SUPPLY AND DEMAND ANALYSIS FOR THE INDUSTRIAL RENTAL AND LAND VALUES

Jinu Kim, Ph.D.
J.Kim@unsw.edu.au
Faculty of the Built Environment
The University of New South Wales
Sydney 2052 Australia

Paper to be submitted to
Pacific-Rim Real Estate Society Fourth Annual Conference
19 - 21 January 1998, Perth, Western Australia

[98PRRES]

Abstract

The theoretical framework of the study predicts that the way in which the values of typical industrial properties perform is a function of economics and location factors. Using a least-square regression analysis, the Industrial Rental Value Model (IRVM) and the Industrial Land Value Model (ILVM) were developed in order to analyse the rental and land values of typical industrial properties in the Sydney industrial property market. The dependent variables of the regression analyses are the rental and land values of the typical industrial properties. Within the framework of the study, the independent variables are divided into two categories such as, economics factors and location factors. The economics factors are sub-divided into the demand side of the economy and the supply side of the economy in terms of the neo-classical economic theory. The urban bid-rent theory can be applied to location factors within the industrial property market. The formulation of the Industrial Rental Value Model (IRVM) and Industrial Land Value Model (ILVM) supports the argument that the performances of rental and land values of typical industrial properties are a function of the demand, supply, and location factors. The conclusions of the study is that the demand side of the economy can predict the performance of the rental values more than the supply side can, while the performance of the land values can be predicted by the demand and supply sides of the economy.

Keywords:
industrial property market, rental and land values, demand, supply.

SUPPLY AND DEMAND ANALYSIS FOR THE INDUSTRIAL RENTAL AND LAND VALUES

1. Introduction

This paper formulates a regression model of industrial rental and land values. It consists of the four parts: (i) An analysis of the variables for the regression model formulation of industrial rental and land values in the Sydney industrial property market. (ii) Formulation of the Industrial Rental Value Model (IRVM). (iii) Formulation of the Industrial Land Value Model (ILVM). (iv) Conclusions.

The theoretical model of the study is that the way in which the values of typical industrial properties perform is a function of economic conditions (economics factors) and location aspects (location factors). The data were collected from organisations such as the Australian Bureau of Statistics (ABS), the New South Wales Valuer General's Office (VGO), the New South Wales Department of Urban Affairs and Planning (DUAP), the Reserve Bank of Australia (RBA), and the Australian Institute of Urban Studies (AIUS). From the data, a regression model was formulated by the use of least-square regression analysis. The regression model supports the argument that the values of typical industrial properties are affected by economics factors (supply and demand) and location factors.

2. Variables in the Model

A regression analysis is concerned with describing and evaluating the relationship between a dependent variable and one or more independent variables. The dependent variables of the regression analyses herein are the industrial rental value and the industrial land value. Since the investment appraisals of property must focus on the occupation and development market in terms of a demand and supply analysis, the gross rental values and land values are the key variables on the revenue and cost sides of investment appraisal (Keogh, 1994; Kim, 1996). Industrial rental and land values are thus identified as important performance measurements in the industrial property market.

Within the theoretical model of the study, the independent variables are divided into two categories i.e., economics factors and location factors. The economics factors are sub-divided into the demand side of the economy and the supply side of the economy in terms of the neo-classical economic theory (Marshall, 1961; Blaug, 1992). The urban bid-rent theory can be applied to location factors within the industrial property market. As industrial areas near the city centre are assumed to have a steeper bid-rent curve than areas farther from the city centre, the distance from the city centre is proposed as one of the main factors in the changes in values of prime quality industrial buildings (Burgess, 1925; Alonso, 1964).

In this study, the prime quality industrial properties with a floor area of approximately 1,000 square metres were selected as typical industrial properties in the Sydney industrial property market. Such industrial properties usually occupy approximately 2,000 square metres of land.

Exhibit 1 shows a list of the original variables in the regression analysis of the Sydney industrial property market. The industrial rental value or industrial land value is the dependent variable. Some variables are transformed to logarithm functions for further regression analysis (see Exhibit 2). Industrial rental values and industrial land values are not mathematical averages of the rents and land prices in the Local Government Area (LGA). They are estimations made by the valuers of fair market values at 30th June for typical industrial properties in the nominated locality between 1976 and 1993. The Gross Domestic Products (GDP), new capital expenditure on plant and equipment (PNE), the values of industrial building approvals (APPR), and the values of industrial building commencements (COMNSW) are based on the financial year at current prices. Interest rates (INTEREST, BANKBILL) are based on averages in financial years.

The theoretical model of this study predicts that the values of typical industrial properties are a function of economics factors (supply and demand) and location factors. The independent variables are then divided into three categories, which include the demand side of the economy, the supply side of the economy, and the location factors. The independent variables on the demand side of the economy include GDP, PNE, INTEREST, and BANKBILL. The independent variables on the supply side of the economy include APPR and COMNSW. The independent variable DISTANCE is the only variable for location factors in the data, because the other variables are controlled in the typical industrial properties.

The method of least-square regression analysis depends upon the nature of the relationship between the dependent and independent variables. These may be linear, but alternatively, any of the many types of non-linear relationships may be represented. There is some strength in an argument that curvilinear relationships may exist within the data. The dependent variable LAND against DISTANCE, for example, is likely to be curvilinear, as land value will reach a minimum value which is unaffected by distance beyond a certain limit. A simple transformation of either the dependent variable or the independent variable, or of both, is often sufficient to make the simple linear regression model appropriate for the transformed data. It can be said that the rate of change in the values is a better dependent variable than the changes in the values. As the rental and land values of typical industrial properties will reach a minimum value which is unaffected by the distance from the city centre beyond a certain limit, RENT or LAND against DISTANCE may have a curvilinear relationship (semilog form).

After comparing the simple regression analyses with the original and the transformed data, it is clear that the analysis with the transformed data has a higher coefficient of determination and a lower standard error of estimate than the one with the original data. Hence, the use of the linear regression model with transformed data (logarithms of variables) appears to be more appropriate. This form is called a log-linear functional form that is popular in econometric work (Maddala, 1992).

Exhibit 2 shows a list of the variables used in the regression analysis for the model formulation of industrial rental and land values. There are two dependent variables and

13 independent variables. The independent variables of DISTANCE, INTEREST, and BANKBILL are kept as for the original data. The interest rates are kept as original because of the nature of data - as percentages. The other variables are transformed to logarithmic functions. In the regression analysis, one-year lagging variables of all independent variables for the economics factors are included in order to investigate a certain lagging effect in the serial data in the regression model.

Given the complexity of non-linear regression analysis, and given that a consistent method of analysis should ideally apply across all relationships for ease of comparison, it was decided to use linear regression techniques in the analysis of the data.

3. Regression Equations Based on Stepwise Regression Procedures

In this section, a subset of independent variables and a benchmark for the estimates of the model are identified in order to formulate a regression model of industrial rental and land values in the Sydney industrial property market. Firstly, the least-square regression equation for the industrial rental values of typical industrial properties is determined using a stepwise regression procedure with all 13 independent variables. Secondly, the regression equation of the industrial land values of typical industrial properties is similarly determined.

Stepwise regression procedures were adopted in order to select a good subset of independent variables to be included in the regression equation. This search method develops a sequence of regression equations, at each step adding or deleting an independent variable, in order to select the variables. The criterion for adding or deleting an independent variable can be stated equivalently in terms of an error-sum-of-squares reduction, a coefficient of partial correlation, or an F statistic (Neter, Wasserman, and Kunter, 1983: 430).

Exhibit 3 shows correlations between variables in the regression analysis (lagging variables are excluded). Exhibit 3 shows that there are significant correlations between some of the independent variables in the regression analysis. This means that the regression analysis may have included the presence of multicollinearity that may have unduly influenced the estimates of the regression analysis.

One formal method of detecting the presence of multicollinearity is to use variance inflation factors (*VIF*). A *VIF* measures how much the variance of the estimated regression coefficient is inflated when compared to the case in which independent variables are not linearly related. The largest *VIF* value among all independent variables is often used as an indicator of the severity of multicollinearity. A maximum *VIF* value in excess of 10 is often taken as an indication that multicollinearity may be unduly influencing the least-squares estimates (Neter, Wasserman, and Kunter, 1983: 391-392).

From the results of the regression equations, which are based on stepwise regression procedures, an appropriate subset of independent variables and a benchmark of the estimates of the model were identified to formulate a regression model of industrial rental and land values in the Sydney industrial property market. The regression model, with the selected independent variables, is then tested for satisfaction of the basic assumptions of regression analysis. This is to become the Industrial Rental Value Model (IRVM) and the Industrial Land Value Model (ILVM), subject to validation of the model.

3.1 Regression Equation of Industrial Rental Values based on Stepwise Regression Procedures

In order to formulate a regression equation of the industrial rental values based on stepwise regression procedures, all 13 independent variables and the dependent variable (LOGRENT) were included in the regression analysis (see Exhibit 2). Exhibit 4 shows the result of the final step of the stepwise regression analysis. As there are significant correlations between some of independent variables, the methods of detecting and deleting the presence of multicollinearity are included in the stepwise regression procedures.

Among the 13 independent variables, six variables (LOGGDP, LOGPNE, DISTANCE, LLOGPNE, LLOGAPPR, and LLOGCOM) are included in the regression equation by a forward stepwise regression. The variables of LOGPNE and DISTANCE are statistically significant at the 0.05 level among these six variables in the regression equation, while the intercept is not statistically significant at the 0.05 level. However, none of variables for the supply side of the economy are statistically significant at the 0.05 level in the regression equation of industrial rental values. As the *VIFs* of five independent variables except DISTANCE are greater than 10, multicollinearity may have unduly influenced the least-square estimates of the regression analysis (Neter, Wasserman, and Kunter, 1983: 391-392).

The statistically significant variables of LOGPNE and DISTANCE are then selected as the independent variables for the model formulation of industrial rental values. The coefficient of multiple determination of the equation is $R^2 = 0.9407$ and the standard error of estimate is 0.1226, which can be a benchmark for the estimates of the IRVM.

3.2 Regression Equation of Industrial Land Values based on Stepwise Regression Procedures

In order to formulate a regression equation of the industrial land values based on stepwise regression procedures, all 13 independent variables and the dependent variable (LOGLAND) were included in the regression analysis (see Table 2). Stepwise regression procedures were adopted in order to identify a good subset of independent variables and a benchmark for the estimates of the model.

Exhibit 5 shows the results of the final step of the stepwise regression analysis. Among 13 independent variables, six variables (LOGGDP, LOGPNE, BANKBILL, LOGAPPR, DISTANCE, and LLOGCOM) are included in the regression equation by a forward stepwise regression. The variables LOGGDP, LOGAPPR and DISTANCE are statistically significant at the 0.05 level among these six variables in the regression equation, while the intercept is not statistically significant at the 0.05 level. From the results of the regression analysis of industrial land values, based on stepwise regression procedures, the statistically significant variables LOGGDP, LOGAPPR and DISTANCE, are selected as the independent variables for the model formulation of industrial land values. The coefficient of multiple determination of the equation is R^2 = 0.9505 and the standard error of estimate is 0.1930, which can be a benchmark for the estimates of the ILVM.

In summary, for the regression model of industrial rental and land values, the variables LOGPNE and DISTANCE are selected as the independent variables through a regression analysis of industrial rental values, based on stepwise regression procedures. The variables LOGGDP, LOGAPPR, and DISTANCE are selected as the independent variables through a regression analysis of industrial land values, based on stepwise regression procedures. Hence, the four variables LOGGDP, LOGPNE, LOGAPPR, and DISTANCE are identified as the independent variables for formulating a regression model of industrial rental and land values in the Sydney industrial property market.

The variables LOGGDP and LOGPNE are the independent variables for the demand side of the economy. LOGAPPR is the independent variable for the supply side of the economy, while DISTANCE is the independent variable for the location factors. This selection of the independent variables then supports the theoretical model of the study, which predicts that the way in which the values of typical industrial properties perform is a function of economics (supply and demand) and location factors.

4. Industrial Rental Value Model (IRVM)

4.1 Regression Model of Industrial Rental Values

In Section 3, the variables LOGGDP, LOGPNE, LOGAPPR, and DISTANCE are selected as the independent variables for formulating a regression model of industrial rental and land values in the Sydney industrial property market. In this section, the regression model, with the selected independent variables, is formulated. The regression model is then tested to determine how well the basic assumptions of regression analysis are satisfied. The regression model is to be the Industrial Rental Value Model (IRVM), subject to validation of the model.

Because of the multicollinearity problem, a selection needs to be made between the variables LOGGDP and LOGPNE as the independent variable for the demand side of the economy. The variable LOGPNE is selected as the independent variable for the demand side of the economy after trial and error[1]. The variables LOGAPPR and DISTANCE were identified as the independent variables for the supply side of the economy and the location factors respectively in the Sydney industrial property market (see Section 3). Hence, the three variables LOGPNE, LOGAPPR, and DISTANCE are

[1] The regression equation with the independent variables LOGGDP (instead of LOGPNE), LOGAPPR, and DISTANCE included a statistically insignificant intercept at the 0.05 level. However, the regression equation with the intercept forced to nil (intercept = 0) cannot satisfy the basic assumption of having no correlations between the errors and the independent variables.

identified as the independent variables for formulating a regression model of industrial rental and land values in the Sydney industrial property market. These three independent variables are part of the theoretical model of this study.

Exhibit 6 shows the results of a least-square regression analysis with the three independent variables based on demand, supply, and location factors. From Exhibit 6, the two independent variables LOGPNE and DISTANCE in the regression model are statistically significant at the 0.01 level, while the independent variable LOGAPPR is statistically significant at the 0.05 level. The coefficient of multiple determination of the model is R^2 = 0.9454, which is similar to that (R^2 = 0.9407) of the regression equation of industrial rental values shown in Exhibit 4. The standard error of estimate of the regression model (0.1235) is also similar to that of the regression equation (0.1226). This means that the results of the regression model with the independent variables LOGPNE, LOGAPPR, and DISTANCE are similar to those of the regression equation based on stepwise regression procedures in terms of the prediction of the dependent variable LOGRENT. The regression model's *F*-statistic of 496.71 is significant at the 0.01 level, leading to a rejection of the null hypothesis that the parameter estimates of the regression model are zero. Hence, the regression model with the three independent variables LOGPNE, LOGAPPR, and DISTANCE can be selected as the IRVM subject to validation of the model.

4.2 Validation of the Industrial Rental Value Model (IRVM)

A regression analysis is based on some basic assumptions: normality of error terms; a zero mean of the error terms; homoskedasticity of error terms[2]; no serial correlation between the error terms; no correlation between errors and independent variables; and no multicollinearity between independent variables (Neter *et al.*, 1983; Berry and Feldman, 1985; Mendenhall *et al.*, 1989; Maddala, 1992). If these basic assumptions do not hold, a proposed regression model is not appropriate. It is thus advised that if the assumptions are seriously violated, an alternative model should be formulated or the variables should be transformed. To test whether the underlying assumptions of the IRVM are satisfactory, the residuals of the regression model were analysed.

To test the normality of the error terms, a normal probability plot was produced. Exhibit 7 shows a normal probability plot of residuals respectively. Exhibit 7 shows that the residuals are approximately normally distributed. To test for homoskedasticity of the error terms, a scatter plot of the standardised residuals against the regression-predicted values is produced in Exhibit 8. From Exhibit 8, it can be said that the residuals are randomly distributed around the mean (= zero) and that the spread of them appears fairly stable within the range of the predicted value. This suggests that the homoskedasticity assumption is not violated in the regression model.

Since the *VIF* values of the all three independent variables are less than 10, there is no evidence of the presence of multicollinearity, which may have unduly influenced the

[2] The homoskedasticity assumption is that the errors in the regression equation have a common variance. It means that the error variance is constant for all the observations. (Maddala, 1992)

results of the regression analysis, between the independent variables in the regression model. This means that the assumption of ‘no multicollinearity’ is not violated in the regression model.

To detect the presence of autocorrelations between the error terms, the Durbin-Watson test is employed. From Exhibit 6, the result of the Durbin-Watson test statistic is d = 1.7425. There are 90 observations and 3 independent variables. From the table of Durbin-Watson test bounds (Neter, Wasserman, and Kunter, 1983: 531), for α = 0.01, p – 1 = 3, and n = 90, the two critical values are:

$$d_L = 1.45 \qquad d_U = 1.59$$

Since $d = 1.7425 > d_U = 1.59$, it is concluded that the error terms are not autocorrelated in the regression model. The assumption of ‘no autocorrelations’ is thus not violated in the regression model.

To test the assumption of ‘no correlations’ between the errors and the independent variables, scatter plots of the standardised residuals against the independent variables of LOGPNE, LOGAPPR, and DISTANCE were produced (see Exhibits 9, 10, and 11). From Exhibits 9, 10, and 11, it can be seen that the residuals of the regression model are not correlated with the independent variables.

Through the residual analysis, the possibility of violation of the basic assumptions for the IRVM was tested. The results of the test are satisfactory; thus the IRVM can be used for the analysis of the dependent variable (LOGRENT) using the independent variables (LOGPNE, LOGAPPR, and DISTANCE) for the Sydney industrial property market.

5. Industrial Land Value Model (ILVM)

5.1 Regression Model of Industrial Land Values

In order to formulate a model of industrial land values, a regression analysis is used with similar procedures to the IRVM, as described in Section 4. Given that a consistent method of analysis should apply across all relationships for ease of comparison, the regression model of industrial land values includes the independent variables LOGPNE, LOGAPPR, and DISTANCE, like the IRVM. Exhibit 12 shows the results of the regression analysis with the three independent variables.

From Exhibit 12, the variables LOGPNE, LOGAPPR, and DISTANCE in the regression model are significant at the 0.01 level. The coefficient of multiple determination of the model is R^2 = 0.9442, which is similar to that (R^2 = 0.9505) of the regression equation of industrial land values shown in Exhibit 5. The standard error of estimate of the model (0.2039) is similar to that of the regression equation of industrial land values based on stepwise regression procedures (0.1930). This means that the results of the regression model with the independent variables LOGPNE, LOGAPPR, and DISTANCE are similar to those of the regression equation based on stepwise regression procedures in terms of the prediction of the dependent variable LOGLAND.

The regression model's F-statistic of 485.10 is significant at the 0.01 level, leading to a rejection of the null hypothesis that the parameter estimates of the regression model are zero. Hence, the regression model with the three independent variables of LOGPNE, LOGAPPR, and DISTANCE can be selected as the ILVM, subject to validation of the model.

5.2 Validation of the Industrial Land Value Model (ILVM)

To test whether the underlying assumptions of the ILVM are satisfactory, the residuals were analysed, as described in Section 4.2.

To test the normality of the error terms, a normal probability plot was produced in Exhibit 13. The exhibit shows that the residuals are approximately normally distributed. To test for homoskedasticity of the error terms, a scatter plot of the standardised residuals against the regression predicted values was produced in Exhibit 14. From Exhibit 14, it can be said that the residuals are randomly distributed around the mean (= zero) and that the spread of them appears fairly stable within the range of the predicted value. This suggests that the homoskedasticity assumption appears not to be violated in the regression model.

Since the *VIF* values of the all three independent variable are less than 10, and the Durbin-Watson $d = 1.8053 > d_U = 1.59$ (see Exhibit 12), there is no evidence of the presence of multicollinearity and autocorrelations in the regression model. This shows that the assumptions of 'no multicollinearity' and 'no autocorrelations' are not violated in the regression model.

To test the assumption of 'no correlation' between the errors and the independent variables, scatter plots of the standardised residuals against the independent variables LOGPNE, LOGAPPR, and DISTANCE were produced (see Exhibits 15, 16, and 17). From Exhibits 15, 16, and 17, it can be seen that the residuals of the regression model are not correlated with the independent variables.

Through the residual analysis, the possibility of the violation of the basic assumptions for the ILVM was tested. The results of the test are satisfactory, thus the ILVM can be used for the analysis of the dependent variable (LOGLAND) using independent variables (LOGPNE, LOGAPPR, and DISTANCE) for the Sydney industrial property market.

6. Conclusions

The IRVM and ILVM are formulated by multiple regression analysis, and are validated by the satisfaction of the basic assumptions for regression analysis. The high coefficients of multiple determination of the IRVM (R^2 = 0.9454) and ILVM (R^2 = 0.9442) support the argument that the industrial rental and land values are key variables of performance measurement in the industrial property market. From Exhibits 6 and 12, the summary of the estimates of the IRVM and ILVM are as follows:

Figures in parentheses are *t*-values.

** : significant at the 0.01 level. * : significant at the 0.05 level.

		IRVM	ILVM
Number of Cases		90	90
Multiple Determination (R^2)		0.9454	0.9442
Adjusted R^2		0.9435	0.9423
F – statistics		496.71	485.10
Standard Error of Estimate		0.1235	0.2039
Intercept		2.1428 (13.9989)**	2.3023 (9.1102)**
LOGPNE	Regression Coefficient	0.7038 (13.4126)**	0.6402 (7.3896)**
	Beta Coefficient	0.7750 (13.4126)**	0.4317 (7.3896)**
LOGAPPR	Regression Coefficient	0.0946 (2.2054) *	0.3156 (4.4568)**
	Beta Coefficient	0.1274 (2.2054) *	0.2604 (4.4568)**
DISTANCE	Regression Coefficient	–0.0190 (15.4222)**	–0.0558 (27.4148)**
	Beta Coefficient	–0.3885 (15.4222)**	–0.6983 (27.4148)**

As expected, the IRVM and ILVM have a positive regression coefficient for the variable LOGPNE and a negative coefficient for the variable DISTANCE. The variable LOGAPPR has a positive regression coefficient, although it represents the supply side of the economy. The regression coefficient for independent variable of the supply side of the economy should be negative because increased supply reduces prices. In this study, the variable LOGAPPR is used as a proxy variable for the supply of typical industrial properties. The development activities supply new stock to the property market through the development of new buildings and/or the refurbishment of old buildings (Keogh, 1994). When there is excess supply, the values of building approvals fall; when there is insufficient supply, the values of building approvals increase. Hence, the values of building approvals have an indirect relationship with the supply in the property market. This means that the regression coefficient of the variable LOGAPPR can be positive despite representing the supply side of the economy. In other words, the independent variable LOGPNE directly represents the demand side, while the independent variable LOGAPPR indirectly represents the supply side. The independent variable DISTANCE represents location factors for the typical industrial properties.

The regression coefficients of DISTANCE (location factors) in the IRVM and ILVM are –0.0190 and –0.0558 respectively, which are both statistically significant at the 0.01 level. Hence, there is negative, statistically significant relationship between DISTANCE and LOGRENT, DISTANCE and LOGLAND. This supports the argument that the rental and land values of typical industrial properties are affected by location factors in the Sydney industrial property market.

The regression coefficient of LOGPNE (demand side) in the IRVM is 0.7308, which is statistically significant at the 0.01 level. Hence, there is a positive, statistically significant relationship between LOGPNE and LOGRENT. The regression coefficient of LOGAPPR (supply side) in the IRVM is 0.0946, which is statistically significant only at the 0.05 level. Hence, there is a positive, statistically significant relationship between LOGAPPR and LOGRENT. The regression coefficients of LOGPNE and LOGAPPR in the ILVM are 0.6402 and 0.3156 respectively, which are statistically significant at the 0.01 level. Hence, there is a positive, statistically significant relationship between LOGPNE and LOGLAND, LOGAPPR and LOGLAND. This supports the argument that the rental and land values of typical industrial properties are affected by economics factors in the Sydney industrial property market.

The results of the parameter estimates of the IRVM an ILVM support the argument that the values of typical industrial properties are affected by economics and location factors. However, the regression coefficient of LOGAPPR (supply side of the economy) in the IRVM is statistically significant only at the 0.05 level, while the other regression coefficients in the IRVM and ILVM are statistically significant at the 0.01 level. None of variables for the supply side of the economy are statistically significant at the 0.05 level in the regression equation of industrial rental values (see Section3.1). Hence, it is concluded that the demand side of the economy can predict the performance of the industrial rental values more than the supply side can, while the performance of the industrial land values can be predicted by both of the demand and supply sides of the economy.

Exhibit 1: List of the Original Variables in the Regression Analysis

Variable	Description	Unit
RENT	Industrial rental value (gross, at 30th June)	$/m^2$ p.a.
LAND	Industrial land value (at 30th June)	$/m^2$
GDP	Annual gross domestic products (Australia, at current prices)	$ billion
PNE	Annual new capital expenditure on plant & equipment (Australia, at current prices)	$ billion
INTEREST	Long-term interest rate as 10 year bonds rate (average for a financial year)	% p.a.
BANKBILL	Short-term interest rate as 90 day bank bills yield (average for a financial year)	% p.a.
APPR	Values of industrial building approvals for a financial year (Sydney statistical division, at current prices)	$ million
COMNSW	Values of industrial building commencements for a financial year (NSW, at current prices)	$ million
DISTANCE	Distance from CBD	Kilometres

Exhibit 2: List of the Variables in the Regression Analysis

Variable	Description	Unit
LOGRENT	log - RENT (gross, at 30th June)	$/m^2$ p.a.
LOGLAND	log - LAND (at 30th June)	$/m^2$
LOGGDP	log - GDP (Australia, at current prices)	$ billion
LOGPNE	log - PNE (Australia, at current prices)	$ billion
INTEREST	Long-term interest rate as 10 year bonds rate (average for a financial year)	% p.a.
BANKBILL	Short-term interest rate as 90 day bank bills yield (average for a financial year)	% p.a.
LOGAPPR	log - APPR (Sydney statistical division, at current prices)	$ million
LOGCOM	log - COMNSW (NSW, at current prices)	$ million
DISTANCE	distance from CBD	Kilometres
LLOGGDP	1 year lagging variable of LOGGDP	$ billion
LLOGPNE	1 year lagging variable of LOGPNE	$ billion
LINTERES	1 year lagging variable of INTEREST	% p.a.
LBANKBIL	1 year lagging variable of BANKBILL	% p.a.
LLOGAPPR	1 year lagging variable of LOGAPPR	$ million
LLOGCOM	1 year lagging variable of LOGCOM	$ million

Exhibit 3: Correlations between Variables in the Regression Analysis

Variable	LOG RENT	LOG LAND	LOG GDP	LOG PNE	INTE REST	BANK BILL	LOG APPR	LOG COM	DIST ANCE
LOGRENT	1.00	0.90*	0.88*	0.89*	0.24*	0.14	0.82*	0.84*	-0.39*
LOGLAND		1.00	0.66*	0.67*	0.18	0.12	0.65*	0.65*	-0.70*
LOGGDP			1.00	0.98*	0.14	0.00	0.87*	0.89*	0.00
LOGPNE				1.00	0.30*	0.14	0.90*	0.93*	0.00
INTEREST					1.00	0.87*	0.38*	0.41*	0.00
BANKBILL						1.00	0.35*	0.36*	0.00
LOGAPPR							1.00	0.97*	0.00
LOGCOM								1.00	0.00
DISTANCE									1.00

* significant at the 0.05 level

Exhibit 4: Results of Regression Analysis based on Stepwise Regression Procedures (Regression Equation of Industrial Rental Values)

Regression Summary for the Dependent Variable: LOGRENT

N = 85 $R^2 = 0.9407$ Adjusted $R^2 = 0.9362$

$F(6,78) = 206.30$ $p < 0.000$

Standard Error of Estimate: 0.1226

Variable	B*	SE of B	*t*	p-level
Intercept	1.3223	0.7803	1.6947	0.0942
LOGGDP	0.2574	0.1922	1.3390	0.1845
LOGPNE	0.8443	0.1935	4.3643	0.0000
DISTANCE	–0.0191	0.0013	–15.1623	0.0000
LLOGPNE	–0.3590	0.1916	–1.8733	0.0648
LLOGAPPR	0.1647	0.0853	1.9301	0.0572
LLOGCOM	–0.0786	0.1197	–0.6569	0.5132

Variable	Beta**	SE of Beta	*VIF*
LOGGDP	0.2679	0.2000	52.63
LOGPNE	0.9001	0.2062	55.87
DISTANCE	–0.4180	0.0276	1.00
LLOGPNE	–0.4208	0.2246	66.23
LLOGAPPR	0.2443	0.1266	21.10
LLOGCOM	–0.1038	0.1580	32.89

* B: Regression Coefficient

** Beta: Beta Coefficient

Exhibit 5: Results of Regression Analysis based on Stepwise Regression Procedures (Regression Equation of Industrial Land Values)

Regression Summary for the Dependent Variable: LOGLAND

N = 85 $R^2 = 0.9505$ Adjusted $R^2 = 0.9463$

$F(6,78) = 247.80$ $p < 0.000$

Standard Error of Estimate: 0.1930

Variable	B*	SE of B	*t*	p-level
Intercept	−1.0657	1.2682	–0.8404	0.4033
LOGGDP	0.9390	0.3739	2.5111	0.0141
LOGPNE	–0.2793	0.3622	–0.7711	0.4430
LOGAPPR	0.2584	0.0902	2.8645	0.0054
BANKBILL	0.0165	0.0125	1.3202	0.1906
DISTANCE	–0.0562	0.0020	–28.3496	0.0000
LLOGCOM	0.0970	0.0945	1.0269	0.3077

Variable	Beta**	SE of Beta	*VIF*
LOGGDP	0.5689	0.2248	80.32
LOGPNE	–0.1734	0.2248	79.11
LOGAPPR	0.2114	0.0738	8.53
BANKBILL	0.0660	0.0500	3.91
DISTANCE	–0.7167	0.0253	1.00
LLOGCOM	0.0746	0.0726	8.25

* B: Regression Coefficient

** Beta: Beta Coefficient

Exhibit 6: Results of the Regression Model (IRVM)

Regression Summary for the Dependent Variable: LOGRENT

N = 90 $R^2 = 0.9454$ Adjusted $R^2 = 0.9435$

F(3,86) = 496.71 $p < 0.000$

Standard Error of Estimate: 0.1235

Variable	B	SE of B	*t*	p-level
Intercept	2.1428	0.1531	13.9989	0.0000
LOGPNE	0.7038	0.0525	13.4126	0.0000
LOGAPPR	0.0946	0.0429	2.2054	0.0301
DISTANCE	–0.0190	0.0012	–15.4222	0.0000

Variable	Beta	SE of Beta	*VIF*
LOGPNE	0.7750	0.0578	5.26
LOGAPPR	0.1274	0.0578	5.26
DISTANCE	–0.3885	0.0252	1.00

Durbin-Watson test: $d = 1.7425$

Exhibit 7: Normal Probability Plot of Residuals (IRVM)

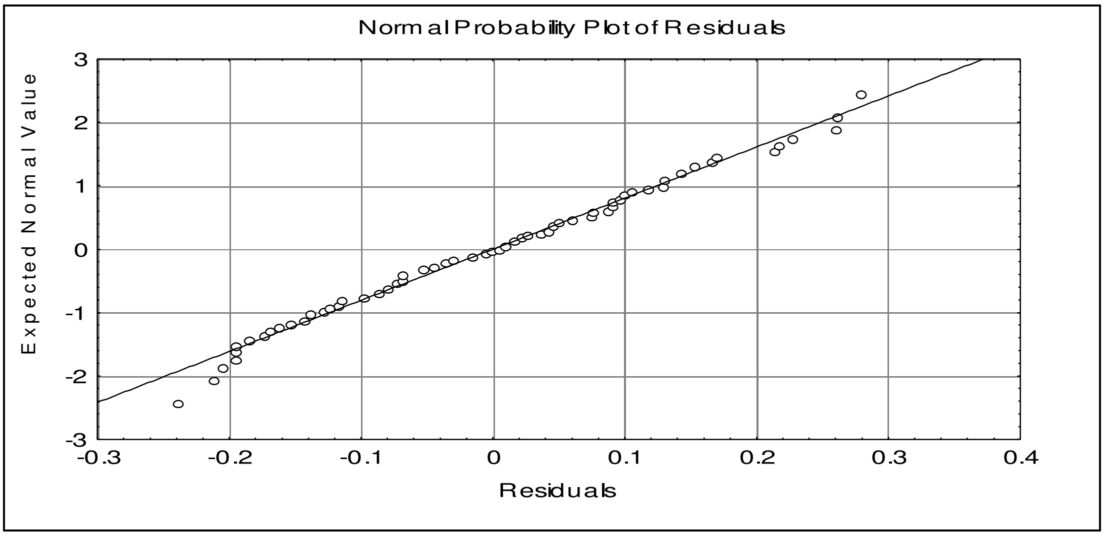


Exhibit 8: Scatter Plot of Standardised Residuals and Predicted Values (IRVM)

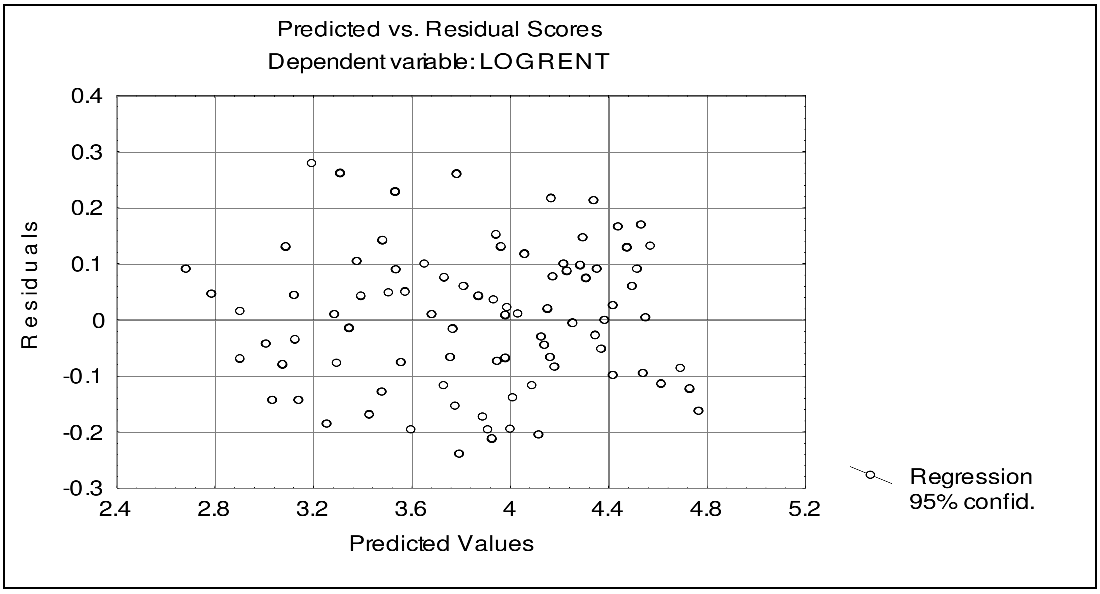


Exhibit 9: Scatter Plot of Standard Residuals and LOGPNE (IRVM)

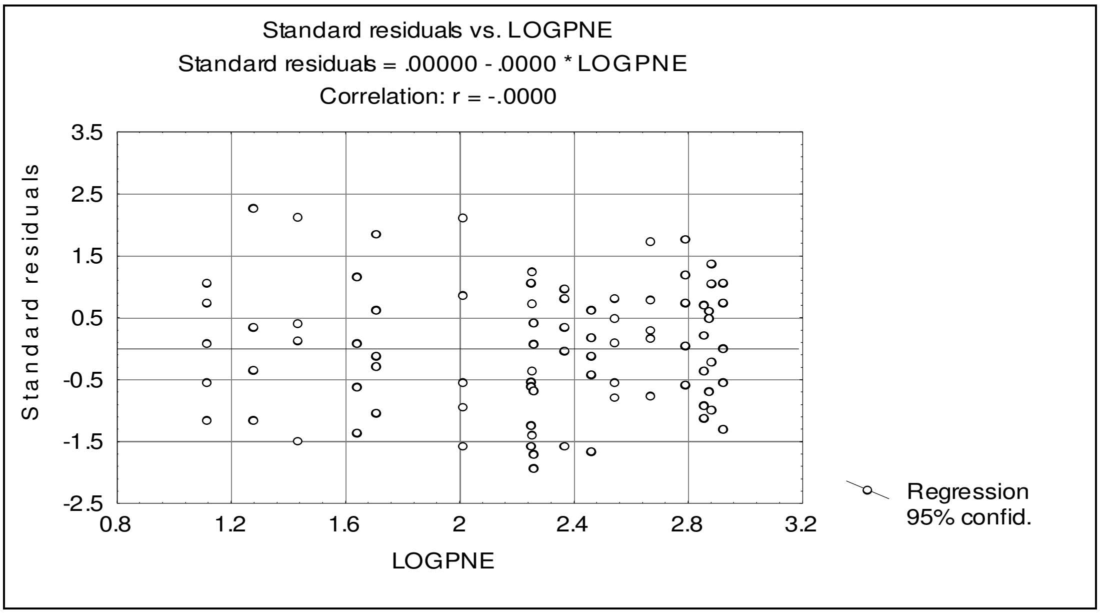


Exhibit 10: Scatter Plot of Standard Residuals and LOGAPPR (IRVM)

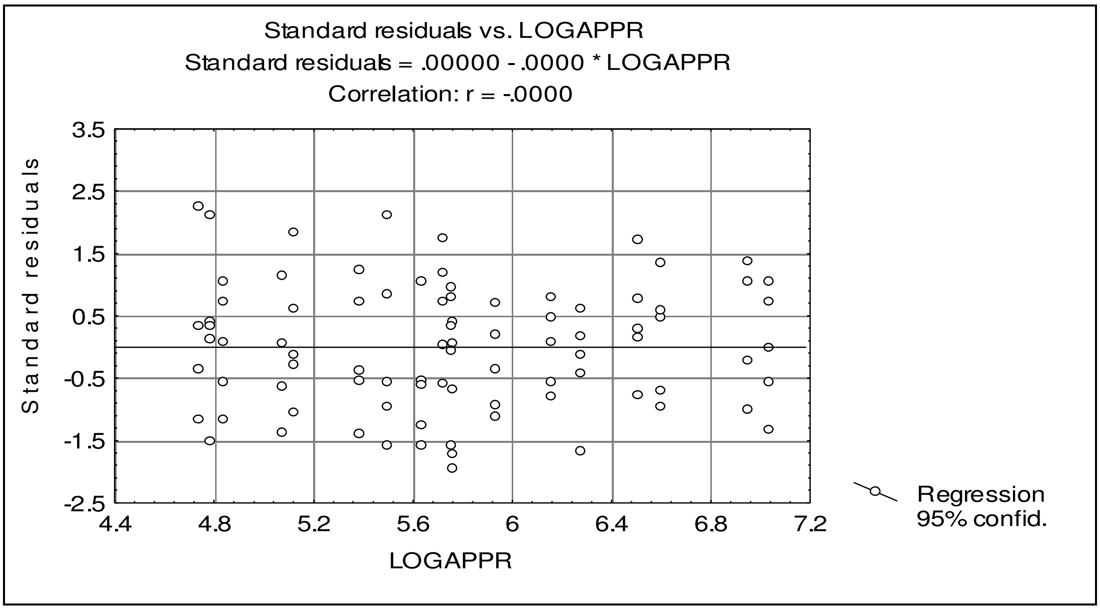


Exhibit 11: Scatter Plot of Standard Residuals and DISTANCE (IRVM)

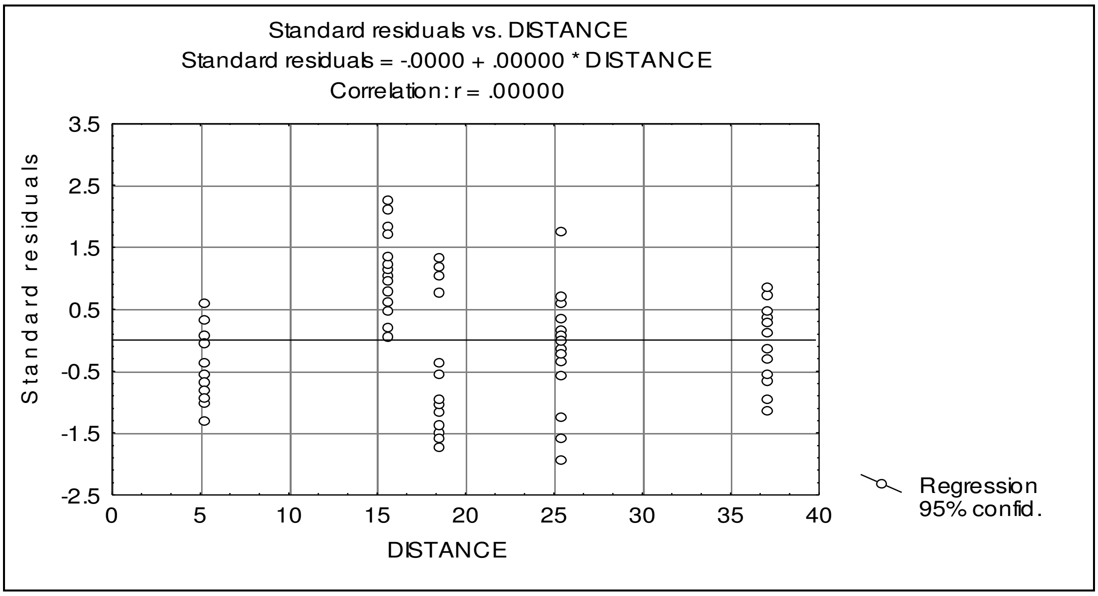


Exhibit 12: Results of the Regression Model (ILVM)

Regression Summary for the Dependent Variable: LOGLAND

N = 90 $R^2 = 0.9442$ Adjusted $R^2 = 0.9423$

$F(3,86) = 485.10$ $p < 0.000$

Standard Error of Estimate: 0.2039

Variable	B	SE of B	*t*	p-level
Intercept	2.3023	0.2527	9.1102	0.0000
LOGPNE	0.6402	0.0866	7.3896	0.0000
LOGAPPR	0.3156	0.0708	4.4568	0.0000
DISTANCE	–0.0558	0.0020	–27.4148	0.0000

Variable	Beta	SE of Beta	*VIF*
LOGPNE	0.4317	0.0584	5.26
LOGAPPR	0.2604	0.0584	5.26
DISTANCE	–0.6983	0.0255	1.00

Durbin-Watson test: $d = 1.8053$

Exhibit 13: Normal Probability Plot of Residuals (ILVM)

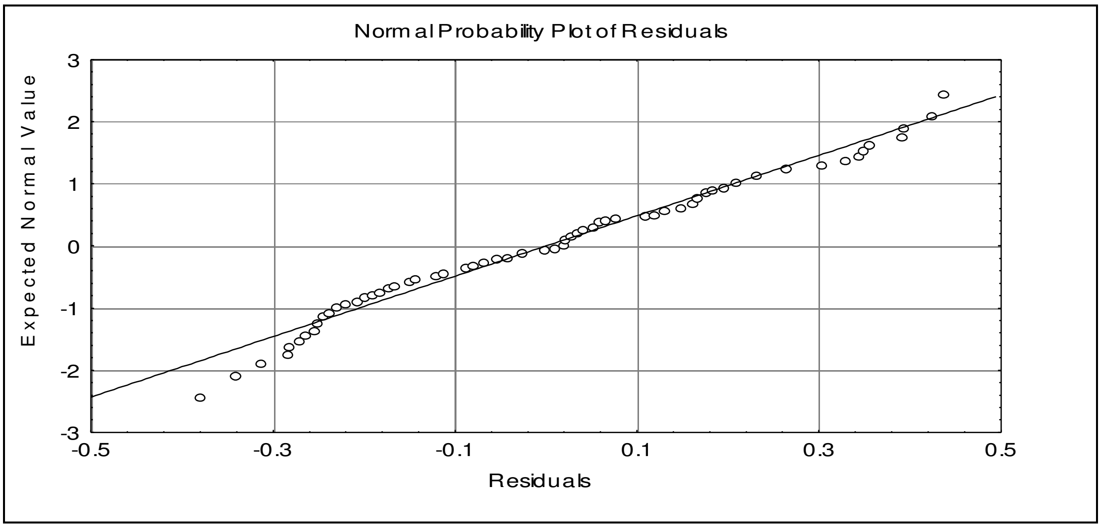


Exhibit 14: Scatter Plot of Standardised Residuals and Predicted Values (ILVM)

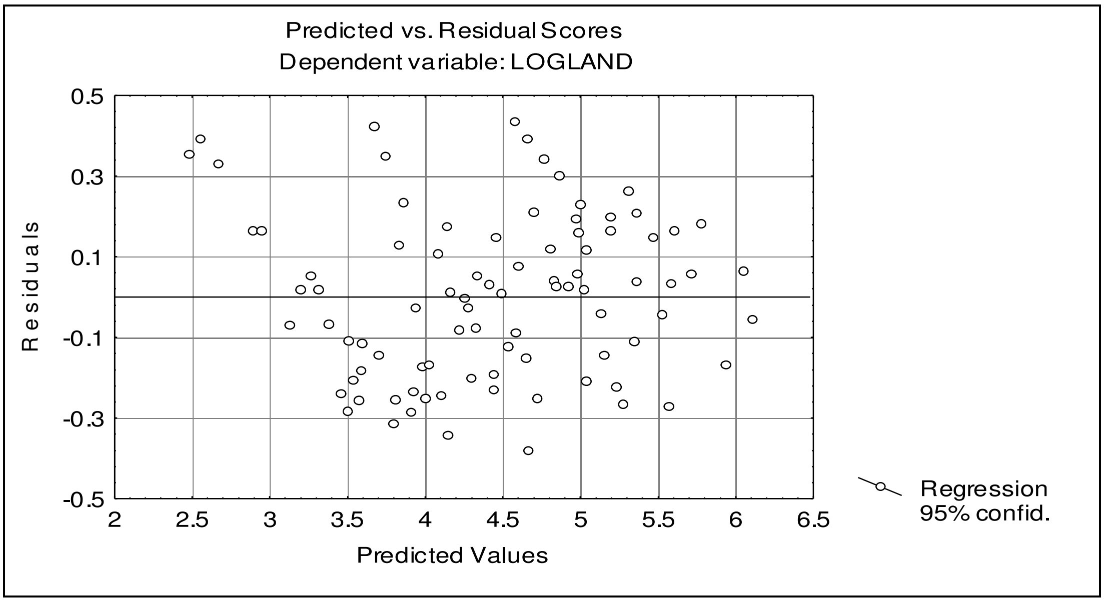


Exhibit 15: Scatter Plot of Standard Residuals and LOGPNE (ILVM)

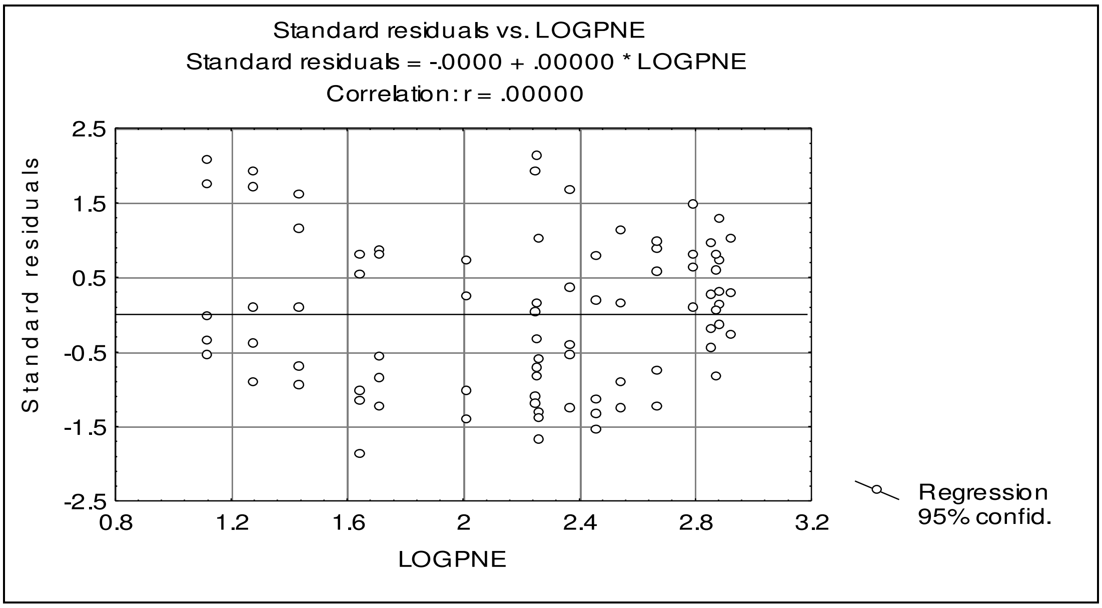


Exhibit 16: Scatter Plot of Standard Residuals and LOGAPPR (ILVM)

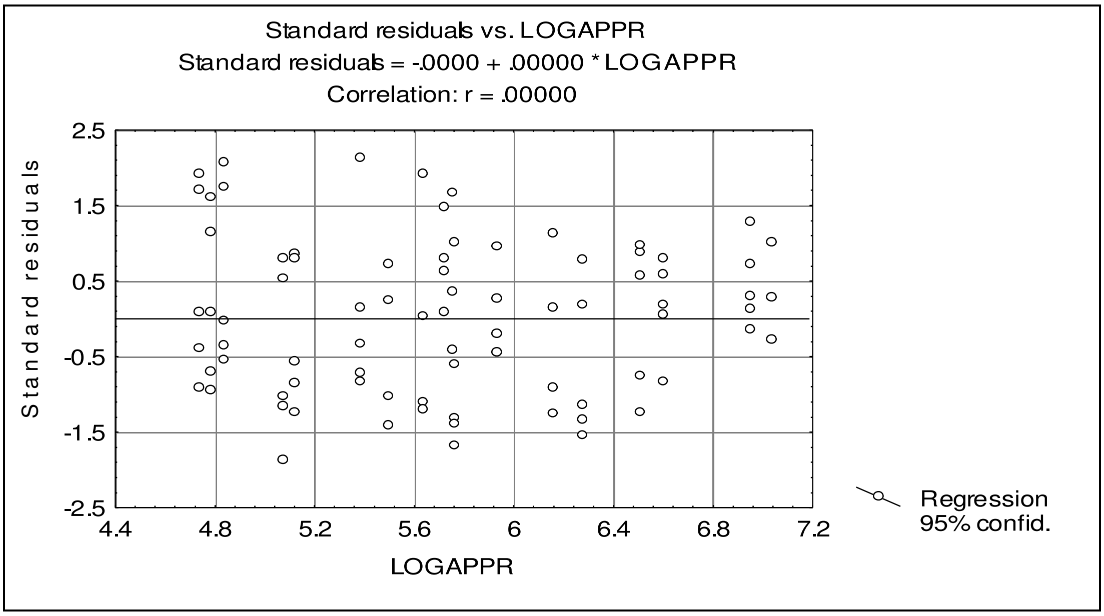
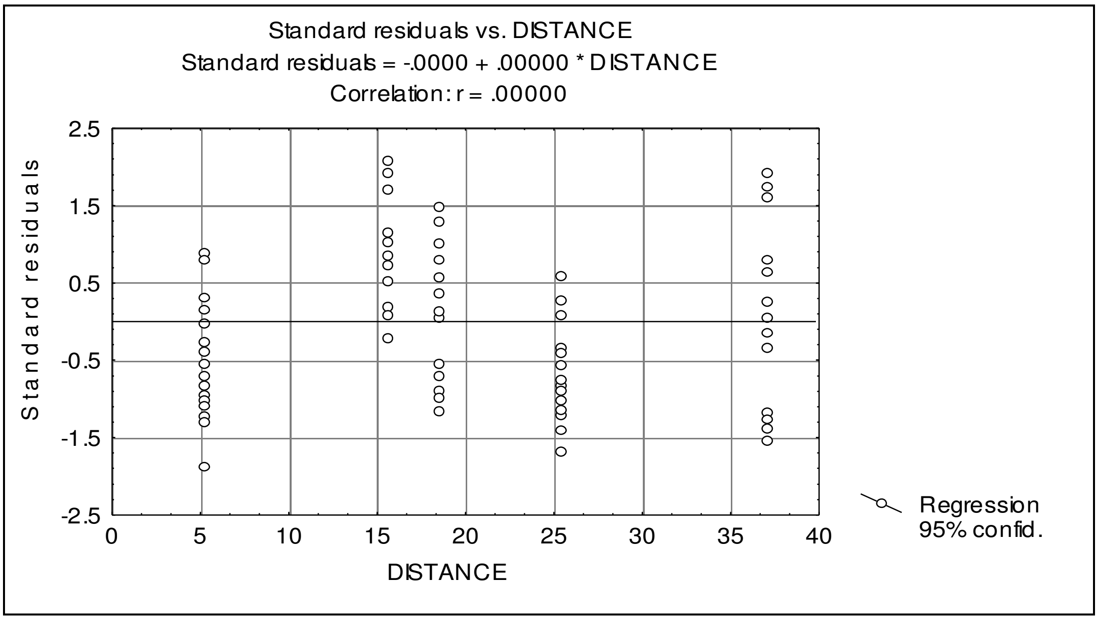


Exhibit 17: Scatter Plot of Standard Residuals and DISTANCE (ILVM)



References

Alonso, William (1964) **'Location and Land Use'.** Cambridge, Mass.: Harvard University Press.

Blaug, Mark (1992) **'The Methodology of Economics or how economists explain'** (2nd ed.). Cambridge: Cambridge University Press.

Burgess, E. W. (1925) **'The Growth of the City: An Introduction to Research Project'**, Chapter 2 in Park, R.E., and McKenzie, R.D. (1967), **'The City'.** Chicago: University of Chicago Press.

Keogh, G. (1994) **'Use and Investment Markets in British Real Estate'.** Journal of Property Valuation & Investment, Vol.12, No.4, pp.58-72.

Kim, J. (1996) **'Effects of the Economic and Location Factors upon the Sydney Industrial Property Market'**. Proceedings, 5th Annual International Real Estate Conference of the American Real Estate and Urban Economics Association, Orlando, Florida, 23-25 May 1996.

Marshall, Alfred (1961) **'Principles of Economics'** (9th ed.). New York:

Maddala, G. S. (1992) **'Introduction to Econometrics'** (2nd ed.). New York: Macmillan Publishing Company.

Neter, J., Wasserman, W., and Kutner, M. (1983) **'Applied Linear Regression Models'.** Homewood, Illinois: Irwin.