

A Study of Retail Property Prices in Seoul

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Abstract

The purpose of this study is to identify the determination variables which affect the retail property prices in Seoul by examining the variables related to the economic conditions of retail trade areas, physical characteristics of buildings, and location. About 146 major retail property data from 1 December 2007 to 31 December 2007 were analysed. Regression analysis and a structural equation modelling (SEM) were constructed to test the significance of the variables on the retail property prices in Seoul. The results indicate that age of building, size of shop and location explain a significant portion of the variability of the retail property prices. Through the empirical analysis, it was concluded that the retail property prices in Seoul were affected by the economic conditions, physical characteristics, and location.

Keywords: Retail property, Retail property prices, Structural Equation Modelling (SEM)

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1. Introduction

The factors that have major effects upon values of the existing stock of properties are identified as: the economic factors; the location factors; and the property factors (Cooper & Guntermann 1974; Fraser 1984; Salway 1986; Jaffe & Sirmans 1989; Baum 1991). The economic factors refer to the economic conditions as a wide range of aspects at the national level, while the location factors refer to location aspects at the regional level. Finally, the property factors describe the characteristics of property itself such as the buildings and the land belonging to it. The economic conditions are concerned with macro-economic matters such as: the state of the national economy; the state of the financial market; and the changes of taxation. The location aspects are concerned with micro-economic matters such as: the local demand and supply; the planning and development policies of the region; and changes in charges and fees. The characteristics of property itself are the functional aspects of the property, the aesthetic aspects of the buildings, and the physical aspects of the land and buildings.

These three types of factors arise out of the basic natures of properties such as longevity, immobility, and heterogeneity. A property does not comprise only the brick, soil, columns, and physical features, but is defined as a bundle of privileges or benefits accruing to the owner for the period of the ownership. Because the stream of benefits produced from a property depends as much on factors external to the locus of the property itself, the value of a property depends to a considerable degree on the state of the economic base and the quality and type of location.

Retail property prices and rents are decided locally and individually based on the retail environment of the retail trade area where the target customers exist, so the economic conditions of retail trade area greatly affect retail property prices. The change in the economic conditions of retail trade area results in the increase or decrease in retail rents, brings about new retail trade areas or shopping centres to compete against the existing commercial establishment, and brings changes in the consumers' standing. Changes in public transportation, introduction of large wholesale or retail stores, introduction or transfer of public agencies or big businesses, and increase in income and accompanying change in consumption pattern are some of the factors, which may bring changes to market power. Despite the importance of the economic conditions of retail trade area, researches on concrete factors which affect the economic conditions of retail trade area have thus far

been neglected. This study will discuss the variables that affect the retail property price and rent of individual store and their importance by utilizing data on retail properties in Seoul.

2. Literature review

The studies that deal with factors, which affect retail rents, investigated how spatial factors of retail property affected retail rents until 1980s, and they have progressed to investigating how non-spatial factors, such as the nature of consumers or image of shopping centres, affect the retail rents since 1990s. The studies of real estate models to estimate and predict the real estate values increased rapidly. Similar price models with real estate leases were constructed for the real estate price index. Recently the studies increased to examine casualty or co-relationship between real estate prices and macroeconomic variables in USA and UK (Ball *et. al* 1998; Hamelink *et. al* 2000).

The profits from real estate investments vary greatly in accordance with the cycling aspects of real estate markets. So, participants' in real estate markets are concerned with variations in profits and the factors influencing such variations. However, there are fewer empirical analyses on the determination and prediction of retail rents than those on residential rents. The studies on retail property rents are normally classified into microscopic (cross-sectional) analysis and macroscopic (time series) one.

The results in the research by using the cross-section analysis showed that retail rents are affected by the terms of lease, the ratio rents, and tenant position as a national chain. In addition, it was found that gross floor area, age of shopping centre, and anchor tenant are major factors in determination of retail rents (Benjamin *et. al* 1990). The retail rents are positively related to market area, traffic volume and were negatively related to location variables, age, and vacancy of shopping centre (Sirmans and Guidry 1993). The condition and profitability of retail business decided the demand of retail space and it could induce the fluctuation of retail rents. The variables which represent the demand strength of retail space proportionally are related to the fluctuation of retail rents. More recent study found that the retail rents are negatively related to the distance from bus-stop or subway station (Hickling Lewis Brod Inc 2002). Also, the retail rents are positively related to vacancy rate, age, the distance from shopping centre, buying power, and remodelling of shopping centre variables (Hardin, Wolverton & Carr 2002).

There are some studies on the relation between macroeconomic variables and retail rents. Lessors and lessees in the property market generally check a variety of the price, index, and rate related to the rents, such as: the real estate rental value index; the price of

commercial property; loan interest rate; consumer price index; regional vacancy rate; repair expenses; and depreciation allowance of buildings. Previous studies in USA and UK show that macroeconomic variables influenced upon commercial rental values. In addition the studies show that GNP, retail sales, consumer price index, interest rate, construction permission quantity of commercial buildings, and vacancy rate influenced upon retail rents.

According to other studies on retail rents or retail property, stores located in a huge shopping mall is more competitive than stores located in a small shopping centre (Eaton & Lipsey 1982; Mulligan 1983). Furthermore, Ghosh (1986) reports that landowners or low-level retailers benefit from the availability of multi-purpose shopping. Moreover, the lease term, percentage rent, or name value of franchise affect the rents of each store (Benjamin, Boyle & Sirmans 1990), and the size or age of shopping centre or nature of anchor tenants may decide the rents as well (Sirmans & Guidry 1993). Also, stores which are traditionally known to draw a sizable volume of traffic often end up paying less for rent. (CALUS 1975)

Many studies used the retail rents and nature of the market or the economic conditions of the primary retail trade area as an explanatory variable, but studies which deal with the variables on the economic conditions of retail trade area are extremely limited. The buying power in retail trade area is known to be important in determining the amount of retail sales and setting retail rents (Ingene and Lusch 1980; Okoruwa *et al* 1994), and the image of anchor tenants or characteristics of the population are part of the variables that reflect the economic conditions of the retail trade area. (Hardin & Wolverson 2001)

3. The research model and data

In this study, a retail trade area means a spatial and local area, which includes the most practical place of trading for consumers as well as businesses. In general, the retail trade area is determined by the nature of stores, physical obstacles, competitions within the location, driving distance, and other elements. In addition, the special image of retail property or anchor tenants, or the economic conditions of a retail trade area may increase the amount of sales in retail real estate, and the increase will be reflected in retail property prices and rents. The model also explains the recent accumulation of retail stores at the centre of a shopping district, and the crowding phenomenon, which allows the consumers to visit many stores in single visit, thereby saving the cost of travelling. However, the phenomenon differs in scale and pattern depending on the local characteristics. (Dipasqual & Wheaton 1996)

In general, the structure or characteristic of a retail trade area changes according to the physical conditions, such as type of residence, or road construction, or investment in new buildings. Factors describing the characteristics of retail trade area include the size of retail trade area, shape of retail trade area, local population, nature of the population (age, gender, income, and so on), potential expense, degree of market penetration, degree of market dominance, absorption power of client, approachability of store, and transportation. Factors determining the economic conditions of a retail trade area include the price of real estate, population, housing, industry, and real estate development. The index describing the economic conditions of a retail trade area include: the size of the population; average household size; population density; population spread according to age; population increase rate; weekly population index; income within retail trading area, and the buying power in retail trading area.

The economic forces of a retail trade area differ depending on the type of real estate in the area. The economic conditions index of residence was used in the retail trade area, which includes the rate of home ownership, single housing, apartment, duplex housing, and other types of housing. Moreover, the economic conditions index of a retail trade area related to industry includes the number of businesses, number of employees, spread of employees per industry, increase of sales amount in wholesale and retail businesses, and degree of concentration within 1 sq. km for wholesale, retail, and restaurant businesses. The economic conditions index of a retail trade area related to the real estate price includes monthly rent of store, deposit money for the house rents, and office rents. Lastly, the economic conditions index of commercial power related to real estate development includes the viability of the area to turn it into a commercial area next to a subway station, commercial area through rezoning, part of land planning, business building, administrative town, residential and commercial building, project of expanding or repairing a road, and redevelopment project.

3.1. Theoretical model

This study has considered the variables, such as, the monthly rent or deposit per 3.3 m² within the retail trade area, population of the retail trade area, the number or types of housing within the retail trade area, and the number, types, or members of businesses within the retail trade area, to determine the retail property price per 3.3 m². The retail property price according to this model is the function of effective buying power, where the effective buying power is determined by the size of population and income within the retail trade area.

$$\text{Retail Price}_{ji} = (\text{Eco}_j, \text{Phy}_j, \text{Lco}_j) \quad (1)$$

This study investigates the economic variables of trade area which affect the retail property price using multiple-regression analysis (ordinary least squares) and structural equation model to examine the relationship between the retail property price and the various descriptive variables.

Economic Conditions (Eco)

- ***The monthly rent or deposit of retail trade area***

The average retail property price of a retail trade area is interpreted as the index, which reflects the present and future economic conditions of the relevant retail trade area. Retail rent is also interpreted as the index, which reflects the present and future possibility of the relevant retail trade area. Retail rents means the amount being paid by the new tenant to the owner for certain rights attached to the business, facilities, or ground being transferred. There is retail property price for business, facility, or ground, but they are all added together when dealing with retail real estate. Firstly, retail rents for business arises from the successful efforts of present tenant to enliven the business of the store or commercial area, and it awards the tenants for the build-up of royal clients, reputation of the store, and the sole right to a franchise and resulting superior standing in the market.

Secondly, retail property rents for facility is formed when the existing tenants asks for the cost for the facility they invested, such as interior, sign, or equipment, at the start of their business from new tenants who happens to engage in the same type of business as the existing tenant.

Thirdly, retail rents for ground is reward for good business due to the store location.

Lastly, other retail property price includes the amount new tenant pays to the existing tenant for any other rights besides business, facility, or site.

- ***Population***

Population is the basic unit of demand for goods or services. The demand here means the valid demand for goods or services, and it is included in this study as a major variable because the object among the population is determined by the types of goods or services. Fixed and floating population is directly related to the amount of sale in retail real estate. Thus, the valuation of retail real estate is proportionally related to the number of people passing through the area, that is, the concentration of population or change in the background population determines the value of the consumption centre. Also, the increase

of population and accompanying changes in environments are very important in consumption activities. Variables representing income, such as occupation, education level, and spending, are important variables which affect the retail sales of stores. Especially, the characteristics of population within retail trade area represent the quality of retail trade area. In this respect, in the consumer market of food or clothing, the total population size is an important index which determines the volume of demand for the products.

- ***Housing***

Housing takes up an important part of national economy. Housing is a part of stock, a fixed capital, and it takes up a portion of political means in creating wealth. Housing is closely related to the industry of locale. Like a luxury vehicle, housing is also a symbol of prestige one occupies in the society. A large portion of individual wealth is spent on the purchase or maintenance of housing, and the state or type of possession of housing directly or indirectly represents the social position or income level of the resident. The type of ownership, size of possession, and location of the residence are used as variables representing the income of individual along with the source and amount of income and occupation.

Thus, this study used the resident of apartment and ownership of housing as well as the average amount of vehicle and residential tax as proxy variables to represent the income level of the area.

- ***Industry***

The source of demand for real estate is a part of the business activity in the area. Changes in hiring practice of economically active population for each industry greatly affect the market, and they are followed by changes in the consumption patterns. That is, people working in the secondary or tertiary industry maintain the westernised life style, so they contribute greatly in increasing the demand for consumer goods including durable consumer goods. In this case, department stores with the concentration of sales businesses or discount stores with restaurants will suitably cater to the population as well as the food court, entertainment district, hotel, or theatre.

Physical Attributes (Phy)

There are two types of physical attributes. (1) Physical attributes of the site consist of size, shape, topography, climate, vegetation, natural drainage, soil and subsoil. (2) Physical attributes of a structure including exterior physical features and interior physical features. Exterior physical features consist of substructure and superstructure. Interior physical features are composing of walls, supports and finish and equipment, mechanical systems,

plumbing, heating, ventilating, and air-conditioning.

In general, lower retail rent is charged in older shopping centres. Some studies underline detrimental effects of physical and functional obsolescence that arise as properties age. The age variable captures retail property depreciation and obsolescence, and is negative and statistically significant. The age of retail property is inversely related to the rent because older retail properties suffer physical neglect, inappropriate tenant mix, and older facilities. Also, size of the property is the most dominant variable in the explanation of the price of property. The shopping centre size variable is positive and statistically significant, indicative of a possible on site aggregation effect as centres increase in size.

Location Factor (Lco)

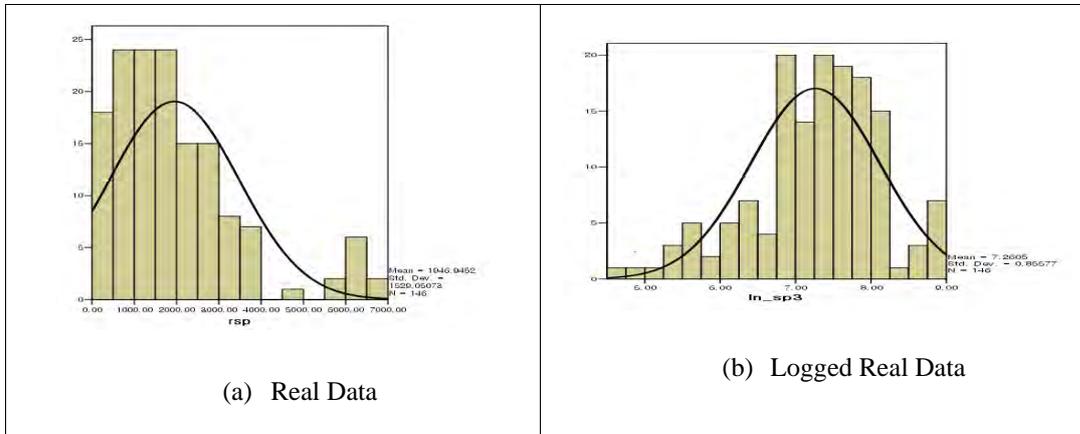
Location factors that affect retail property address five main variables: (1) access; (2) visibility, (3) traffic counts; (4) location within an urban area; and (5) the presence of other complementary stores, including restaurants. Access generally refers to the convenience of local transportation and road. Several empirical studies have linked access to the location needs of retail stores. Visibility concerns the ability of potential shoppers to enjoy an unobstructed view of a store or its sign from a number of vantage points. The importance of this factor has been demonstrated with respect to retail location. The factor of automobile traffic counts in front of a store or on the nearest public roadway is also an important consideration for store location. The presence of banking & financial services and the real estate industry may help rather than hinder sales, and the presence of banking & financial services and the real estate industry in the immediate vicinity is often referred to as a business cluster.

3.2. Data

This study focused on the commercial establishments along the roads in Gangnam-gu, which is one of the 25 local government districts in Seoul Metropolitan Area. This study used 146 data for retail real estate transaction (monthly rent, deposit, and retail property price) from December 1st 2007 to December 31st 2007 and the 2007 Annual Statistics Report of Seoul. Retail property price per 3.3 m² was assigned as a response factor, and economic conditions, physical attributes, and location were assigned as explanatory variables. The explanatory variables were Shinsa-area, Yeosam1-area, Irwonbon-area, Suseo-area, Yeosam2-area, Cheongdam-area, Apgujeong-area, Irwon-area, Poyi-area, average apartment sales price, size of shop, ground floor, number of stories, age of building, chonse price, rental bond per 3.3 m², Monthly rent per 3.3 m², sum of loan, sales

of trade area, index of retail trade area. The data which were used in this study are summarised in the Appendixes I and II.

Figure 1: Retail Property Price - Data Transformation



The distribution of retail property prices (real data) shows the form of a long tail in the right-hand direction as in the Figure 1. Then, the data was transformed logarithmically to do parametric statistics based on normal distribution and tests. The distribution of retail property price (transformed data) shows a bell-shaped normal distribution.

4. Empirical result

The data was transformed logarithmically and was analysed with the multiple-regression method.

4.1 Extraction of significant variables

Before deciding significant variables, proper number of variables which make up the scaled-down model was selected through the plots with Mallows' C_p and adjusted coefficient of determination ($adjR^2$). According to Mallows' C_p , a scaled-down model with more than 7 but less than 9 variables was preferred (Appendix III), whereas according to the adjusted coefficient of determination ($adjR^2$) standard, selection of 8 variables was preferred (Appendix IV).

This study selected the adjusted coefficient of determination ($adjR^2$) as the standard in selecting major variables, and selected the final model after considering the mean square error (MSE) and Mallows' C_p . In this case, the highest value of the adjusted coefficient of

determination ($\text{adj}R^2$) would be the most ideal, whereas the lowest value was preferred for the mean square error (MSE) or Mallows' C_p .

The result from the stepwise regression method is summarised in the Table 1. For the major variables, steps 1 and 2 selected *size of shop* and *age of building* as in the forward selection method, step 3 selected *Poyi area*, step 4 selected *ground floor*, step 5 selected *Irwon area*, step 6 selected *chonsei price*, step 7 selected *local retail sales*, and step 8 selected *sum of loan*. The value of Mallows' C_p was the lowest in the 8th step, whereas the adjusted coefficient of determination ($\text{adj}R^2$) was the highest.

P-values of all eight selected variables are below 0.05, thereby making them significant above 95%. In addition, the adjusted coefficient of determination ($\text{adj}R^2$) which denotes the explanatory power of the optimal regression model was 0.51, which was rather high when compared to the results from previous studies.

Table 1: Result of Variable Selection using Stepwise Regression Method

Step	Variables	R-Square	Adjusted R-Square	C(p)	Root MSE	Sig.
1	<i>size of shop</i>	0.2057	0.2002	97.0745	0.76557	0.0001
2	<i>age of building</i>	0.3338	0.3245	60.5249	0.70358	0.0001
3	<i>Poyi area</i>	0.4039	0.3914	41.4132	0.66786	0.0001
4	<i>ground floor</i>	0.4562	0.4408	27.6874	0.64786	0.0003
5	<i>Irwon area</i>	0.4780	0.4594	23.1200	0.64017	0.0168
6	<i>chonsei price</i>	0.5016	0.4801	18.0090	0.62944	0.0113
7	<i>local retail sales</i>	0.5188	0.4944	14.8441	0.61944	0.0282
8	<i>sum of loan</i>	0.5326	0.5053	12.6839	0.61724	0.0461

4.2. Reduced Model

Based stepwise selection of variable, this study was able to build the optimal regression model and the results show in the Table 2. The constant for the regression equation was 9.50, and the regression coefficient for *size of shop* was -0.31. Also, *t*-value of the *size of shop* was -4.47, and the probability of significance was 1%. This means that size of shop was the variable that affected the retail property price the most. In addition, the *t*-value of *age of building* was -0.66, the significance probability was 1%, so H_0 was rejected with $\alpha=0.01$. Moreover, with $\alpha=0.01$ it was statistically significant for the regression coefficient

of each variable representing *Poyi-area* (t-value: -1.78, significance probability: 1%), *ground floor* (t-value: 0.488, significance probability: 1%), *Irwon-area* (t-value: -1.35, significance probability: 1%), *chonsei price* (t-value: 0.005, significance probability: 1%), *retail sales* (t-value: -0.32, significance probability: 1%), and *sum of loan* (t-value: 0.024, significance probability: 1%).

Based on the parameter estimate of regression coefficient in the Table 2, the regression equation can be written as below:

$$\ln_{\hat{y}} = 9.50 - 0.30 \times (\ln_{size}) - 0.69 \times (\ln_{age}) - 1.78 \times (Po-a) + 0.48 \times (gf) - 1.35 \times (Ir-a) + 0.05 \times (\ln_{chon}) - 0.32 \times (\ln_{rsa}) + 0.024 \times (\ln_{loan}) \quad (2)$$

Where

y = retail property price per 3.3 m²

Table 2: Result of Reduced Regression Analysis

(a) Analysis of variance

Source	DF	Sum of Mean	Squares Square	F Value	Pr > F
Model	8	56.59491	5.24256	19.51	<.0001
Error	137	49.66437	0.14763		
Corrected Total	145	106.25928			
	Root MSE	0.60209	R-Square	0.5326	
	Dependent Mean	7.26034	Adj R-Sq	0.5053	
	Coeff Var	8.29287			

(b) Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Prob > t	Variance Inflation
Intercept	1	9.50727	0.38338	24.80	<0.0001	0
Size of shop	1	-0.30199	0.06759	-4.47	<0.0001	1.67560
Age of building	1	-0.66997	0.10712	-6.25	<0.0001	1.19044
Poyi area	1	-1.78086	0.36493	-4.88	<0.0001	1.07944
Ground floor	1	0.48821	0.12355	3.95	0.0001	1.52285
Irwon area	1	-1.35826	0.44196	-3.07	0.0026	1.06285
Chonsei	1	0.05197	0.01922	2.70	0.0077	1.16477
Retail sales	1	-0.32692	0.12383	-2.64	0.0093	1.33270
Sum of loan	1	0.02410	0.01197	2.01	0.0461	1.35028

The relative importance of variables in explaining retail property prices can be analysed with t-value in the Table 2 (b) Parameter Estimates. When the standard estimate was employed to find out the weight of each explanatory variable, the importance decreased among the variables according to the following order; *age of building* (-6.25), *Poyi area* (-4.88), *size of shop* (-4.447), *ground floor* (3.95), and *Irwon area* (3.07).

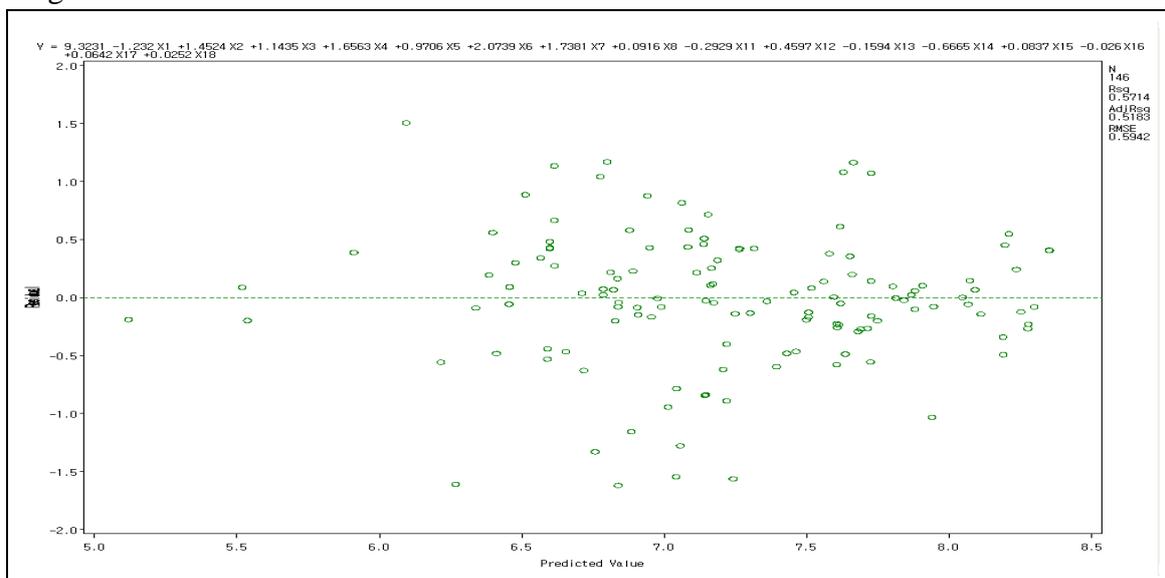
4.3. Verification of the model

To verify the appropriateness of the final model written in the Equation 2, this study investigated residual analysis, influence evaluation and multicollinearity.

The independence of residue, homogeneity of variance, and normalization were investigated to review the appropriateness of the model using the chosen variables. The value of Durbin-Watson was obtained to discover the independent nature of residue. As the value of Durbin-Watson D is 1.190 (number of observation = 146, first order autocorrelation = 0.391), the independent nature of residue is also satisfied.

In order to check the homogeneity of variable in residue, a residual plot was drawn in the Figure 2. The residual plot displayed a distribution shape concentrated in certain area, and this is a phenomenon often found in data representing the value of real estate. There does not appear to be any discernable pattern in the plot indicating that a straight line fit is appropriate. From the scatter plot of residuals against predicted values, we can see that there is no clear relationship between the residuals and the predicted values.

Figure 2: Residual Plot



In addition, this study employed the histogram and normal probability to investigate the normalization of residue, and the residue had a shape close to a normal distribution as shown in the Figures 3 and 4, thereby satisfying normalization of residue. The figures show that the independence of residue, homogeneity of variance, and normalization were satisfactory.

Figure 3: Histogram of Residue

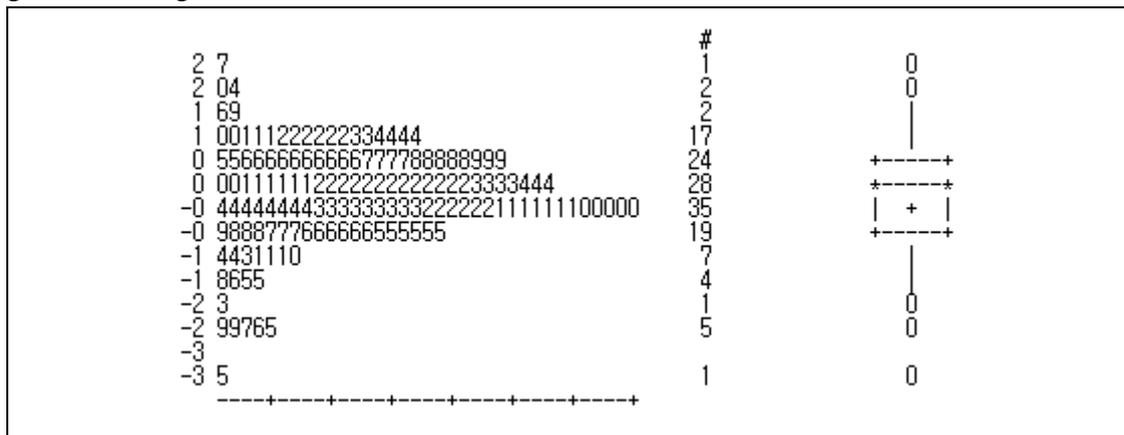
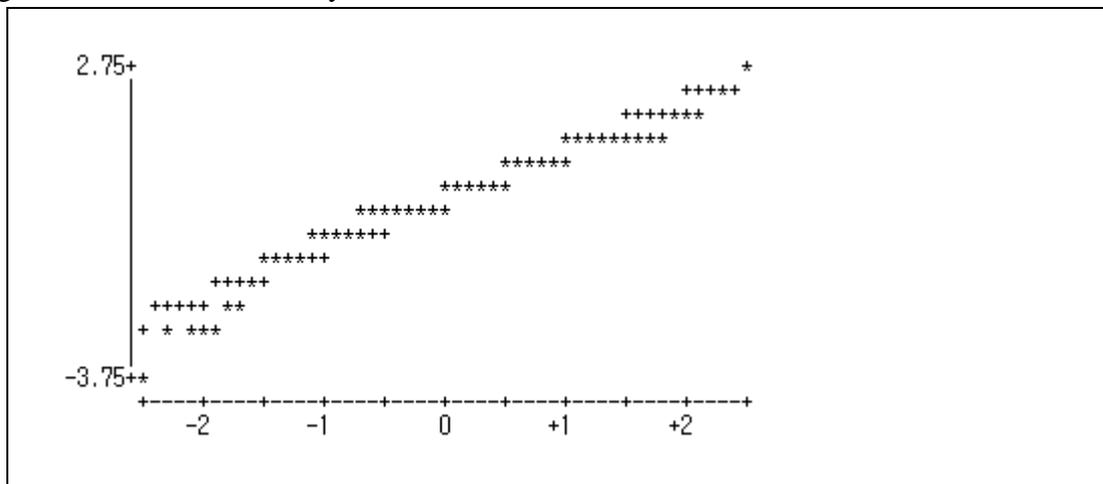


Figure 4: Normal Probability of Residue



This study also analysed the multicollinearity based on variable inflation factor (VIF). As the variable inflation factor for each selected variables was less than 7 the Table 2, multicollinearity among individual variables of the regression equations was not a problem.

The figures showing the independence of residue, homogeneity of variance, and normalization were satisfactory when they were checked with the most appropriate model built by the chosen variables, and this study confirmed that the retail property price is

affected by age of building, Poyi area, size of shop, ground floor, Irwon area, chose price, local retail sales, and sum of loan.

4.5. Structural Equation Model

The retail property price decision model within retail trade area is regraded as function of the variables representing economic conditions, physical attributes, and location factors. From the Table 3, the meaning of each principal component was interpreted based on the common characteristics of the results. It shows that the principal component 1 (Factor 1) can be called physical attributes, the principal component 2 (Factor 2) can be called the economic conditions, and the principal components 3 and 4 (Factors 3 and 4) can be called the location factors.

Table 3: Eigenvectors of the Correlation Matrix

Variables	Prin1	Prin2	Prin3	Prin4
Irwon-area	0.072	-0.374	0.769	-0.305
Poyi-area	-0.176	-0.327	0.077	0.864
Size of shop	-0.827	-0.115	0.139	-0.073
Age of building	0.272	-0.596	-0.38	-0.377
Ground floor	0.779	0.165	-0.063	0.119
Chonse price	0.533	0.174	0.527	0.099
Local retail sales	0.067	0.846	-0.012	-0.069
Sum of loan	-0.649	0.372	0.084	-0.115

The results of the factor regression with the factors (physical attributes, economic conditions, and location factors) are shown in the Table 4. The *Beta* (β) values indicate the relative influence of the variables. The physical attributes factor has the greatest influence on retail property price ($\beta = 0.421$), followed by economic conditions ($\beta = 0.419$). The $\text{adj}R^2$ value indicates that about 33% of the variance in retail property price can be explained by the predictor variables (three factors).

To illustrate multistage systems, assume that retail property price is influenced by the economic conditions, physical attributes and location factors. The relationships among these factors can be depicted as in the Figure 5. In this diagram the connecting lines

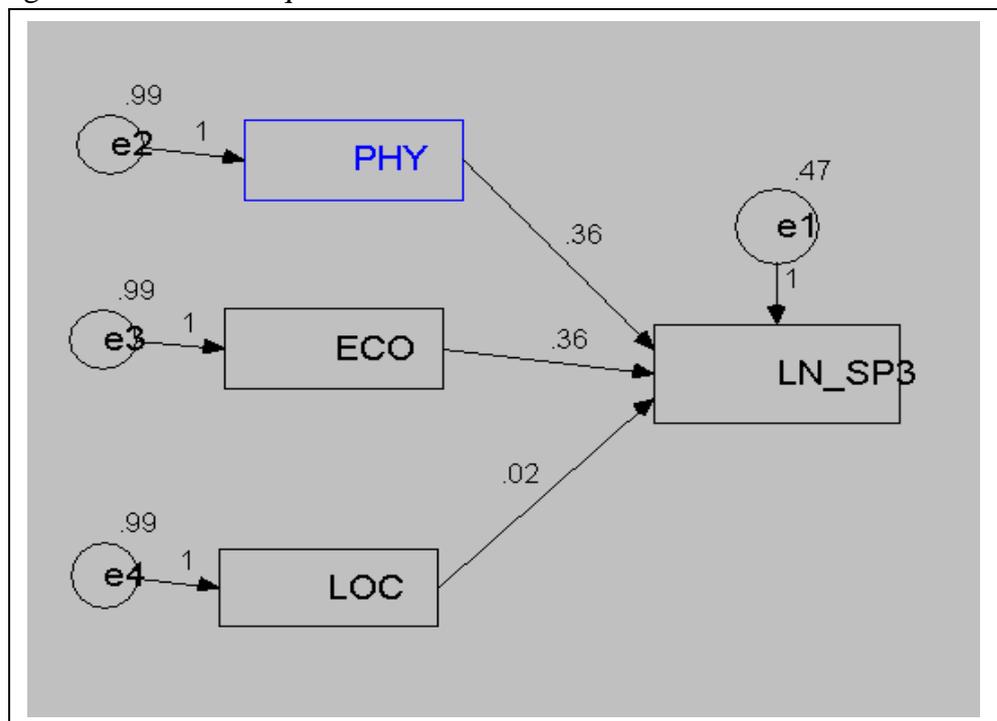
indicate relationships between variables, and the arrows indicate the direction of causality for those relationships. The 0.360, 0.359 and 0.021 values are un-standardised regression coefficients that indicate the magnitude of each relationship.

Table 4: Results of the Factor Regression

	Unstandardised Coefficients		Standardised Coefficients	<i>t</i>	Signif of <i>t</i>
	B	Std Error	<i>Beta</i>		
intercept	7.261	0.058		126.186	0.000
Physical attributes	0.360	0.058	0.421	6.241	0.000
Economic conditions	0.359	0.058	0.419	6.214	0.000
Location factor 1	0.021	0.058	0.025	0.365	0.716
Location factor 2	0.020	0.058	0.023	0.338	0.736

(adjR² = 33%)

Figure 5: Structural Equations Model



5. Conclusion

This study described in details how certain variables of the economic conditions in retail trade area, physical attributes and location factors related to the determination of retail property prices. For the empirical model, this study used a data set of the prices of retail real estate in Gangnam-gu, Seoul and the 2007 Annual Statistical Report of Seoul. This study selected significant variables from the 20 variables related to the economic conditions, physical attributes and location factors using statistical analysis.

According to the analysis, *ground floor*, *chonsei price*, *sum of loan* were positively related to the retail property prices, while *age of building*, *size of shop*, *Poyi-area*, *Irwon-area* and, *local retail sales* were negatively related to the retail property prices. Especially, *age of building*, *size of shop*, and *Poyi-area* were found to be important explanatory variables in calculating the retail property prices.

When this study observed the statistical analysis of the optimal model based on the 8 explanatory variables, each *P*-value for every explanatory variable was found to be below 0.05, so the finding was significant with 95% reliability. Also, both the adjusted coefficient of determination ($\text{adj}R_2$) = 0.5053 and the value of $F = 19.51$ were rather high when compared to the results from previous studies. The residual analysis, influence evaluation, and multicollinearity analysis were performed as parts of the regression analysis, and the Durbin-Watson value of residue was found to be 1.199, thereby satisfying the independence of residue. Also, the distribution of residue was close to normal, so the result satisfied the normalisation.

Through an empirical analysis, this study has proved that the retail property prices in Gangnam-gu, Seoul are affected by the economic conditions, physical attributes, and location factors. The analysis shows that economic factors within the retail trade area as well as the physical attributes of retail properties have highly affected retail property prices at the statistically significant level with the reliable model in Seoul.

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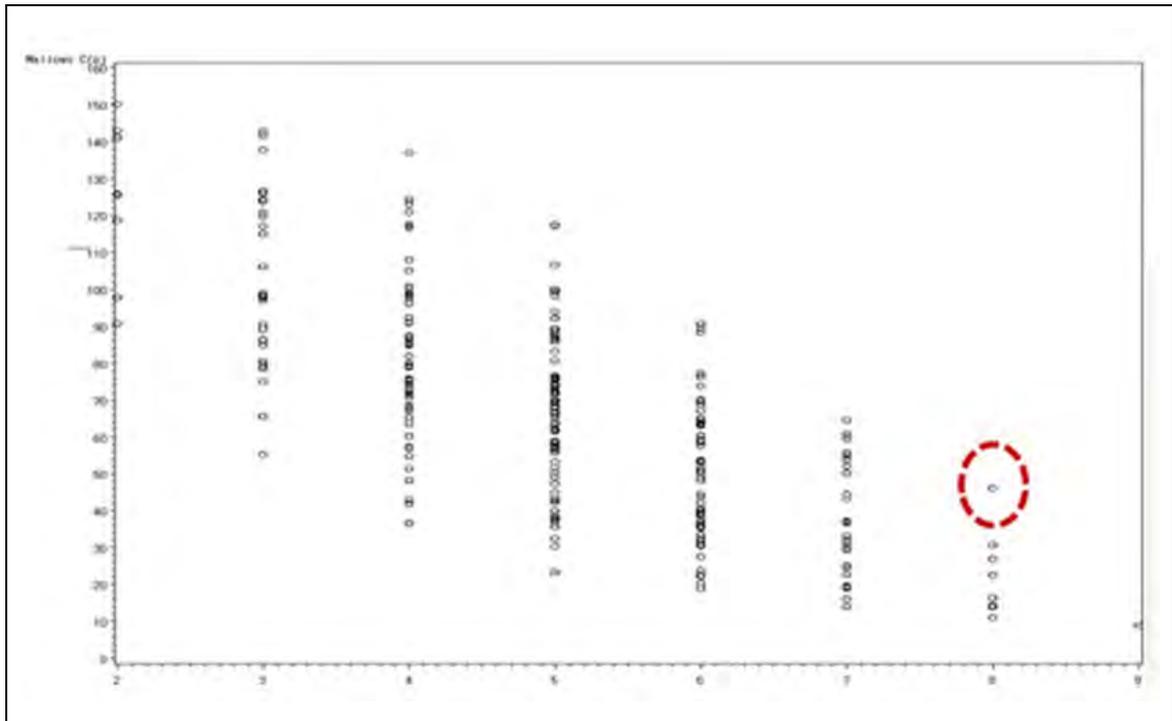
Appendix I: Definition of Variables

	Label	Define Variable	Unit	Type of Variable
Response Variable	SP	Retail property price per 3.3 m ²	Ten thousand won/ 3.3 m ²	Continuous Variable
Explanatory Variables	Shin (x1)	Shinsa-area	-	Dummy Variable
	Yeosam1 (x2)	Yeosam1-area	-	Dummy Variable
	Irwonbon (x3)	Irwonbon-area	-	Dummy Variable
	Suseo (x4)	Suseo-area	-	Dummy Variable
	Yeosam2 (x5)	Yeosam2-area	-	Dummy Variable
	Cheongdam (x6)	Cheongdam-area	-	Dummy Variable
	Apgujeong (x7)	Apgujeong-area	-	Dummy Variable
	Irwon (x8)	Irwon-area	-	Dummy Variable
	Poyi (x9)	Poyi-area	-	Dummy Variable
	Apt Sales Price (x10)	Average Apartment Sales Price	-	Continuous variable
	Size of shop (x11)	Size of shop	-	Continuous variable
	Ground floor (x12)	Ground floor	-	Continuous variable
	Story (x13)	Number of stories	-	Continuous variable
	Age (x14)	Age of building	-	Continuous variable
	Chonsei (x15)	Chonsei price	-	Continuous variable
	Rental bond (x16)	Rental bond per 3.3 m ²	Ten thousand won / 3.3 m ²	Continuous variable
	Rent (x17)	Monthly rent per 3.3 m ²	Ten thousand won / 3.3 m ²	Continuous variable
	Loan (x18)	Sum of loan	Ten thousand won / 3.3 m ²	Continuous variable
	Tr_sales (x19)	Retail Sales of Trade area	-	Dummy Variable
	Tr_index (x20)	Index of retail Trade area	-	Dummy Variable

Appendix II: Descriptive Statistics

Variable	Mean	Standard Deviation	Minimum	Maximum
Retail property price	76036.52	103748.3	4500	770000
Shinsa-area	0.81	0.394	0	1
Yeosam1-area	0.39	0.491	0	1
Irwonbon-area	0.03	0.163	0	1
Suseo-area	0.18	0.369	0	1
Yeosam2-area	0.1	0.304	0	1
Cheongdam-area	0.03	0.163	0	1
Apgujeong-area	0.04	0.202	0	1
Irwon-area	0.01	0.116	0	1
Poyi-area	0.02	0.142	0	1
Size of shop	56.61	89.746	0	700
Age of building	8.34	6.648	0	1
Ground floor	0.82	2.313	-2	20
Chonse price	779.14	12700	779.14	2499.32
Local Retail Sales	0.68	0.469	0	1
Sum of loan	14225.57	39401.667	0	300000

Appendix III: Selection of variable with Mallows' C_p



Appendix IV: Selection of variable with the adjusted coefficient of determination

