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Assessing the Spatial Variability of Capitalization Rates

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The capitalization rate is a critical indicator that is used extensively for property valuation in the real estate sector. This study assesses and compares the spatial variability of the capitalization rates in two distinct areas: an urban and a rural area in South Korea. The capitalization rate is confirmed to be stable for the urban area, but the rural area shows significant spatial variations. These findings suggest that researchers should test the existence of a stable capitalization rate as a prerequisite before proceeding to investigate other relevant issues in real estate. The approach in this study is recommended for use in real estate practices such as property valuation and investment decisions.

Keywords

Capitalization rate, Property valuation, Spatial variability, Real estate

1. Introduction

The capitalization rate is a popular metric for determining whether a property is worth purchasing. It has been widely used to capture the relationship between income and property value in the real estate sector and serves as a reliable tool for property valuation. In using the capitalization rate, the income stream generated from a property can be effectively converted into an estimate of the property value. Discerning the capitalization rate is also critical for investors because it gives them an estimate of the potential return on their investments. In addition, researchers use the capitalization rate to analyze asset portfolios or compare the performance of different submarkets.

Despite the frequent use of the capitalization rate, stakeholders—particularly property valuation experts—rarely pay attention to the assumption that underlies these applications; i.e., a stable capitalization rate should exist in the market to enable reliable extractions. This study empirically determines whether a stable capitalization rate exists in the study areas.

Two study areas in South Korea, a highly urbanized and a rural region, are chosen for the analysis. The capitalization rates for each property in both areas are calculated. Subsequently, a test for the spatial variability of the rate is conducted. If the spatial variability of the rate is found to be insignificant, a stable capitalization rate can be assumed to exist in the area of interest. By contrast, if the test reveals significant spatial variability in the rate, a reliable and global capitalization rate is unlikely to exist in the area of concern. Finally, for the areas wherein a stable rate exists, land prices are estimated by dividing annual rents by the rate and comparing these estimates with the observed prices to determine if a stable capitalization rate can be effectively used for valuation.

The contribution of this study is twofold. Unlike previous studies that focus on the temporal trends and international or national variations of the capitalization rate, this study takes a micro-spatial perspective; that is, the rate is analyzed on an individual property level. As expressed succinctly in Kiel and Zabel (2008), property prices and rents vary significantly even when properties are adjacent to each other. Thus, aggregating property data at the macro-spatial level inevitably cancels out this variation (information loss), which should be avoided whenever possible. In addition, to the best of our knowledge, this study is the first to empirically evaluate the constancy of the capitalization rate in the real estate market.

The rest of this paper is organized as follows. Section 2 explains the use of the capitalization rate in property appraisals and reviews the related literature. Section 3 presents the data, study area, and methodology used to assess the constancy of the capitalization rate. Section 4 presents the results and interpretations. Finally, the limitations of the study and avenues for subsequent research are presented in Section 5.

2. Literature Review

2.1 Using the Capitalization Rate for Valuation

In property valuation, the three following approaches are commonly used for value estimation: the sales comparison method and the cost and income approaches (Gloudemans and Almy, 2011). The sales comparison method estimates values by comparing similar properties sold recently in the vicinity of the property being appraised. The cost approach determines values by estimating the reproduction cost of a property and subtracting depreciation accruals from the cost. The income approach estimates values by converting the income stream generated by a property into a price. This approach determines property value by capturing the income that deeply concerns investors.

The income approach is consistent with the value theory (Tosh and Rayburn, 2004), and most investors prefer this approach to other methods while making property decisions. This study investigates the relationship between rent and land prices for commercial properties. In commercial properties, the income approach is always recommended in the literature (Gloudemans and Almy, 2011) and valuation manuals (Appraisal Institute, 2020), because income (rent) is the most accurate proxy of value estimates for income-producing properties.

The income approach can be further divided into several subcategories; one representative method is the *income capitalization method*. This method estimates the value of a property by calculating the income (typically, rental income) that a property generates and dividing the income by the capitalization rate. The capitalization rate is usually derived from the market by observing the associations between the rent and price levels of properties in a neighborhood.

However, the validity of a property valuation based on the income capitalization method rests on the premise that a constant capitalization rate exists in the real estate market (French, 2003). Despite the importance of this assumption in property valuation, studies on the constancy of the capitalization rate are rarely found in the real estate literature.

2.2 Previous Studies on Capitalization Rate

Previous studies have examined the capitalization rate from two perspectives. The first approach examines the capitalization rate through a time-series analysis framework. Here, the capitalization rate is often referred to as the rent-to-price ratio; Davis et al. (2008) provide an early example of this approach. They analyze the rent-to-price ratio in the United States (US) between 1960 and 2006 and find that the ratio remained between 5.0% and 5.5% from 1960 to 1995 but sharply decreased to 3.5% after 1995. Campbell et al. (2009) examine the rent-to-price ratio in the US between 1975 and 2007. They claim that interest rate is not the only driver that affects the rent-to-price ratio and argue

that housing premiums account for a significant fraction of the ratio volatility. The long-term trend of the ratio has been analyzed extensively in the past, mostly under the assumption that a fundamental ratio exists between property prices and rents (Střeleček et al., 2010; André et al., 2014; Cui et al., 2018; Lee and Park, 2018). These studies are undertaken at an international or national scale, and find that this ratio almost always tends to return to its historical average value.

The second approach studies the capitalization rate by focusing on its determinants. McDonald and Dermisi (2009) find that a lower capitalization rate is associated with elements such as Class A and newer buildings, and building renovations. Pivo and Fisher (2011) show that walkability (i.e., accessibility) is a key factor in decreasing the capitalization rate. In a recent study, Letdin et al. (2022) demonstrate that tenant characteristics like the status of the parent company, ownership structure, and default risk affect the capitalization rate of commercial properties. Estimating a reliable capitalization rate by considering the relevant determinants is a popular issue in property valuation and has been actively examined by several studies (Sivitanides et al., 2001; Chaney and Hoesli, 2012; Artese et al., 2022; Stokes, 2022). Table 1 summarizes the previous studies mentioned in this section.

Although the capitalization rate has been dealt with from the perspective of a temporal or cross-sectional analysis, few studies have focused on the constancy of the capitalization rate on a micro-spatial scale. An exception is Carrillo and Yezer (2022) who indicate that house price estimates are only reliable when the capitalization rate is constant within the housing market being analyzed. Thus, they emphasize that researchers should evaluate the stability of the capitalization rate among housing units in the preliminary stages of their analysis. We take one step further by empirically investigating the constancy of the capitalization rate at the individual property level.

3. Data and Methodology

3.1 Dataset and the Study Area

The rent and land price data are obtained from the Korea Institute of Local Finance (KILF). The KILF collects price-related information of commercial properties annually, such as rents and land prices, for local tax assessment. The rent information is collected from property listing websites like Naver Real Estate (https://land.naver.com), and land prices are surveyed by field inspection staff at the KILF. All of the information in the dataset is current as of December 2021. The KILF feeds this dataset into a subsequent tax assessment model to impose property taxes on commercial properties.

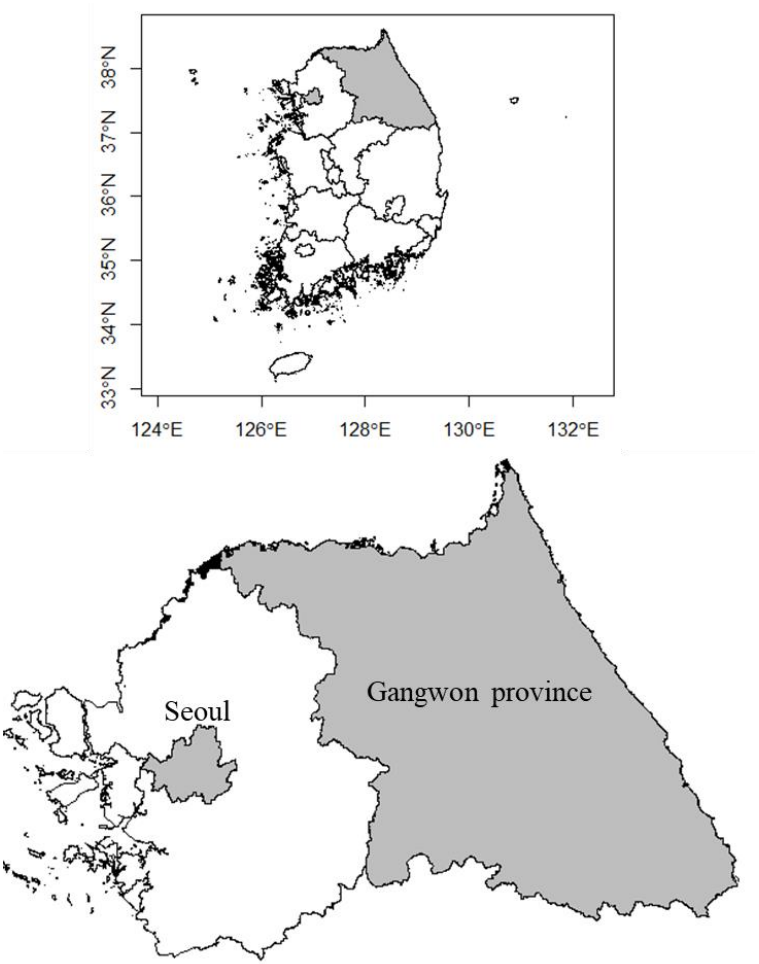
Table 1 Descriptive Statistics

Perspective	Reference	Study area	Study Subject
Temporal analysis	Davis et al. (2008)	US	Rent-to-price ratio of commercial properties between 1960 and 2006
	Campbell et al. (2009)	US	Rent-to-price ratio of commercial properties between 1975 and 2007
	Střeleček et al. (2010)	EU countries	Rent-to-price ratio of agricultural land between 2000 and 2008
	André et al. (2014)	Organisation for Economic Co-operation and Development (OECD) countries	Price-to-income and price-to-rent ratios between 1970 and 2011
	Cui et al. (2018)	Beijing, China	Comparison of housing price and rent
	Lee and Park (2018)	Seoul, South Korea	Rent-to-price ratio of houses between 2005 and 2017
Determinants of capitalization rate	McDonald and Dermisi (2009)	Chicago, US	Factors associated with a lower capitalization rate
	Pivo and Fisher (2011)	US	Relationship between walkability and capitalization rate
	Letdin et al. (2022)	US	Relationship between tenant characteristics and capitalization rate
	Sivitanides et al. (2001)	US	Factors associated with appraisal-based capitalization rates
	Chaney and Hoesli (2012)	Switzerland	Comparison of transaction-based and appraisal-based capitalization rates
	Artese et al. (2022)	Theoretical	Capitalization rate in building damage appraisal
	Stokes (2022)	Iowa, US	Capitalization rate of farmland

Two study areas are chosen for analysis: Seoul and Gangwon Province in South Korea. Seoul, the capital of South Korea, is a highly urbanized region with a population of approximately nine million people. In contrast, Gangwon Province is a typical rural area where improved properties such as offices and retail shops are sparsely scattered. These two study areas are selected owing to their opposing landscapes, which would likely show distinct capitalization rate

patterns.[1] Figure 1 shows the study areas, and Table 2 presents the descriptive statistics of 1260 properties and the local profile of each area.

Figure 1 Study Areas



[1] Both urban and rural places exist in Gangwon Province. Thus, it is worthwhile to filter typical rural submarkets from the province and analyze them. However, this segmentation of the province causes the problem of a small dataset.

Table 2A Descriptive Statistics of Samples

Seoul (n = 696)	**Min.**	**Median**	**Mean**	**Max.**
Annual rent (KRW/m^2)	87,000	454,000	591,000	10,973,000
Land price (KRW/m^2)	2,600,000	7,640,000	10,300,000	123,700,000
Floor area (m^2)	16.5	51.1	86.7	2,158.6
Property age (years)	0	29	27	89
Gangwon Province (n=564)	**Min.**	**Median**	**Mean**	**Max.**
Annual rent (KRW/m^2)	52,000	206,000	259,000	1,564,000
Land price (KRW/m^2)	190,000	1,020,000	1,430,000	8,140,000
Floor area (m^2)	21.2	63.0	83.8	752.6
Property age (year)	0	10	14	73

Notes: KRW denotes South Korean Won, and 1 USD = 1341 KRW (25 April, 2023)

Table 2B Local profile of study areas (KOSIS, 2022)

Region	**Area**	**Population density**	**Median household income**	**Sample**
Seoul	605 km^2	15,650 persons/km^2	72.4 million KRW	696
Gangwon Province	16,875 km^2	90 persons/km^2	55.0 million KRW	546

Notes: KRW denotes South Korean Won, and 1 USD = 1341 KRW (25 April, 2023)

The annual rent in Table 2(a) was calculated by dividing the adjusted rent by floor area, and the adjusted rent was estimated as follows:

$$Adjusted\ rent = monthly\ rent \times 12 + security\ deposit \times 0.08 \quad (1)$$

In Equation (1), the deposit-rent conversion rate applied by the KILF for tax assessment purposes in 2021 is 8%. For example, 10,000 USD of deposit is converted into 800 USD of annual rent at this rate. This rate is determined by considering the interest rate, inflation, and business cycle of the real estate market. The land price in the table is calculated by dividing the price surveyed by the assessment staff by site area.

3.2 Geographically Weighted Regression

This study employs the geographically weighted regression (GWR) method to confirm that a stable capitalization rate exists in the market. The GWR is a local version of ordinary regression that produces locally varying coefficients by explicitly considering geographical coordinates.[2] The GWR is a form of the weighted least squares that allows properties that are further away from the

[2] Refer to Fotheringham et al. (2003) and Wheeler and Páez (2010) for details on the GWR.

subject property to be assigned less weight in the estimation (Cohen et al., 2020; Sisman and Aydinoglu, 2022). The GWR is generally expressed as:

$$y_i = \beta_0(u_i, v_i) + \sum_{j=1}^{k} x_{ij}\beta_j(u_i, v_i) + \varepsilon_i, \quad \varepsilon_i \sim N(0, \sigma^2) \tag{2}$$

where (u_i, v_i) are the geographical coordinates of sample i. The coefficients $\beta_j(u_i, v_i)$ are estimated by using the spatial weight matrix $\mathrm{W}(u_i, v_i)$. The Gaussian function $w_{ij} = \exp\left[-\frac{1}{2}\left(\frac{d_{ij}}{b}\right)^2\right]$ is used to create the spatial weight matrix (kernel weight), where d_{ij} is the distance between samples i and j, and b is the bandwidth parameter. An adaptive bandwidth is employed for the analysis of fixed and adaptive bandwidths.

The equation used in this study to fit the GWR is:

$$Rent = f\,(Land\ price + Floor\ area + Property\ age) \tag{3}$$

where *Floor area* and *Property age* are employed as the control variables. Both *Rent* and *Land prices* are measured per square meter. Owing to data unavailability, only these three variables are used to estimate the rent. The coefficients of *Land price* indicate the capitalization rates and are of key interest in this study. Coefficients of *Land price* derived in this way are approximately equal to those calculated by dividing the rent of a property by its land price and controlling for other explanatory variables. This figure may not be a capitalization rate in a strictly theoretical sense because the rate should be calculated by dividing the net operating income of the property by its property value (Larriva and Linneman, 2021). Net operating income refers to the income after subtracting vacancy and operating expenses from potential growth income (rent). As vacancy and operating expenses at the individual property level are often unavailable in practice, and comprise a small percentage of the total rent, the entire rent is frequently used as a proxy for net operating income.[3]

A Monte Carlo (randomization) test is applied to the GWR fitting to evaluate the spatial variability of the coefficient for each variable. The GWR is fitted 100 times to a randomized subset of the dataset for each study area and the p-value for each explanatory variable in Equation (2) is estimated. If the p-value of a variable is lower than a particular threshold, this means that the coefficient of the variable locally varies significantly. In other words, the GWR needs to be applied to this variable. By contrast, if the p-value of a variable is higher than a particular threshold, its coefficient is insignificant in terms of its spatial variability; thus, ordinary regression will suffice.

[3] As of 2022, the average vacancy is 6.5% and 21.5% in Seoul and Gangwon Province, respectively. The average ratio of operating expense to rent is 13.2% and 13.0% in Seoul and Gangwon Province, respectively (KOSIS, 2023).

4. Results and Discussion

4.1 Results

Table 3 shows the results of repeated GWR fitting, that is, the Monte Carlo test results of 100 simulations. For Seoul, all of the p-values for the variables are higher than the usual threshold of 0.05, which means that constant coefficients can be assumed for all variables. Thus, an ordinary regression needs to be applied to Seoul, and a global coefficient of *Land price*, that is, a stable capitalization rate, can be assumed for this region.

As for Gangwon Province, the p-values for all of the variables except *Floor area* are lower than the usual threshold of 0.05; thus, locally varying coefficients for the intercept, *Land price*, and *Property age* can be assumed. Therefore, a GWR needs to be applied to Gangwon Province, with *Floor area* being exceptionally employed as a fixed-coefficient variable.[4] To summarize, a global coefficient of *Land price*, that is, a stable capitalization rate is unlikely to exist in Gangwon Province.

Table 3 P-values from Monte Carlo Test

Region	Intercept	Land price	Floor area	Property age
Seoul	0.34	0.99	0.71	0.30
Gangwon Province	0.00	0.01	0.17	0.00

Following the results of Table 3, an ordinary regression is fitted to Seoul, and a GWR is applied to Gangwon Province. Table 4 shows the results. In Seoul, the coefficient of *Land price* is 0.047, thus indicating that the capitalization rate is approximately 4.7%. The coefficient of *Floor area* is negative (-0.077), which is reasonable because the rent per square meter tends to decrease as the floor area increases. The coefficient of *Property age* is also negative (-0.413), which is consistent with a priori expectation because prices are likely to decrease as properties deteriorate and become obsolete.

For Gangwon Province, the global coefficient of *Floor area* is negative (-0.047), which is reasonable. Of the locally varying variables, the coefficient of *Land price* deserves special attention, with values that range from 0.003 to 0.225. This indicates that the capitalization rate in Gangwon Province may range between a minimum of 0.3% and a maximum of 22.5%, depending on the geographical location. Figure 2 shows the spatial distribution of the *Land price* coefficients,[5] which reveals that the capitalization rate in this region is significantly variable; thus, a global capitalization rate can hardly be assumed.

[4] This type of GWR is referred to as a mixed GWR in the literature.
[5] The continuous surface in the figure is created by using a kriging technique, a standard method of spatial interpolation (Oliver and Webster, 2014).

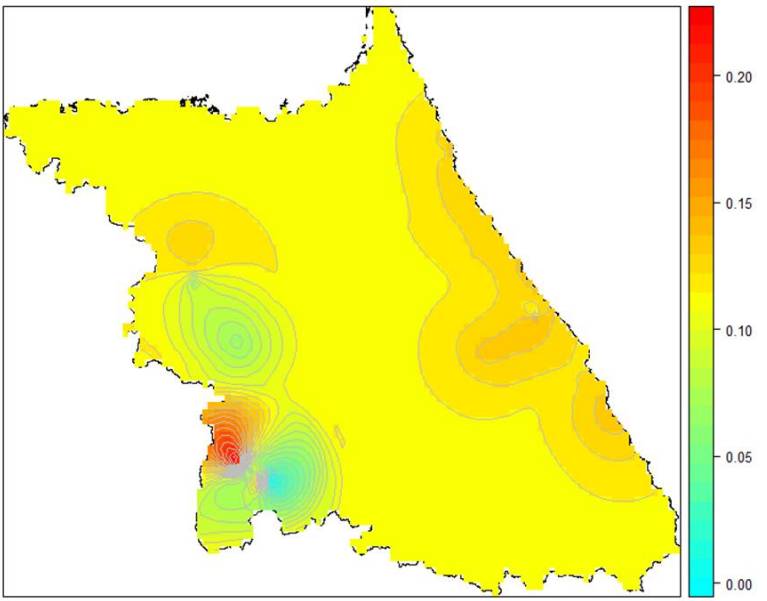
Table 4A Seoul (Ordinary regression)

Variable	Estimate	Standard Error	P-value
Intercept	28.046	4.561	0.000
Land price	0.047	0.002	0.000
Floor area	-0.077	0.014	0.000
Property age	-0.413	0.128	0.001
R^2	0.43		

Table 4B Gangwon Province (GWR)

Global Variable	Estimate	Standard Error	P-value
Floor area	-0.047	0.008	0.000
Local Variable	**Min.**	**Median**	**Max.**
Intercept	-11.520	21.151	39.779
Land price	0.003	0.112	0.225
Property age	-2.227	-0.344	4.725
Adaptive bandwidth	Number of nearest neighbors: 25		
Kernel function	Gaussian		
Quasi-global R^2	0.49		

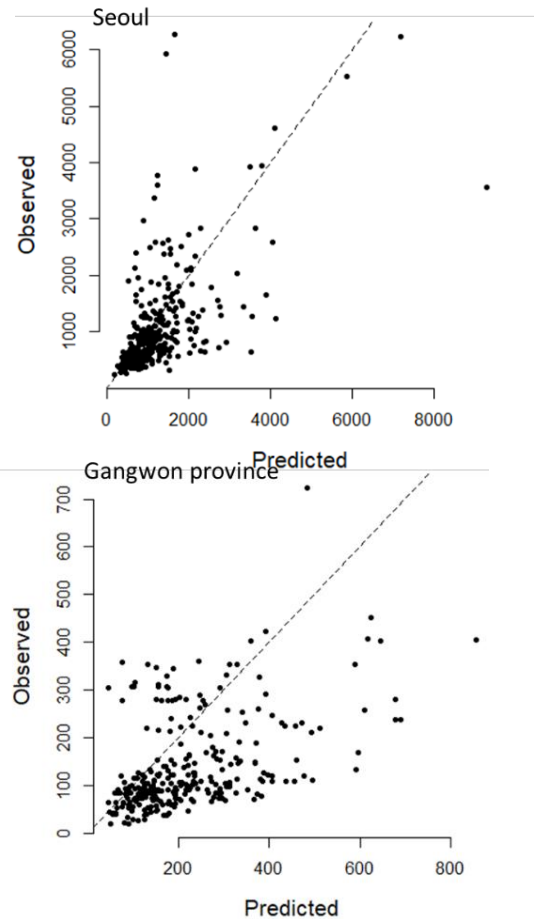
Figure 2 Distribution of Land Price Coefficients in Gangwon Province



4.2 Validation

If there is knowledge of a stable capitalization rate in the market of interest, land prices can be reliably estimated by dividing rents by the capitalization rate. As explained earlier, this valuation approach is referred to as the income capitalization method in the property valuation literature (International Association of Assessing Officers, 2013). Figure 3 shows the goodness-of-fit between estimated land prices by using the income capitalization method and observed land prices. At the outset, a separate holdout dataset is reserved for the income capitalization method in this study: 348 and 282 property samples in Seoul and Gangwon Province, respectively, which comprise half of the property samples in Table 2.

Figure 3 Goodness-of-fit of the Income Capitalization Method (unit: 10,000 KRW/m^2; 10,000 KRW is equal to 7.5 USD)



In Seoul, the predicted prices closely follow the observed prices, thus confirming that a stable capitalization rate is an acceptable assumption for this region. In contrast, the predicted prices in Gangwon Province considerably deviate from the observed prices and have a marked upward bias, thus implying that the income capitalization method is not a suitable valuation approach for this region.

5. Conclusions

In this study, the capitalization rates of the commercial properties in the two chosen study areas in South Korea have been calculated. The significance of the spatial variability of the capitalization rates is tested by using the GWR approach through a Monte Carlo test. The results reveal that a stable capitalization rate could exist in Seoul but not in Gangwon Province. Accordingly, the income capitalization method performs better in Seoul than in Gangwon Province.

These findings provide useful guidelines for real estate stakeholders. As a valuation measure, the capitalization rate is frequently employed to compare the profitability of different properties and determine diverse investments. These decisions can be reliably made only when a stable capitalization rate exists in the market. Accordingly, real estate industry practitioners can apply the approach proposed in this study and evaluate the existence of such capitalization rates.

Owing to data unavailability, this study uses only physical variables to estimate rent. It is well-known that non-physical factors, such as foot traffic in a neighborhood, presence of competing stores, and tenant status also affect rent levels. Moreover, real estate policies such as rent control and tax incentives have a significant influence on the market.[6] These social and political determinants of rent should be considered in future studies. In addition, the proposed approach should be applied to different geographical settings to assess the generalizability of the findings in this study. Unlike Gangwon Province, Seoul is highly urbanized and homogeneous in terms of commercial property composition and size. As shown in this study, Seoul is relevant for the application of the income capitalization method. Thus, it is worth investigating other study areas to generalize the finding that a homogeneous and highly developed city is more suitable for using the income capitalization method.

[6] For example, commercial properties with deposit less than 900 million KRW (670,000 USD) are subject to rent control in Seoul, but only those with a deposit less than 370 million KRW (280,000 USD) are subject to rent control in Gangwon Province.

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