmic functional forms in housing market analysis is not uncommon. Colwell *et al*. (1985) test their hypotheses on six functional forms (Linear, Semi-Log, Exponential, Log-Linear, Inverse and Inverse-Inverse). The Log Linear Model is selected because of the ease in interpreting the regression coefficient while its log likelihood at the 95% level of confidence is not significantly different from the maximum log likelihood given by other models. Similarly, Rosiers *et al*. (1996) demonstrate that all tested functional forms (Linear, Semi-Log, Log-Linear and Inverse models) yield satisfactory results although the best performance is obtained using either a log-linear or the inverse model.

.Research Model

The relationship between property value and the key characteristics of a property are broadly summarized in Exhibit 1.

Exhibit 1

However, it is acknowledged that the locational and neighbourhood attributes cannot be clearly segregated. For example, the proximity to a good quality school can bring about a higher neighbourhood quality and a good neighbourhood can in turn attract better amenities such as higher-grade shopping malls. For the purpose of this study, the quality of the neighbourhood is not considered as the social and environmental characteristics of HDB estates are similar due to the current governing policies which include the predominant land use, family income cap in eligibility for HDB flats application and racial quota for each estate.

A log linear hedonic price equation is developed to explore the relationship between the market resale price and the various relevant physical attributes such as floor area, floor level, age as well as the location of the property in relation to sports centre, schools, places of worship, parks, industrial buildings, MRT, bus-interchange and most importantly, distance to the shopping centre. Time of sales is also included to account for fluctuations in the market resale price. One advantage of this functional form is that the parameter estimates are actually direct expressions of elasticity coefficients.

The data relate to nineteen (which have established town centres - Exhibit 2) of the twenty seven HDB housing estates in Singapore.

Exhibit 2

HDB housing blocks within 500m radius from the centre of the shopping centre were extracted from StreetMap@Singapore, a free electronic street directory provided by SLA. The data for the selected blocks were obtained from SISV Realink Database for a period of three years from November 2005 to October 2008. The data extracted include the resale price, address, floor level, floor area, type of housing unit, transaction date and age of the unit at the point of sale. In addition two sets of secondary data were collected over a period from 7 December 2008 to 27 December 2008 for the paper :

a) Crow-fly (straight-line) distance from the centre of the block to the centre of the shopping centre/town centre, as measured from the plans**.**

b) On-site survey to determine the locational attributes of the areas that are under investigation.

A total of 8627 housing transaction records were obtained for this study. As HDB is only able to provide 5 categories of floor levels, dummy variables instead of a discrete variable for each floor level are deployed to differentiate one category of floor level from another. Similarly, the amenities/externalities in the locational attribute are assigned dummy variables except the proximity to shopping centre, which is the focus of this study. The crow-fly (straight-line) distance between the centre of the block and the centre of the shopping centre/ town centre is used to determine the impact of shopping centre on housing price. Age and time-period of the sale of the transacted unit are discrete variables whereas area and distance to shopping centre are continuous variables (see Exhibit 3).

Exhibit 3

Specifically, the estimators of the discrete and continuous variables represent the corresponding price elasticity. The significance of the coefficient 'DistShop' is of concern in this study. The sign of 'DistShop' variable will indicate whether it is a positive (sign '–' since price will decrease with increase in distance from the shopping centre) or a negative (sign '+') externality. The variables for the hedonic model are shown in Exhibit 3.

The regression equation is expressed as follows:

$$\begin{aligned}\text{Ln(Price)} = {} & \alpha + \beta1(\text{Level}) + \beta2(\text{Type}) + \text{B3Ln(Age)} + \\ & \beta4\text{Ln(Area)} + \beta5(\text{Sch}) + \beta6(\text{Park}) + \beta7(\text{Sea}) + \beta8(\text{Worship}) + \\ & \beta9(\text{Office}) + \beta10(\text{Industrial}) + \beta11(\text{MRT}) + \beta12(\text{Bus}) + \beta13(\text{Sports}) + \\ & \beta14(\text{Library}) + \beta15(\text{CC}) + \beta16(\text{Market/FC}) + \beta17(\text{Medical}) + \\ & \beta18(\text{Police}) + \beta19\text{Ln(DistShop)} + \beta21\text{Ln(Index)} + \varepsilon_i\end{aligned}$$

where α = Intercept

$\beta1 \ldots \beta n$ = Regression coefficients

ε = Random element that reflects the unobserved variation in the house prices

Three models of the above regression equation are used for the analyses:

a) <u>Model A</u>

This is the aggregate model using the full sample of 8627 sales data to assess the price -distance relationship of shopping centres and property values in general, i.e. to test Hypothesis One and Two that flats near to a shopping centre command a premium and that property value will decrease with increase in distance to the shopping centre. The sample is also analysed on a per estate basis for clarity on the effect of the shopping centre proximity factor.

b) <u>Model B</u>

The full sample is sub-divided into 5 concentric zones at 100m intervals to assess if the price-distance effect is consistent throughout the whole spatial distance of 500m. The five designated zones are : Zone 1 (>0m to 100m), Zone 2 (>100m to 200m), Zone 3 (>200m to 300m), Zone 4 (>300m to 400m) and Zone 5(>400m to 500m).

c) <u>Model C</u>

Two sub-samples are delineated to test Hypothesis Three, i.e. whether the proximity factor to a town centre with a shopping mall commands a higher premium than one without a mall. There are 7317 sales data for the town centres with a shopping mall and 1310 sales data for conventional town centres.

Evaluation of Models

To ensure the accuracy of the model, the Pearson's Bivariate Correlation Analysis Test was carried out prior to the running of regression of the full sample. The Pearson's correlation coefficient is used to check the correlation among the predictors and to eliminate those that are strongly correlated. Field (2005) suggests that a correlation factor of around 0.8 or 0.9 is of concern and that the related predictors should be eliminated.

From the correlation matrix shown in Exhibit 4, it is observed that the 'Type' and Ln_Area are highly correlated with a factor of 0.942. Since the type of flats is highly associated with floor area, the floor area variable can represent it. Thus, to avoid multicollinearity problem, the 'Type' (type of flats) variable was removed prior to the running of the regression.

Residual analysis was also carried out to detect potential outliers which can cause the model to be biased. This is to prevent estimators from being unduly affected by some market anomaly. The standardized residuals are checked to ensure that no more than 5% of the cases have absolute values above 2 and that no more than 1% have absolute values above 3 (Field [2005]). A total of 378 cases out of 8627 sales data have standard residuals above 2. This is around 4.4% which is within the norm. Similarly, the proportion of 0.5% of the sales data with absolute values above 3 is within the acceptable level of 1% (i.e. 78 < 86 respectively)

Exhibit 4

Both R^2 and F-ratio are used to assess the goodness of fit for the three models. A good model should have a large F-ratio that is greater than 1 (Field [2005]). All the three models have high explanatory power and statistically significant F-ratio (Exhibit 5)

Exhibit 5

Results for Model A – Hypotheses One & Two

The sales data for the study mainly relate to 3-room, 4-room and 5-room flats (90%) with 2-room and executive-type flats making up for the remaining 10%. The results presented in Exhibit 6 reveal that the mean price of flats is $286,288 with a standard deviation of $91,157. The highest/minimum price is $728,000 and $107,000 respectively. The mean price of flats (by type of flats) varies from estate to estate. Furthermore, the average age of the flats within 500m radius from the centre is 18 years.

Exhibit 6

All variables (with the exception of office, β=0.009, ρ-value 0.061>0.05) in the full regression model are statistically significant at the 95% confidence level (Exhibit 7).

The results reveal that larger and newer flats located on higher floors command a higher price. Where externalities are concerned, flats near amenities such as medical institution, community centre, sports facilities, parks and seas command a premium that ranges from 8.1% to 32% (Exhibit 7). In contrast, amenities like schools, library, MRT, police stations, market/food centre, bus interchange and industrial area have a negative impact on the transacted prices.

Exhibit 7

The hypothesized signs for the coefficients of all the variables are consistent with the regression results except for medical, MRT, schools and library. For the latter two, a possible reason could be that these places generate a lot of human and vehicular traffic which can disturb the peaceful sanctuary expected from a residential area. The most striking feature of the results is the high coefficient of the dummy variable ‘Sea’ (β=0.283) and ‘Sports’ (β=0.324) which are statistically significant at the 95% confidence level (Exhibit 7).

The coefficient for ‘Ln_DistShop” (β=-0.047, see Exhibit 7) is of primary interest as that is the focus of the paper. The results imply that as distance from the shopping centre decreases by 1%, price of the flats increases by 4.7% (i.e. proximity to a shopping centre commands a premium). The premium is statistically significant and consistent with the earlier findings of Sirpal (1994) and Rosiers *et al*. (1996).

Further analysis is also carried out to determine if the premium paid for the proximity factor observed in the full sample model is consistent with that for each estate (Exhibit 8). The results in Exhibit 8 indicate that the shopping centre proximity premium, which varies across estates, is statistically significant for all estates except Bishan, Jurong East and Toa Payoh. The highest proximity factor premium occurs in Marine Parade (β=-0.238, ρ<0.05) and the lowest in Bedok (β=-0.017, ρ<0.05).

Thus, there is not sufficient evidence to reject Hypothesis One and Two which state that flats near to the shopping centre command a premium and that property value decreases with increased distance from the shopping centre, i.e. shopping centre is a positive externality.

Exhibit 8

Results of Model B - Test of Hypothesis One and Hypothesis Two

The results presented in Exhibit 9 show that the premium for proximity to shopping centre varies across the five concentric zones. However, the premium for each of the five zones is statistically significant at the 95% confidence level. Within 100m radius proximity to shopping centres (Zone 1), flats are more desirable and can command a premium of 15% ($\rho<0.05$). Beyond 100m, the premium for shopping centre proximity factor declines in an inconsistent pattern. Flats in Zone 2 command a price premium of 9.1% whereas those in Zone 3 can command a premium of 9.4%. The premium for the proximity factor is reduced to 7.7% in Zone 4 before this attribute becomes more attractive again in Zone 5 ($\beta=0.132$, $\rho<0.05$).

Exhibit 9

The results suggest that the relationship between house prices and distance to the nearest shopping centre is non-monocentric which is consistent with earlier findings by Rosiers *et al*. (1996). However, they contradict Sirpal (1994) that house prices tend to rise with an increase in distance from the nearby shopping centre, reach a peak, and then fall.

Furthermore, the results show that homeowners value properties within very close proximity (>0-100m) to the shopping centres. This suggests that in Singapore, homeowners have a higher threshold of the negative externalities such as noise, pollution and traffic congestion generated by the shopping centres than their counterparts in the 'West' where similar studies have been carried out. This is most likely due to homeowners' preference for the convenience factor of being close to shops. Another reason could be the scarcity of flats within Zone 1 as evidenced by the number of resale transactions for the zone.

Beyond 200m, though homeowners still regard the shopping centre as a positive externality, they are perhaps willing to tradeoff the 'convenience' for other factors, like having less noise, pollution and traffic. Moreover, the analysis show that the proximity effect of shopping centre on housing value, may extend beyond 500m radius.

Results of Model C- Test of Hypothesis Three

Two sub-samples are delineated to test Hypothesis Three as to whether the premium paid for proximity factor to a town centre with shopping mall is higher than one without. The test statistics in **Exhibit 10** show that flats within a town centre with a shopping mall commands a price premium of 6.1% (ρ<0.05) as opposed to one without. This establishes Hypothesis Three. However, homebuyers should be aware that this result is an average statistic, generated from an aggregate model. As shown in Model A (see Exhibit 8), housing premium for shopping centre proximity factor varies across estates. Some estates with conventional town centre can actually command a higher premium than one with shopping mall.

The sign generated for the coefficient 'Ln_DistShop' for the subset without a shopping mall is positive, which contradicts all earlier findings. This suggests that a conventional town centre is a negative externality. However, since the result is not statistically significant, this finding is not much of a concern

Exhibit 10

Post Model Evaluation

To ensure the reliability of the model, the assumptions of the multiple regression analysis are tested for heteroscedasticity, multicollinearity and independence of residuals.

Assumption of normal distribution of data is an important prerequisite for some statistical tests (parametric) and regression methods. This assumption can be tested by using various graphical methods like rankit plots, normal probability plots and tests like Shapiro-Wilk [SW] or Kolmogorov-Smirnov [KS] tests. For this research, the graphical method is used to test this assumption. A simple way to test the normality assumption is to look at the distribution of data as a histogram and see if it assumes a bell-shaped distribution that is characteristic of a normal or Gaussian distribution [ND]. In addition, the normal probability plots are generated to verify the assumption of normality of errors.

Another critical assumption of the classical linear regression model is that it assumes that all cases have equal error variance (homoscedasticity). If this assumption is not satisfied, heteroscedasticity occurs. When heteroscedasticity is mild, OLS standard errors behave quite well (Long and Ervin [2000]). However, when heteroscedasticity is severe, ignoring it may bias the standard errors and *p* values. The direction of the bias depends on the pattern of heteroscedasticity: *p* values may be too large or too small. Hence, the scatter plots of the residuals of the outcome variable and the predictors are also used to check on the assumption of homoscedasticity.

The histogram and normal probability plot of the three models (see Appendix)) are indicative of a situation in which the assumption of normality of errors is met. The bell-shaped curve of the histograms represents a normal distribution while the normal probability plots show normal distribution of the observed residuals which depict a straight line from the lower left corner to the upper right corner. The scatter plots for the models generally reflect a high degree of randomness apart from some outliers. These patterns show that the assumptions of linearity and homoscedasticity are met.

Multicollinearity refers to the case in which two or more explanatory variables in the regression model are highly correlated, making it difficult or impossible to isolate their individual effects on the dependent variable. It limits the value of the R-square which results in unstable predictor equations and also makes it difficult to assess the importance of the individual predictors. There is no sure method to get rid of this problem although elimination of highly correlated variables through scanning of correlation matrix can help. However, this ball park method tends to miss more subtle forms of multicollinearity. This can be overcome by using SPSS's collinearity diagnostics tools, two of which are the variance inflation factor (VIF) and tolerance statistics (with tolerance being 1 divided by the VIF). The VIF indicates whether a predictor has a strong linear relationship with other predictors. Myers (1990) and Bowerman & O'Connell (1990) suggest a threshold value of 10.

When the error term in one time period is positively correlated with the error term in the previous time period, the problem of autocorrelation occurs. This is common in time-series analysis and leads to downward-biased standard errors (leading to incorrect statistical tests and confidence intervals). The presence of autocorrelation can be tested by calculating the Durbin-Watson statistic. Field (2005) suggests that as a conservative rule of thumb, values less than 1 or greater than 3 are a cause for concern.

Based on the original model specification, the regression results of Model B (Zone 1, Zone 2 and Zone3) and Model C (With Shopping Mall) show that some variables have high VIF values (see Exhibit 11 – Column (c)) which indicate a multicollinearity problem. This results in incorrect signs associated with the coefficients which in turn affects the ability to directly interpret estimated regression coefficient. For example, based on the original specification of Model B–Zone 2, the regression coefficient for 'Ln_DistShop' was not statistically significant ($\beta=0.26$, $\rho>0.05$) with a positive sign instead of a negative sign as observed in other Zones. To address this problem, the affected models were re-specified by dropping the offending (least important) variables (see Exhibit 11)**.**

Exhibit 11

The Durbin-Watson statistic, highest VIF values and lowest tolerance statistics of Model A, B and C are presented in Exhibit 12 The results show that the VIF values are below 10 and tolerance statistics are all above 0.1. Likewise, the Durban-Watson statistic for all models is also between the acceptable range of 1 and 2 which shows that the assumption of independent errors is tenable. Thus, the models are statistically valid and reliable.

Conclusion

Shopping centre is an externality that simultaneously exerts attractive as well as repulsive effects which can impact household's location choice. The paper is aimed at determining the impact and magnitude of shopping centre effect on public residential property values. The hedonic pricing model is used to analyse 8627 sales to ascertain the proximity effect of shopping malls on the price of HDB apartments. The results reveal that homebuyers pay an average premium of 4.7% for shopping centre proximity factor. However, the premium varies from estate to estate, ranging from 23.8% (in Marine Parade) to 1.7% (in Bedok Estate). Furthermore, Flats within the 100m radius from the shopping centre command the highest premium of 15%. The price premium for this attribute decreases with increases in the distance from the shopping centre. However, the decline in premium does not show a consistent pattern. The findings also show that the price-distance relationship for the proximity factor to shopping centre is likely to stretch beyond 500m. Flats within a town centre with a shopping mall on the average, are considered more attractive. Homebuyers pay a price premium of 6.1% for a flat located in an estate with a shopping mall as opposed to one without. However, this does not mean that only flats with proximity to a town centre with shopping mall can command a premium. Some housing estates with conventional town centre fetch a higher premium for the shopping centre proximity factor than some with a shopping mall.

Reference

Basu Sabyasachi and Thibodeau Thomas G.1998), Analysis Of Spatial Autocorrelation In House Prices, *Journal of Real Estate Finance and Economics*, Vol 17(1), 61-85

Berry, B. J. L. and Bednarz, R. S. (1979), 'The Disbenefits of Neighbourhood and Environment to Urban Property', in D. Segal (ed.), *The Economics of Neighbourhood*, Academic Press: New York, pp 219-252

Bloomquist, G.(1974), The Effect of Electric Utility Power Plant Location on Area Property Value, *Land Economics*, Vol 50(1), pp 97-100

Butler Richard V. (1982), The Specification Of Hedonic Indexes For Urban Housing, *Land Economics* Vol 58(1), pp 97 – 108

Carroll T., Clauretie T. and Jensen J. (1996), Living Next To Godliness: Residential Property Values And Churches, *Journal of Real Estate Finance and Economics* Vol 12, pp 319-330

Cheshire, P. and Sheppard, S. (1995), On The Price Of Land And The Value Of Amenities, *Economica* Vol 62, pp 247-267

Clauretie, T. M. and H. R. Neill (2000), Year-Round School Schedules and Residential Property Values, *Journal of Real Estate Finance and Economics* Vol 20:3, pp 311–322.

Constantine, J. (1994), Market Research: Survey of Homebuyers Shows Interest in Traditional Neighbourhood Development, *Land Development* (Winter 1994), pp 5-7

Consumer Reports (1996), *Neighbourhood Reborn* (May 1996), pp 24-29

Colwell Peter F., Gujral Surinder S. and Coley Christopher (1985), The Impact Of A Shopping Centre On The Value Of Surrounding Properties, *Real Estate Issues*, Spring/Summer 1985, pp 35-39

Delaney, C.J. and Timmons, D. (1992), High Voltage Power Lines: Do They Affect Residential Property Value?, *Journal of Real Estate Research* Vol 7 No. 2, pp 315-329

Do Quang A., Wilbur R. and Short J. (1994), An Empirical Examination Of The Externalities Of Neighbourhood Churches On Housing Values, *Journal of Real Estate Finance and Economics* Vol 9(2), pp 127-137

Field Andy (2000), *Discovering Statistics Using SPSS (2nd Edition)*, SAGE Publications

Freeman, A. M., Hedonic Prices (1979), Property Values and Measuring Environmental Benefits: A Survey of the Issues, *Scandinavian Journal of Economics* Vol 81, pp 154–171

Galster, G.(1986), Nuclear Power Plants and Residential Property Values: A Comment on Short-Run vs. Long-Run Considerations, *Journal of Regional Science*, Vol 26(4), pp 803-805

Grether M. David and Mieszkowski, Peter (1980), The Effects Of Nonresidential Land Users On The Prices Of Adjacent Housing: Some Estimates Of Proximity Effects, *Journal of Urban Economics* Vol 8, pp 1-15

Goodman, A.C. and Thibodeau, T.G. (1998), Housing Market Segmentation, *Journal of Housing Economics* Vol 7, pp 121-143

Haurin, D. R. and D. Brasington (1996), School Quality and Real House Prices: Inter- and Intra-metropolitan Effects, *Journal of Housing Economics* Vol 5, pp 351–368

Huh, S. and S. J. Kwak (1997), The Choice of Functional Form and Variables in the Hedonic Price Model in Seoul, *Urban Studies* Vol 34(7), pp 989–998

Kain, J. F. and J. M. Quigley (1970), Measuring the value of house quality, *Journal of the American Statistical Association* Vol 65(330), pp 532-548

Kauko Tom (2003), Residential Property Values And Locational Externalities, *Journal of Property Investment & Finance* Vol 21(3), pp 250-270

Kryvobokov, Marko (2005), What Location Attributes Are The Most Important For Market Value? *Property Management* Vol 25(3), pp 257-286

Lentz, GH and Wang, K (1998), Residential Appraisal And The Lending Process: A Survery Of Issues, *Journal of Real Estate Research* Vol 15(1/2), pp 11-39

Linneman, P., Some Empirical Results on the Nature of the Hedonic Price Function of the Urban Housing Market, *Journal of Urban Economics*, 1980, Vol 8(1), pp 47-68

Mok, H. M. K., P. P. K. Chan and Y-S. Cho (1995), A Hedonic Price Model for Private Properties in Hong Kong', *Journal of Real Estate Finance and Economics* Vol 10, pp 37–48.

Ooi Joseph T.L.and Loo-Lee Sim (2006), The Magnetism Of Suburban Shopping Centre: Do Size and Cineplex Matter?

Rosiers Francois Des, Theriault Marius and Villeneuve, Paul-Y (1999), Sorting Out Access And Neighbourhood Factors in Hedonic Price Modelling, *Journal of Property Investment & Finance* Vol 18(3), 2000, pp 291-315

Rosiers Francois Des, Lagana Antonio, Theriault Marius and Beaudoin Marcel (1996), Shopping Centres And House Values: An Empirical Investigation, *Journal of Property Valuation & Investment* Vol 14(4), 1996 pp 41-62

Rosen, S. (1974), Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition, *Journal of Political Economy* Vol 82(1), pp 35–55

Sirpal R. (1994), Empirical Modeling Of The Relative Impacts of Various Sizes Of Shopping Centres On The Values Of Surrounding Residential Properties, *Journal of Real Estate Research* Vol 9(4), pp 487-505

Theriault Marius, Des Rosiers Francois, Villeneuve Paul and Kestens Yan (2003), Modelling Interactions Of Location With Specific Value of Housing Attributes, *Property Management* Vol.21(1), pp 2-62

Tideman N.T (1970), Land Use Control Through Administered Compensation in *Program on Regional and Urban Economics Discussion Paper No. 59*, Harvard University Press

Tse Raymond Y.C., Love Peter E.D (2000), Measuring Residential Property Values in Hong Kong, *Property Management* Vol 18(5), pp 366-374

Tung-Leong Chin, Chau K.W and Ng F.F.(2004), The Impact Of The Asian Financial Crisis On The Pricing of Condominiums in Malaysia, *Journal of Real Estate Literature* Vol 12, No. 21

SISV Realink Database
http://srv1.sisvrealink.com/office/

StreetMap@Singapore
http://www.map.gov.sg/StreetMap/

Housing Development Board
www.hdb.gov.sg

Quantitative Economics for Business (Econometrics)
http://www.geocities.com/qecon2002/founda10.html

Wikipedia, The Free Encyclopedia
www.wikipedia.org

Singapore Department of Statistics
www.singstat.gov.sg

http://sciwebserver.science.mcmaster.ca/cspa/papers/index.html - F.Long, A. Paez and S.Farber (2007), Spatial Effects In Hedonic Price Estimation: A Case Study In The City of Toronto

Exhibit 1: Broad Attributes and Property Value

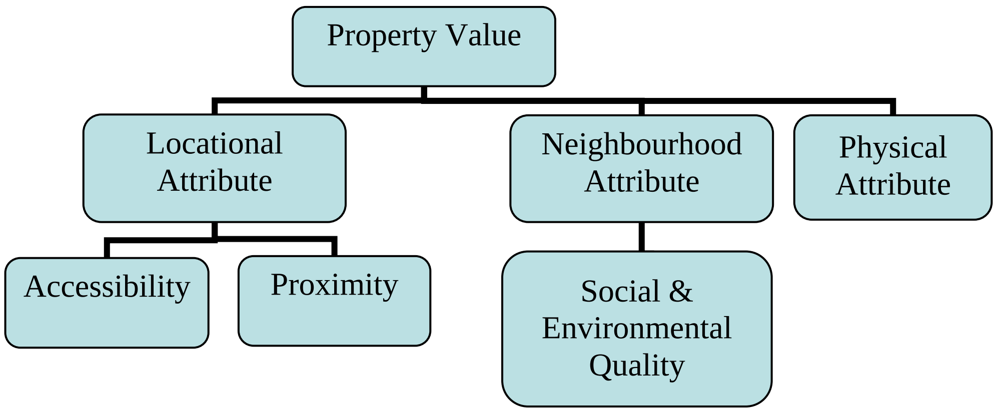


Exhibit 2: HDB Estates with Town Centres

a) HDB Estates with Shopping Mall	
Chua Chu Kang	Lot One
Bukit Panjang	Ten-Mile Junction
Bukit Batok	West Mall
Jurong West	Jurong Point
Marine Parade	Parkway Parade
Tampines	Tampines Mall / Century Square
Pasir Ris	White Sands
Sembawang	Sun Plaza
Woodlands	Causeway Point
Yishun	NorthPoint
Ang Mo Kio	Ang Mo Kio Hub
Sengkang	Compass Point
Hougang	Hougang Mall
Bishan	Junction8
Toa Payoh	Toa Payoh Hub
b) HDB Estates Without Shopping Mall	
Bedok	
Jurong East	
Clementi	
Bukit Merah	

Exhibit 3: Description of Variables

INDEPENDENT VARIABLES				
Attribute	**Variable**	**Definition**	**Type**	**Expected Sign**
Locational	Sch	If a school is located within 500m= 1, otherwise 0	Dummy	Positive
	Park	If a park is located within 500m= 1, otherwise 0	Dummy	Positive
	Sea	If sea is located within 500m=1, otherwise 0	Dummy	Positive
	Worship	If a place of worship is located within 500m= 1, otherwise 0	Dummy	Positive
	Office	If an office building is located within 500m=1, otherwise 0	Dummy	Negative
	Industrial	If a industrial site is located within 500m=1, otherwise 0	Dummy	Negative
	MRT	If MRT is located within 500m= 1, otherwise 0	Dummy	Positive
	Bus	If bus interchange is located within 500m=1, otherwise 0	Dummy	Negative
	Sports	If a sports amenity is located within 500m =1 , otherwise 0	Dummy	Positive
	Library	If a library is located within 500m=1, otherwise 0	Dummy	Positive
	CC	If a community centre is located within 500m=1, otherwise 0	Dummy	Positive
	Market/FC	If a market/food centre is located within 500m=1,otherwise 0	Dummy	Positive
	Medical	If a medical institution is located within 500m=1,otherwise 0	Dummy	Negative
	Police	If a neighbourhood police station is located within 500m=1, otherwise 0	Dummy	Negative
	DistShop	Distance to shopping centre in metres	Continuous	Negative

INDEPENDENT VARIABLES				
Attribute	**Variable**	**Definition**	**Type**	**Expected Sign**
Physical	Level	1 for Level 1 to 5 2 for Level 6 to 10 3 for Level 11 to 15 4 for Level 16 to 20 5 for Level 21 to 25 6 for Level 26 to 30	Discrete	Positive
	Type	2 for 2 room type of flats 3 for 3 room type of flats 4 for 4 room type of flats 5 for 5 room type of flats 6 for Exec type of flats	Discrete	Positive
	Age	Age of the Unit at the Point of Sale	Discrete	Negative
	Area	Floor Area in square metres	Continuous	Positive
Time Period	Index	HDB Quarterly Resale Index Return	Discrete	Positive

Exhibit 4: Pearson Bivariate Correlation

Correlations

		Type	Level	Ln_Price	Ln_Area	Ln_Age	Ln_Index	Ln_DistShop	Sch	Park	Sea	Worship	Office	Industrial	MRT	Bus	Sports	Library	CC	MarketFC	Medical	Police
Type	Pearson Correlation	1	.184**	.749**	.942**	-.486**	.016	.006	.022*	-.164**	-.004	-.274**	-.131**	-.057**	.106**	-.140**	-.261**	.180**	-.026*	-.087**	-.311**	-.236**
	Sig. (2-tailed)		.000	.000	.000	.000	.133	.547	.040	.000	.700	.000	.000	.000	.000	.000	.000	.000	.014	.000	.000	.000
	N	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627
Level	Pearson Correlation	.184**	1	.394**	.174**	-.253**	.024*	.036**	-.024*	-.076**	.039**	-.044**	.074**	.090**	-.056**	.029**	.036**	.117**	.172**	.091**	.165**	.014
	Sig. (2-tailed)	.000		.000	.000	.000	.027	.001	.023	.000	.000	.000	.000	.000	.000	.008	.001	.000	.000	.000	.000	.201
	N	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627
Ln_Price	Pearson Correlation	.749**	.394**	1	.762**	-.395**	.349**	-.058**	-.043**	-.088**	.110**	-.146**	.103**	-.022*	-.044**	-.054**	.000	.189**	.099**	-.042**	.008	-.089**
	Sig. (2-tailed)	.000	.000		.000	.000	.000	.000	.000	.000	.000	.000	.000	.045	.000	.000	.992	.000	.000	.000	.435	.000
	N	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627
Ln_Area	Pearson Correlation	.942**	.174**	.762**	1	-.438**	.009	.028*	-.026*	-.113**	-.021*	-.277**	-.139**	-.078**	.150**	-.162**	-.250**	.196**	-.055**	-.123**	-.330**	-.287**
	Sig. (2-tailed)	.000	.000	.000		.000	.407	.010	.017	.000	.048	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627
Ln_Age	Pearson Correlation	-.486**	-.253**	-.395**	-.438**	1	.025*	.005	-.171**	.340**	.132**	.313**	.250**	.009	-.141**	.015	.403**	-.083**	-.063**	-.016	.204**	.000
	Sig. (2-tailed)	.000	.000	.000	.000		.021	.644	.000	.000	.000	.000	.000	.402	.000	.173	.000	.000	.000	.149	.000	.956
	N	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627
Ln_Index	Pearson Correlation	.016	.024*	.349**	.009	.025*	1	-.029**	-.037**	.011	.065**	.040**	.021*	-.012	-.036**	-.022*	-.003	.001	.023*	-.010	.038**	.031**
	Sig. (2-tailed)	.133	.027	.000	.407	.021		.006	.001	.316	.000	.000	.047	.279	.001	.045	.752	.957	.031	.348	.000	.004
	N	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627
Ln_DistShop	Pearson Correlation	.006	.036**	-.058**	.028*	.005	-.029**	1	.047**	.004	.037**	-.036**	.013	.084**	.069**	-.133**	.022*	.002	-.024*	-.015	-.053**	.030**
	Sig. (2-tailed)	.547	.001	.000	.010	.644	.006		.000	.731	.001	.001	.229	.000	.000	.000	.038	.875	.025	.150	.000	.005
	N	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627
Sch	Pearson Correlation	.022*	-.024*	-.043**	-.026*	-.171**	-.037**	.047**	1	-.220**	-.338**	.147**	-.017	.115**	.112**	.070**	.179**	-.164**	-.101**	.184**	-.279**	.191**
	Sig. (2-tailed)	.040	.023	.000	.017	.000	.001	.000		.000	.000	.000	.109	.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627
Park	Pearson Correlation	-.164**	-.076**	-.088**	-.113**	.340**	.011	.004	-.220**	1	.099**	.149**	.015	.330**	.133**	-.252**	.102**	-.499**	-.375**	-.125**	.113**	.246**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.316	.731	.000		.000	.000	.172	.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627
Sea	Pearson Correlation	-.004	.039**	.110**	-.021*	.132**	.065**	.037**	-.338**	.099**	1	-.075**	.199**	-.066**	-.470**	-.391**	-.060**	.055**	-.172**	.123**	.119**	.120**
	Sig. (2-tailed)	.700	.000	.000	.048	.000	.000	.001	.000	.000		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627
Worship	Pearson Correlation	-.274**	-.044**	-.146**	-.277**	.313**	.040**	-.036**	.147**	.149**	-.075**	1	.225**	.098**	-.202**	.192**	-.133**	-.422**	-.018	-.133**	.088**	.295**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.001	.000	.000	.000		.000	.000	.000	.000	.000	.000	.088	.000	.000	.000
	N	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627
Office	Pearson Correlation	-.131**	.074**	.103**	-.139**	.250**	.021*	.013	-.017	.015	.199**	.225**	1	.304**	-.423**	.035**	.513**	.278**	-.077**	-.213**	.054**	-.116**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.047	.229	.109	.172	.000	.000		.000	.000	.001	.000	.000	.000	.000	.000	.000
	N	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627
Industrial	Pearson Correlation	-.057**	.090**	-.022*	-.078**	.009	-.012	.084**	.115**	.330**	-.066**	.098**	.304**	1	-.240**	-.329**	.182**	.003	.009	.101**	.087**	-.009
	Sig. (2-tailed)	.000	.000	.045	.000	.402	.279	.000	.000	.000	.000	.000	.000		.000	.000	.000	.794	.412	.000	.000	.414
	N	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627
MRT	Pearson Correlation	.106**	-.056**	-.044**	.150**	-.141**	-.036**	.069**	.112**	.133**	-.470**	-.202**	-.423**	-.240**	1	.145**	.129**	-.118**	-.020	-.262**	-.253**	.090**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.001	.000	.000	.000	.000	.000	.000	.000		.000	.000	.000	.064	.000	.000	.000
	N	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627
Bus	Pearson Correlation	-.140**	.029**	-.054**	-.162**	.015	-.022*	-.133**	.070**	-.252**	-.391**	.192**	.035**	-.329**	.145**	1	.155**	-.141**	-.065**	-.316**	.148**	.144**
	Sig. (2-tailed)	.000	.008	.000	.000	.173	.045	.000	.000	.000	.000	.000	.001	.000	.000		.000	.000	.000	.000	.000	.000
	N	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627
Sports	Pearson Correlation	-.261**	.036**	.000	-.250**	.403**	-.003	.022*	.179**	.102**	-.060**	-.133**	.513**	.182**	.129**	.155**	1	.307**	.100**	.002	.251**	.034**
	Sig. (2-tailed)	.000	.001	.992	.000	.000	.752	.038	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000	.825	.000	.002
	N	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627
Library	Pearson Correlation	.180**	.117**	.189**	.196**	-.083**	.001	.002	-.164**	-.499**	.055**	-.422**	.278**	.003	-.118**	-.141**	.307**	1	.464**	.081**	.101**	-.610**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.957	.875	.000	.000	.000	.000	.000	.794	.000	.000	.000		.000	.000	.000	.000
	N	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627
CC	Pearson Correlation	-.026*	.172**	.099**	-.055**	-.063**	.023*	-.024*	-.101**	-.375**	-.172**	-.018	-.077**	.009	-.020	-.065**	.100**	.464**	1	.464**	.485**	-.179**
	Sig. (2-tailed)	.014	.000	.000	.000	.000	.031	.025	.000	.000	.000	.088	.000	.412	.064	.000	.000	.000		.000	.000	.000
	N	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627
MarketFC	Pearson Correlation	-.087**	.091**	-.042**	-.123**	-.016	-.010	-.015	.184**	-.125**	.123**	-.133**	-.213**	.101**	-.262**	-.316**	.002	.081**	.464**	1	.184**	-.150**
	Sig. (2-tailed)	.000	.000	.000	.000	.149	.348	.150	.000	.000	.000	.000	.000	.000	.000	.000	.825	.000	.000		.000	.000
	N	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627
Medical	Pearson Correlation	-.311**	.165**	.008	-.330**	.204**	.038**	-.053**	-.279**	.113**	.119**	.088**	.054**	.087**	-.253**	.148**	.251**	.101**	.485**	.184**	1	.399**
	Sig. (2-tailed)	.000	.000	.435	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000		.000
	N	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627
Police	Pearson Correlation	-.236**	.014	-.089**	-.287**	.000	.031**	.030**	.191**	.246**	.120**	.295**	-.116**	-.009	.090**	.144**	.034**	-.610**	-.179**	-.150**	.399**	1
	Sig. (2-tailed)	.000	.201	.000	.000	.956	.004	.005	.000	.000	.000	.000	.000	.414	.000	.000	.002	.000	.000	.000	.000	
	N	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627	8627

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Exhibit 5: Goodness of Fit Ratio for Model A, B and C

Description	R^2	Adjusted R^2	F-Ratio *
Model A	0.911	0.911	4648.542
Model B- Zone 1	0.982	0.980	482.634
Model B- Zone 2	0.940	0.939	705.401
Model B- Zone 3	0.906	0.905	876.208
Model B- Zone 4	0.905	0.904	1237.574
Model B- Zone 5	0.914	0.913	2221.132
Model C- With Shopping Mall	0.922	0.922	4801.254
Model C- Without Shopping Mall	0.946	0.945	2836.396

Exhibit 6: Descriptive Statistics of Model A

	Mean	N	% of Total N	Std. Deviation	Minimum	Maximum	Kurtosis	Std. Error of Kurtosis	Skewness	Std. Error of Skewness
ANG MO KIO	284743.56	645	7.5%	107306.984	110000	660000	-.185	.192	.596	.096
BEDOK	236235.65	419	4.9%	81696.142	150000	548000	2.114	.238	1.619	.119
BISHAN	345947.38	340	3.9%	106494.477	182000	728000	.312	.264	.886	.132
BT PANJANG	261068.36	112	1.3%	41418.999	208000	400000	.878	.453	.954	.228
BUKIT BATOK	302364.09	573	6.6%	104387.476	138888	620000	-.280	.204	.580	.102
BUKIT MERAH	295313.94	313	3.6%	134052.018	123000	701000	-.460	.275	.832	.138
CHOA CHU KANG	265703.00	265	3.1%	48925.703	190000	450000	1.468	.298	1.183	.150
CLEMENTI	268715.87	491	5.7%	96048.443	145000	635000	.974	.220	1.177	.110
GEYLANG	389338.71	93	1.1%	107205.947	225000	710000	1.551	.495	1.427	.250
HOUGANG	305237.85	568	6.6%	93535.722	145000	596000	.041	.205	.683	.103
JURONG EAST	221782.48	87	1.0%	74658.405	130000	450000	1.114	.511	1.366	.258
JURONG WEST	292820.76	530	6.1%	45657.878	193000	470000	.086	.212	.484	.106
PASIR RIS	383438.51	191	2.2%	80541.087	240000	600000	-.520	.350	.292	.176
SEMBAWANG	288445.26	1159	13.4%	47477.624	189000	460000	.124	.144	.571	.072
SENG KANG	293658.27	729	8.5%	45807.953	209000	460000	-.046	.181	.542	.091
TAMPINES	284099.47	417	4.8%	88032.376	162000	580000	.754	.238	1.102	.120
TOA PAYOH	330671.35	502	5.8%	134864.083	107000	650000	-1.065	.218	.290	.109
WOODLANDS	282909.14	482	5.6%	60971.314	155000	440000	-.485	.222	.236	.111
YISHUN	204975.35	711	8.2%	45353.141	107000	370000	-.091	.183	.714	.092
Total	286287.74	8627	100.0%	91157.204	107000	728000	1.147	.053	.960	.026

Exhibit 7: Unstandardised Coefficients of Model A

Variable	Unstandardized Coefficients		Sig.
	β	Std. Error	
Level	.044	.001	.000
Ln_Area	1.024	.005	.000
Ln_Age	-.165	.003	.000
Ln_Index	1.008	.010	.000
Ln_DistShop	-.047	.003	.000
Sch	-.043	.006	.000
Park	.018	.005	.000
Sea	.283	.017	.000
Worship	.077	.004	.000
Office	.009	.005	.061
Industrial	-.075	.003	.000
MRT	-.265	.010	.000
Bus	-.077	.008	.000
Sports	.324	.006	.000
Library	-.239	.007	.000
CC	.081	.005	.000
MarketFC	-.054	.004	.000
Medical	.116	.006	.000
Police	-.090	.006	.000

Exhibit 8: Impact of Shopping Centre Proximity Factor By Estate

Test Statistics	Marine Parade	Bukit Panjang	Chua Chu Kang	Woodlands	Sengkang	Jurong East*
Unstandardised Regression Coefficient, β	-0.238	-0.211	-0.195	-0.156	-0.126	-0.103
Significance	0.000	0.000	0.000	0.000	0.000	0.290
Adjusted R-Square	0.893	0.925	0.834	0.920	0.846	0.954
Durbin-Watson	1.847	1.788	1.183	1.536	1.491	2.197
F-Ratio	153.948	274.291	266.556	1103.091	802.110	360.311

Test Statistics	Tampines	Clementi*	Ang Mo Kio	Yishun	Pasir Ris	Sembawang
Unstandardised Regression Coefficient, β	-0.094	-0.087	-0.062	-0.062	-0.061	-0.061
Significance	0.000	0.000	0.000	0.000	0.001	0.000
Adjusted R-Square	0.944	0.928	0.956	0.850	0.919	0.873
Durbin-Watson	1.629	1.065	1.216	1.407	1.601	1.316
F-Ratio	1403.910	1258.904	2809.421	1010.310	429.497	1590.570

Test Statistics	Bukit* Merah	Jurong West	Bukit Batok	Hougang	Bishan	Toa Payoh	Bedok*
Unstandardised Regression Coefficient, β	-0.049	-0.047	-0.044	-0.036	-0.035	-0.028	-0.017
Significance	0.000	0.000	0.001	0.000	0.108	0.818	0.036
Adjusted R-Square	0.969	0.875	0.965	0.947	0.920	0.941	0.947
Durbin-Watson	1.668	1.851	1.769	1.412	1.797	1.011	1.935
F-Ratio	1982.146	743.43	3179.858	2026.167	768.672	1587.597	1500.915

*No shopping mall in town centre

Exhibit 9: Test Statistics of 'Ln_DistShop' of Model B-Zone 1 to Zone 5

Test Statistics	Zone 1 (>0m to 100m)	Zone 2 (>100m to 200m)	Zone 3 (>200m to 300m)	Zone 4 (>300m to 400m)	Zone 5 (>400m to 500m)
N	69	599	1470	2483	4006
Unstandardised Regression Coefficient, β	-0.15	-0.091	-0.094	-0.077	-0.132
Std. Error	0.063	0.020	0.023	0.023	0.022
Significance	0.020	0. 000	0.000	0.001	0.000

Exhibit 10: Test Statistics of Ln_DistShop of Model C

Test Statistics	With Shopping Mall	Without Shopping Mall
N	7317	1310
Unstandardised Regression Coefficient, β	-0.061	0.006
Std. Error	0.003	0.007
Significance	0.000	0.353

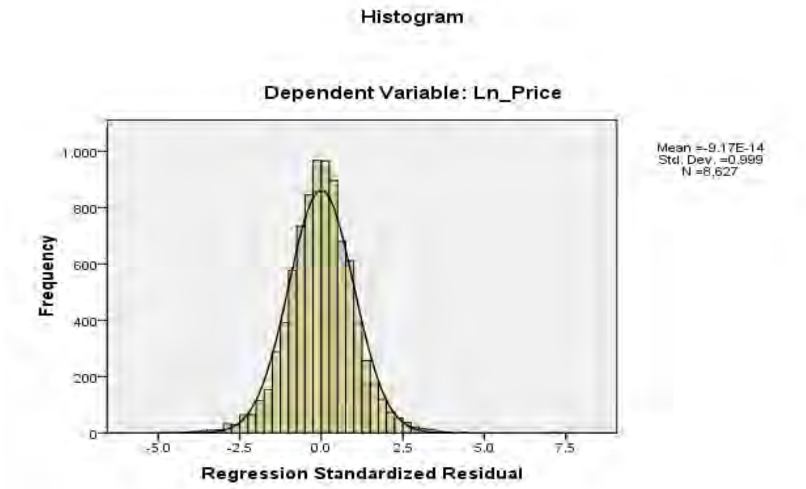
Exhibit 11: List of Dropped Variables

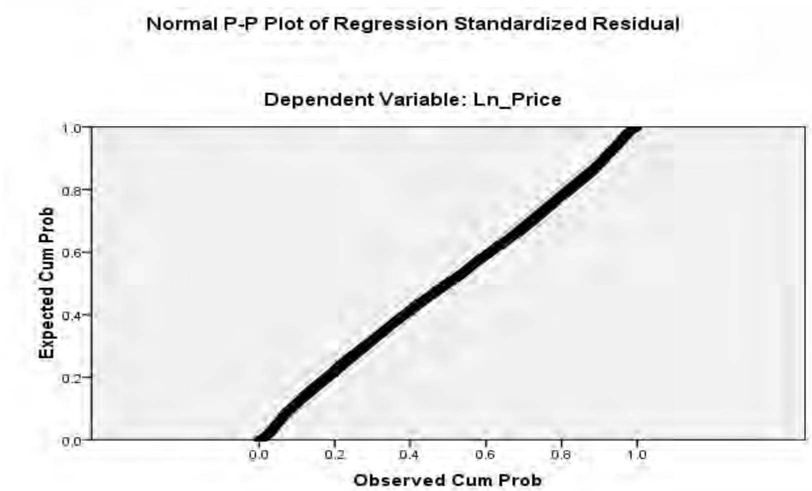
Description (a)	Variables Dropped (b)	Highest VIF Values	
		Before Re-Specification (c)	After Re-Specification (d)
Model B-Zone 1	Police	24.853	6.451
Model B-Zone 2	Sch, Park, Office, Medical	76.063	9.879
Model B-Zone 3	Library, Park, Office	23.254	6.865
Model C-With Shopping Mall	Office, Police	39.372	9.323

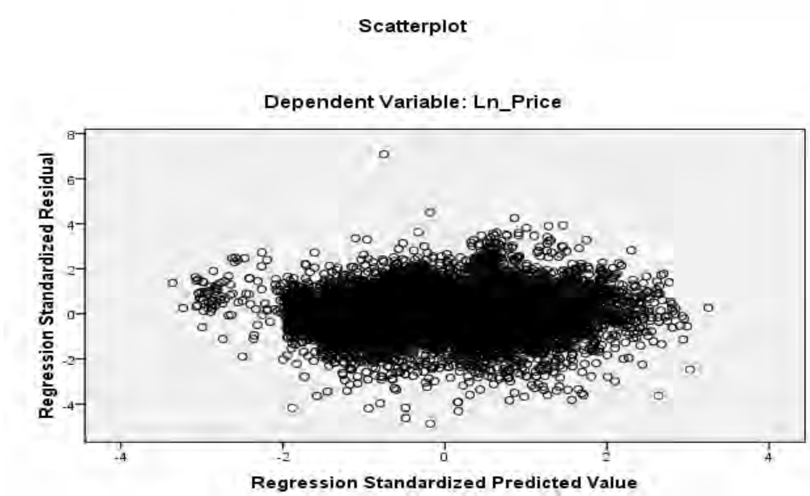
Exhibit 12: Statistics on Test Assumptions

Description	Durbin-Watson Statistic	Highest VIF	Lowest Tolerance Statistic
Model A	1.227	9.362	0.107
Model B-Zone 1	2.226	6.451	0.155
Model B-Zone 2	1.354	9.879	0.101
Model B-Zone 3	1.116	6.865	0.146
Model B-Zone 4	1.265	9.387	0.107
Model B-Zone 5	1.008	9.225	0.108
Model C-With Shopping Mall	1.289	9.323	0.101
Model C-Without Shopping Mall	1.216	1.594	0.627

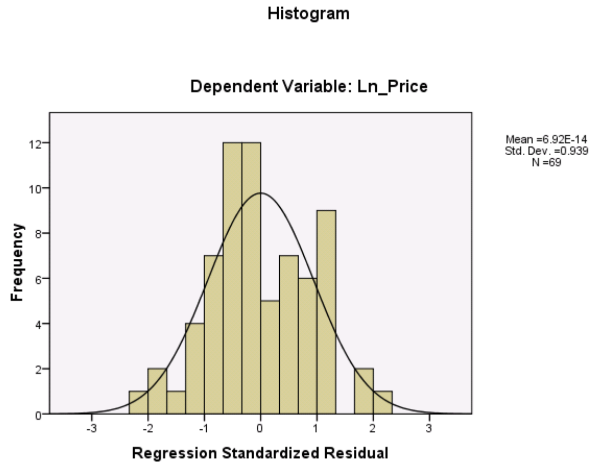
Appendix 1: Histogram, Normal Probability Plots and Scatter Plots for Model A

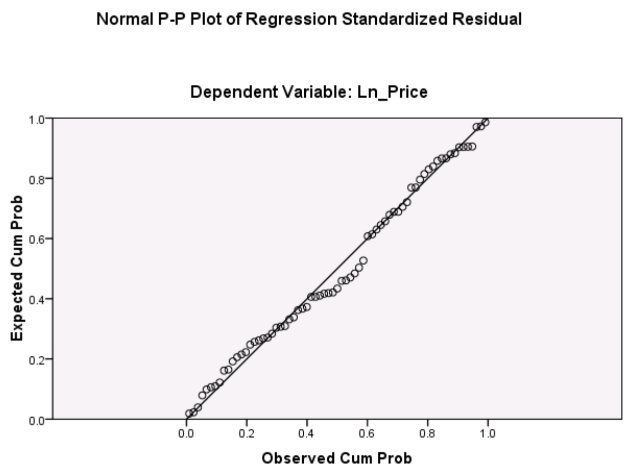


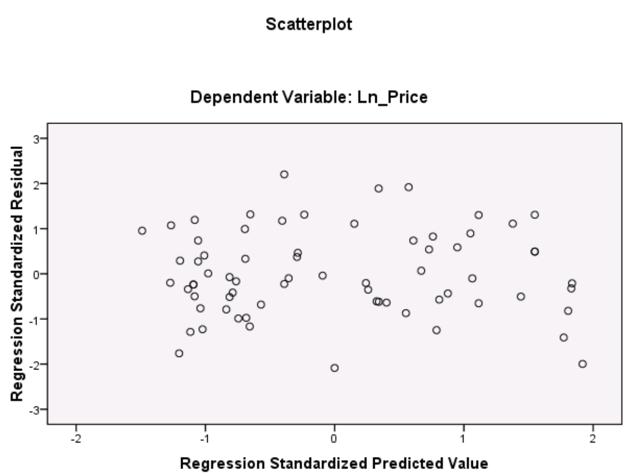




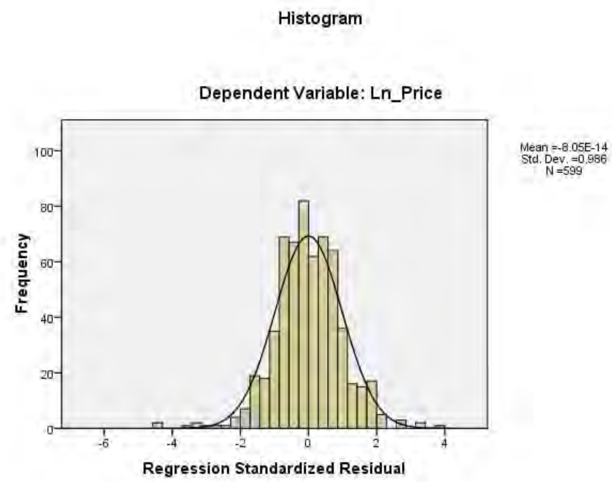
Appendix 2: Histogram, Normal Probability Plots and Scatter Plots for Model B (Zone 1)

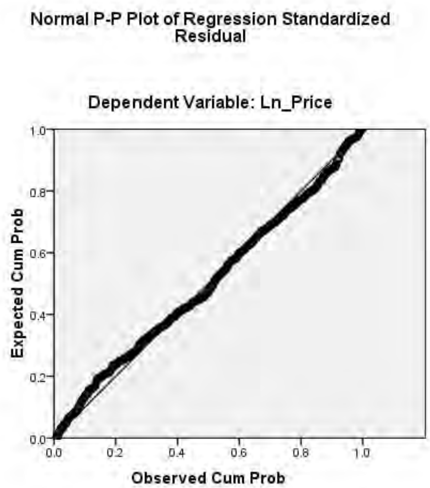


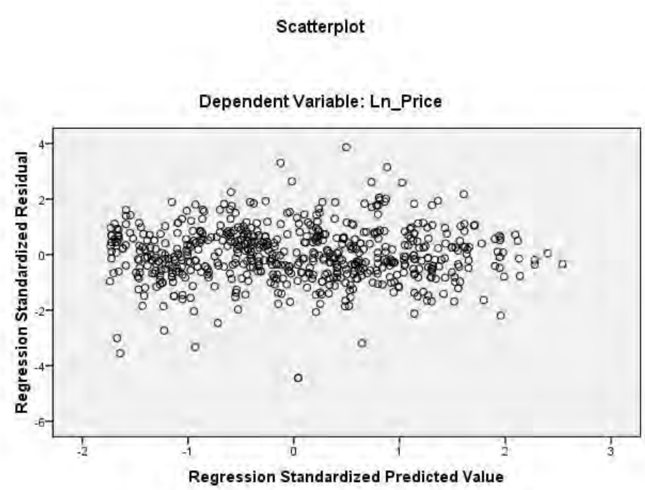




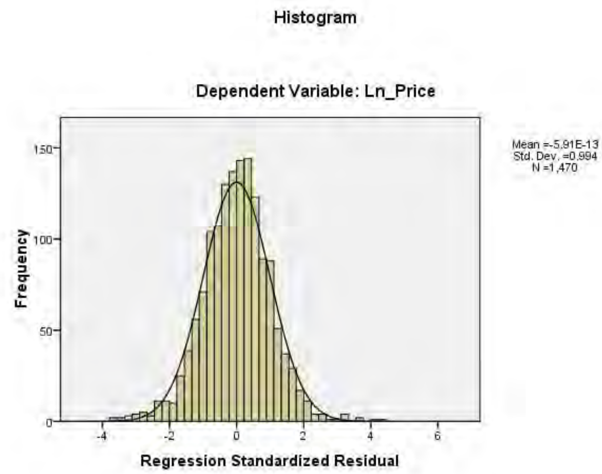
Appendix 3: Histogram, Normal Probability Plots and Scatter Plots For Model B (Zone 2)

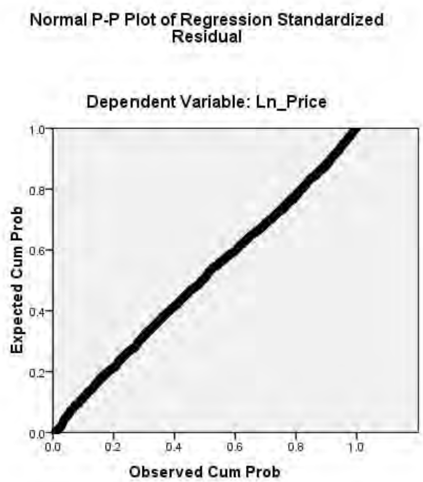


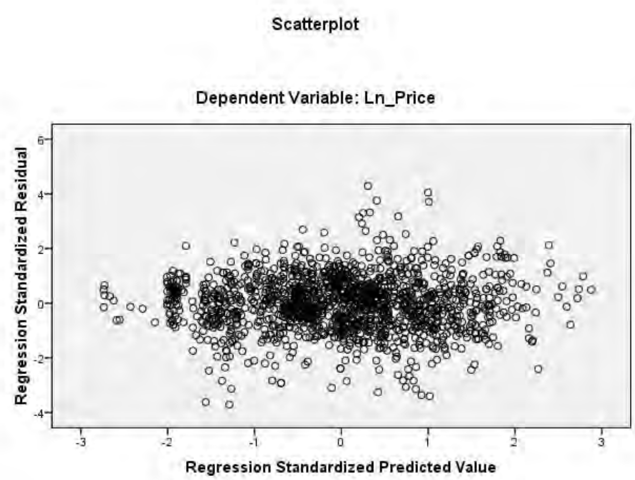




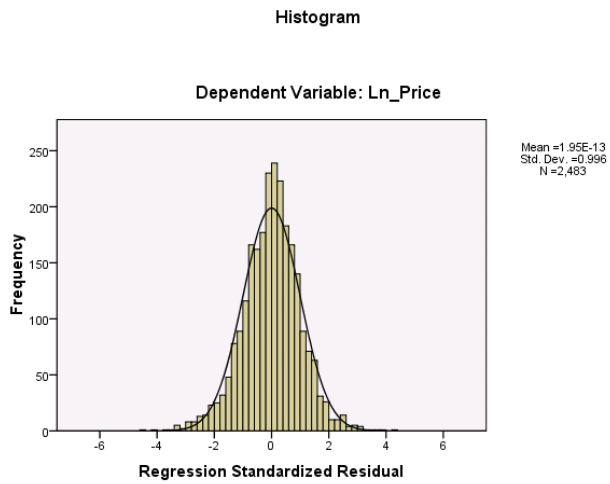
Appendix 4: Histogram, Normal Probability Plots and Scatter Plots For Model B(Zone 3)

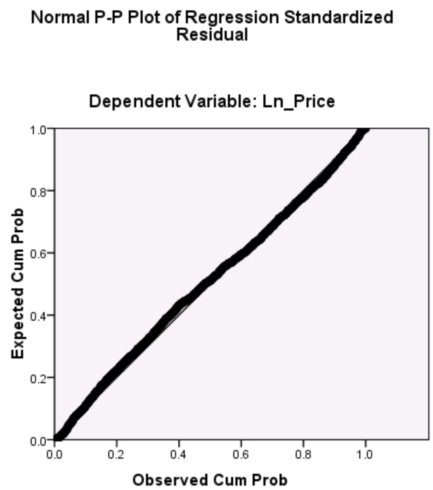


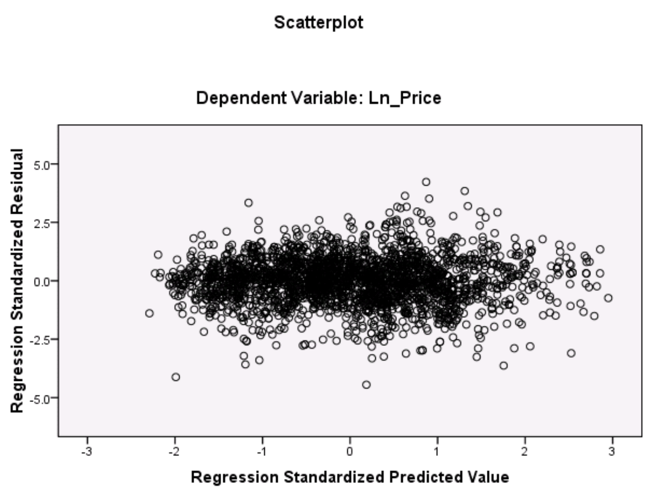




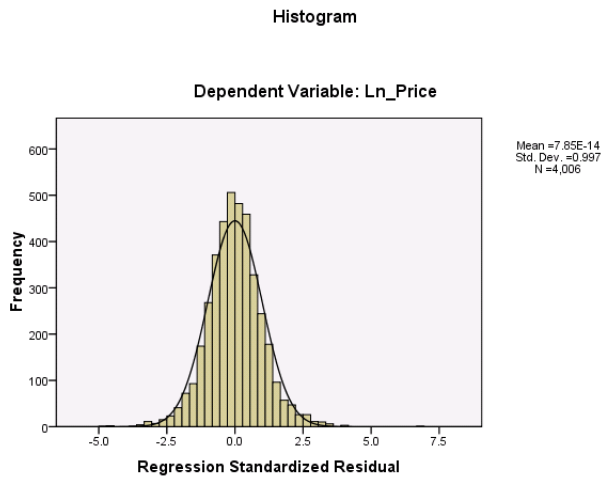
Appendix 5: Histogram, Normal Probability Plots and Scatter Plots For Model B(Zone 4)

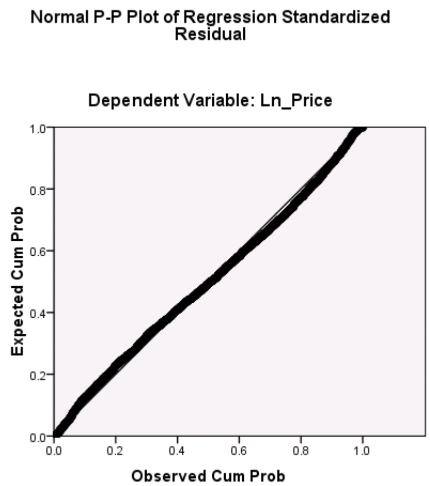


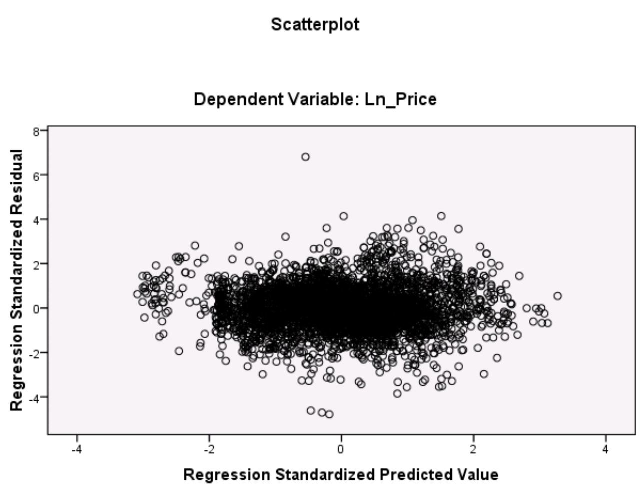




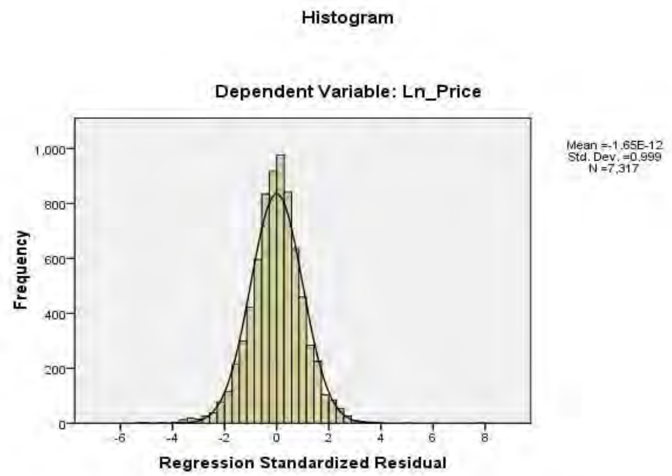
Appendix 6: Histogram, Normal Probability Plots and Scatter Plots For Model B(Zone 5)

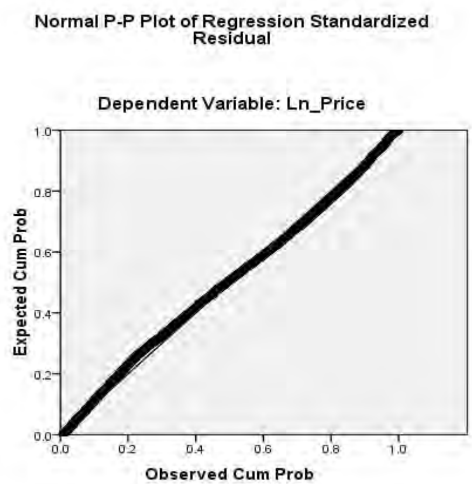


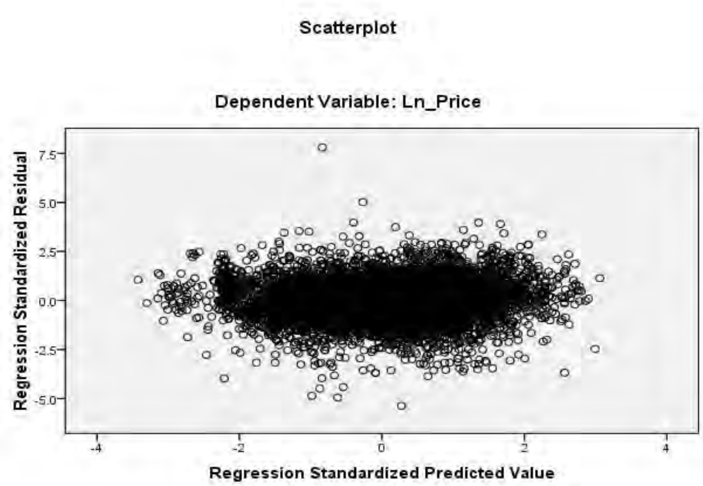




Appendix 7: Histogram, Normal Probability Plots and Scatter Plots For Model C(with Shopping Mall)







Appendix 8: Histogram, Normal Probability Plots and Scatter Plots For Model C(without Shopping Mall)