Investment Analysis by Using Tax Assessment Database on Land Lots in Gwangjin District, Seoul, Korea

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<ABSTRACT>

This paper addresses the issues regarding the performance evaluation of generic investment strategies in land lots in a retail market trade area in a district in Seoul, Korea. To this end, this paper investigates 1993–2016 data on 6,478 parcels of commercially used land parcels in Gwangjin District, one of 25 districts in Seoul, the capital city of South Korea. Gwangjin District extends over 17 km2, with33,307 land lots and a population of 366,939 as of 2015. Because tax assessments in this district are determined by both certified property appraisers (appraisal) and government staff (mass appraisal) in a pegged order, it is generally accepted that the resulting assessed numbers are biased to certain level. Thus, we use the gradient measure to eliminate the most likely biases. Our innovative term of gradient is calculated by subtracting the assessed value of one land lot from that of another in the neighborhood; simply put, the difference of assessed values of

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two land parcels within certain distance bands.

We analyze whole land lots in this district currently used for commercial purposes (retail shops and small offices such as FIRE and clinics), along two dimensions: assessed values and their gradients. What we call the HVHG group consists of land lots with higher assessed values and higher gradients. The HVLG group consists of land lots with higher assessed values but lower gradients. We also consider LVHG (lower assessed values and higher gradients) and LVLG (lower assessed values and lower gradients) groups in our analysis. This research finds that the differences in mean returns between HVLG and other groups except HVHG group are statistically significant based on a paired t-test.

We test a couple of investment analyses. Our investment analyses control for the impact of both the value of land lots and distance from subway station on the realized rate of returns. We find that both the smaller valued and remote from the station groups beat the other groups in a statistically significant manner. In addition, a simple one-year momentum land investment strategy is again tested and the result is statistically not significant. Finally, we also visualize the retail market area and intertemporal changes in the market area.

Key words: Land Value Gradient, Tax Assessment, Land Lots, Land Investment, Data Visualization

I. Introduction

In August 2017, the Korean inter-ministerial committee on the housing market introduced several policy measures to curb housing speculation. In the areas that are to be severely regulated, such as a "designated speculation restriction district," loan-to-value would be limited to 40%, and transactions in these areas might also face scrutiny by the Internal Revenue Service. These measures may possibly force genuine housing investors (e.g., the retired elders) to move to a riskier property class, small retail unit-shops and/or small retail buildings (balloon effect)[1]. However, this class of property market is not transparent at all. There are neither indexes nor data on these small retail unit shop and building markets. Thus, this probable balloon effect may endanger small individual property investors. Our study utilizes practical methods to analyze district-wide small-sized retail property markets. We expect our findings help improve transparency in this market place which is the basic requirement for a prudent investment. Finally such an increased investment will (re-)vitalize local economy.

According to Shin and Kim (2018), "The borders of any retail property market trade area continually change, resembling a living entity that might shrink, expand, or undergo expansion and reduction cycles."This study visualizes intertemporal changes in such a market trade area and also test a couple of investment analyses. Our investment analyses control for the impact of both the size of land lot's assessed value (firm-size effect as in the stock market performance literature) and distance from subway station on the realized rate of returns." To this end, as shown in Shin and Kim (2018), "we divide all the land lots used for commercial purposes, as of 2012, into four groups using both the assessed value and the measured gradient of each land lot: lots with higher assessed values and higher gradients (HVHG), lots with higher assessed values but lower gradients (HVLG), lots with lower assessed values but higher gradients (LVHG), and lots with lower assessed values

1 Most retail buildings in Korea consist of multiple unit shops under strata title. There is simply little or no institutionalized property market.

and lower gradients (LVLG)."

With these four groups, we wish to explore which among the four groups show the best long-term and/or mid-term performance with respect to both the realized assessed land value appreciation rate and the standard deviation of the assessed value series (Sharpe ratio) over the 23 years from 1993 to 2016. We can also test the generic investment performance analysis. The smaller, better hypothesis (small cap effect) is similar to an intertemporal performance analysis between small caps and large caps in the stock market performance literature as in Bauman, Conover and Miller (1998). Similarly, we measure the impact of distance from the four pooled subway stations in the district (KU, Gunja, Children's Park, and Guui stations); within a 200-m versus 200- to 400-m radius from the center of the four stations, where KU and Gunja stations are transit stations between two subway lines while Children's Park and Guui stations serve one subway line[2]. Both investment analyses are for the period 1993 to 2016. Lastly we also test a simple one-year momentum strategy as in Carhart (1997); Hendricks, Partel, and Zeckhauser (1993); Grinblatt, Titman and Wermers (1995).

II. Literature Review

Regarding tax assessment, Cornia and Slade (2006) explain the processes and consequences in detail. The authors analyze the uniformity of the assessed valuation using a Kruskal-Wallis nonparametric test among apartment, industrial, office, and retail properties in Maricopa County in Arizona, United States. The authors found that retail properties are under-assessed compared to apartments. We also use government-announced tax assessment values, used for property tax, capital gains tax, and compensation appraisal due to eminent domain. Chae (1998) estimates hedonic land price model using government-announced tax assessment value data.

Zhou, McMillen, and McDonald (2008) study the land value change due to zoning ordinance changes in the year 1957 in Chicago, United States. This paper considers location choice of household, land use zoning change, and land value change in a real policy experimental setting. The authors found, by using paired t-tests after dividing the research period into three-time periods (pre-revision, a target, and post-revision time periods), that nonresidential landowners do not prefer the existing mixed land use zoning policy. We also consider land use, particularly retail and mixed retail-and-residential land uses. For the empirical test, we also use similar multiple parametric and nonparametric time-period comparison methods. Suh (1990) is one of the primary research achievement in this line of research field in Korea. Lim (2002) estimates land-rent function and show that it looks a V type.

Here is reserved for the literature related to retail market trade area analyses. As cited in Shin and Kim (2018), "Ever since Christaller (1966) introduced central place theory in 1993, many papers have addressed the location choice of retailers. Eppli and Benjamin (1994), document most previous literature on location choice, market area analysis, homogeneous retail agglomeration, and retail demand externality to retail property valuation, including the valuation of lease contracts." In Korea, Kang (2017) measures street centrality with the street width and researches the relationship between land price and his centrality measure.

Another application of gradient measure is population density gradient at the town level (Kim and Lee, 2011). Their gradient measure is different from traditional gradient measures which calculate its value on linear streets (one dimension). Our gradient is similar to them in a sense that we also measure two dimensional (area) gradient.

III. Data

2 Bae et al. (2003) use 200-m radius from the stations of Subway Line No.5 as the closest major impact area.

1. Gwangjin District and its trade area

We first briefly introduce tax assessment in Korea. As shown in Shin and Kim (2018), “There are approximately 40 million (MM) land parcels in Korea. Of these, approximately 32 MM land parcels have been assessed every year since 1990. Certified public appraisers appraise 500,000 pieces of standard lands using the highest and best use method and then use the information from the site inspection to adjust a computer-assisted mass appraisal program, which is used for the assessment of the other 31.5 MM land lots under the supervision of the same appraisers.”

“Gwangjin District is one of 25 districts on the northeastern side of Seoul, the capital city of South Korea. Gwangjin District occupies an area of 17 km2 with approximately 33,307 land lots and a population of 366,939 as of 2015.” In Gwangjin District, two teams of certified property appraisers (two on each team for a total of four) are appointed as assessors. The two teams assess 919 standard land lots that compose approximately 3.1% of all land lots assessed in Gwangjin District in 2012. Then, the government assesses the remaining non-standard land lots using a computer-assisted mass appraisal program under the appraisers’ supervision.

Table 1. Four research towns in Gwangjin District in 2016

Town	Population	Households	NBE	NE	Area (m2)	PD	ED
Gunja	22,070	10,218	1,566	7,756	7,400	2.98	1.05
Whayang	24,699	14,698	2,510	14,547	11,600	2.13	1.25
Jayang	109,099	44,055	4,076	22,303	46,100	2.37	0.48
Guui	79,276	33,487	8,152	44,606	29,700	2.67	1.50
District, Total	372,164	158,960	24,760	117,420	17,000,000	0.02	0.01

*The KU Station area is composed of the southern part of Hwayang and the northern part of Jayang towns.

** NBE: No. of business establishments, NE: No. of employees, PD: Population density (person/m2), ED: Employment density (person/m2)

*** Source: Wikipedia and Seoul Statistics (stat.seoul.go.kr)

Based on employment density per square meter, Jayang Town (0.48) is a residential area while

Whayang Town (1.25) is more likely a business area, actually a retail area. Based on Table 2, in 2009, there is a significant zoning regulation change for commercial land use. Additionally, the tax assessment data in 2006 shows missing values. Thus, we use the average of 2005 and 2007 for the land lots in 2006 when we need the value and gradients from 2006.

Table 2. Expansion of commercial land use: From 2003 to 2015

Year	Total lots	Total area(m2)	Commercial (m2)	Residential (m2)	Total assessed lots
2007	34,337	17,050,000	178,894	11,351,106	30,677
2008	34,222	17,050,000	178,894	11,391,106	31,230
2009	34,169	17,050,000	196,503	11,373,497	31,450
2010	33,913	17,050,000	196,503	11,373,497	31,340
2011	33,901	17,050,000	196,503	11,373,497	31,316
2012	33,712	17,050,000	196,503	11,373,497	31,150
2013	33,669	17,050,000	196,503	11,373,497	31,267
2014	33,476	17,050,000	196,503	11,373,497	31,118
2015	33,307	17,050,000	196,503	11,373,497	31,160
Growth rate (2007-2015)	0.97	1.00	1.10	1.00	1.02

* Source: Stat Korea (kosis.kr) and Korea Appraisal Board (KAB)

This district consists of seven towns. Among them, as cited in Shin and Kim (2018), "the Guui-Gangbyeon (in short, Guui) Station area (447,749 m2) and KU Station area (214,509 m2) are, respectively, the 24th and 37th largest active sub-center areas in Seoul, Korea (Yim and Lee, 2016). Table 3 describes nine types of retail-related business tenants in Gwangjin District in 2014, using the Korean Standard Industrial Classification table.

Table 3. Retail-related business tenants in Gwangjin District in 2014

Classification	NBE*	NE*	NEE*	Remarks
Retail	6,219	19,432	3.1	clothing, convenience stores and cosmetics
Hotel and Restaurant	4,622	16,729	3.6	Inns, Restaurants, Bars
Finance and Insurance	200	2,902	14.5	Bank, Insurance
Property and Renting	1,142	3,558	3.1	Appraisal, Realtor, Car rental
Special Service	773	4,706	6.1	Legal, Accounting, Architect, R&D
General Service	400	7,648	19.1	Travel agency, Gardening, Cleaning service
Clinics	849	9,283	10.9	Dentist, Clinics
Arts and Sports	914	3,469	3.8	Karaoke, Billiard parlor, Game rooms,
Repairs and Other Services	2,734	6,345	2.3	Repair shops, Hair shops, Funeral parlors
Gwangjin District, Subtotal	17,853	74,072	4.1	

* NBE: No. of business establishments, NE: No. of employees, NEE: No. of employees per establishment

** Source: Seoul Statistics (stat.seoul.go.kr)

The KU Station area was famous for an agglomeration of hair designer shops. In Whayang Town, as of 2015, there were 98 hair shops registered; one store serves 252 residents in the town. These 98 hair shops were clustered together on one street, serving people living in the north-east side of Seoul.

Table 4. Hair shop agglomeration in 2015

Town	No. of hair shops	Area (m2)	Population	Area (m2)/shop	Population/shop

Whayang	98	11.600	24,699	118	252
Gwangjin	868	17,000,000	372,164	19,585	429

* Source: Gwangjin district open data plaza (data.gwangjin.go.kr) and Seoul Statistics (stat.seoul.go.kr)

2. Descriptive Statistics

Please refer to the table below for descriptive statistics on land lots in Gwangjin District in 2016.

Table 5. Descriptive statistics; assessed value in 2016

Items	Count	Mean	Max	Min	STD
Value (KRW/m2)/2016	33,469	2,834,732	26,500,000	13,800	1,606,438

*Reprinted from Shin and Kim (2018)
**m^2 is a square meter, approximately 10 square feet.
***Value is measured in Korean Won (KRW), which is approximately USD 1/1000.
****Thus, the average size of a land lot is 5,200 square feet while the average value is USD 283 per 1 square feet.

In 2012, 28,745 of the 31,150 land lots (95.3%) in Gwangjin District were in residential zones while 2% were in commercial zones[3]. However, 22.5% of residential zone areas currently include either commercial or mixed commercial/residential activities. As shown in Shin and Kim (2018), Of the many items included in assessment reports, we just use the addresses, assessed values, and area size."

3. Gradients

This whole section 3. Gradients is a simple reprint from Shin and Kim (2018) for readability.

3 Yang and Yoo (2014) report that the sales to assessment ratio is in the range of 69~78% on average based on the zoning classification nationally. The largest is that of the commercial zone, with a mean of 78% and an STD of 11%. The authors also report the coefficient of dispersion (11~15), coefficient of variation (14~18), and the price-related differential (0.97~1.09).

"We used land lots' assessed value distance gradients and realized assessed value appreciation rates from 1993 to 2016 per annum. Because tax assessment is carried out by both certified public appraisers (appraisal) and government staff (mass appraisal) in a pegged order, it is generally accepted that the resulting numbers are biased to some degree (Lai and Wang, 1998; Yiu, Tang, Chiang, and Choy, 2006). Thus, we introduce our innovative gradients measure to mitigate or eliminate the probable biases. The gradient in our study is calculated using subtraction to obtain the difference between the assessed values of separate land lots."

"We construct the following model of a given land lot's assessed value:

$$V_{i,t} = P_{i,t} + \varepsilon_{i,t}$$

where V is the assessed value, P is the true value (or market value) of land lot i at time t, and ε is an error term."

$G_i = f(V_{i,t}; V_{J_i,t})$

"Our gradient measure of *i*-th land lot (G_i) is calculated by subtracting $V_{i,t}$ from $V_{j,t}$, where j is another land lot in the *i*'s neighborhood(J_i). *j*, *j*-th land lot is an element in J_i. Therefore, if $V_{i,t}$ and $V_{j,t}$ are i.i.d., then, the error will be canceled out during the taking the expectation of gradients procedure in our study. However we have no further information regarding other moments of the distribution of G_i[4]."

"To calculate the gradient of commercially used land lots, we first select a year that should be the best for sampling. In general, commercially used space should change every year, most likely expanding. That is why we study the change in market area. If we choose the year 1993, the sample size would be minimal among all the years available for selection. Moreover, we cannot see the newly rising hot places converted from residential to commercial usage. This is similar to left

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[4] Considering that the neighborhood sets J_i and J_j, if two land lots i and j are contiguous, should contain strictly positive number of common elements, the resulting G_i and G_j will be correlated.

censoring in survival analysis. On the contrary, if we use the year 2016, we would fail to find matched land lots among the earlier years due to merging and apportionment of land lots. Considering that we cannot identify the history of merging and apportionment of each individual land lot from our data set, we have no choice other than selecting a year in the middle. We finally sample all the commercially used land lots, numbering 6,478 in 2012. Then, we sampled the same 6,478 land lots by matching addresses from the 23-year history of tax assessments, from 1993 to 2016[5]. Again, we have both current usage and area size data only for 2012; thus, we assume no usage change and merging (or apportionment) of land lots during the whole research period[6]. This is not a very restrictive assumption considering that we use in our analyses only the above-median assessed values with respect to the assessed value of the 6,478 land lots. If their usage is not commercial, then they should be automatically excluded from the four sampled land groups, HVHG, LVHG, HVLG, and LVLG."

"To calculate the gradient of each land lot, we first locate neighboring land lots within a radius of 70 to 130 m, the operational definition of neighborhood of land lot *i*. We choose a 70 to 130 m radius because this range includes the lowest number of zero-valued land lots (11 neighborless isolated land lots out of 6,478), and we use a reasonable number of surrounding land lots (34.3) when using the data for 2016. For this calculation, we should include all land lots regardless of current usage. Lastly, a 70-m radius area is acknowledged as a similarly valued land area where a standard land is selected[7]. A standard land is a representative land lot selected out of sets of similarly valued land lots, which is again appraised by certified appraisers."

"Our gradient measure is based not on a whole area but on a donut-like concept, as in Figure 1.

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5 We decided not to use 1990, 1991, and 1992 data. The quality of data during the early years is not reliable because this period is considered one of trial and error.

6 The total number of assessed land lots is 31,160 in year 2015, which differs from the total number in 2003 (30,165) due to either merging or apportionment during the period. However, the difference of 995 land lots (3.3%) is actually negligible.

7 The gradient in a similarly valued land area should be near zero, on average.

Assuming Figure 1 depicts a single land lot in the center, we see that it has six nearby land lots used for its gradient calculation. The location of a land lot is simply the center point of each land lot, regardless of either shape or size. Table 1 in the appendix shows that the number of zero-valued gradients within a 30- to 50-m radius is 308, which is not a small number. Thus, the donut-type measure provides an operationally handy, identifiable, and intuitive gradient measure."

Figure 1. Donut-type gradient

*Inner circle of 70-m radius (solid line); outer circle of 130-m radius (dotted line)

**Reprinted from Shin and Kim (2018)

Source: Wikimedia.org

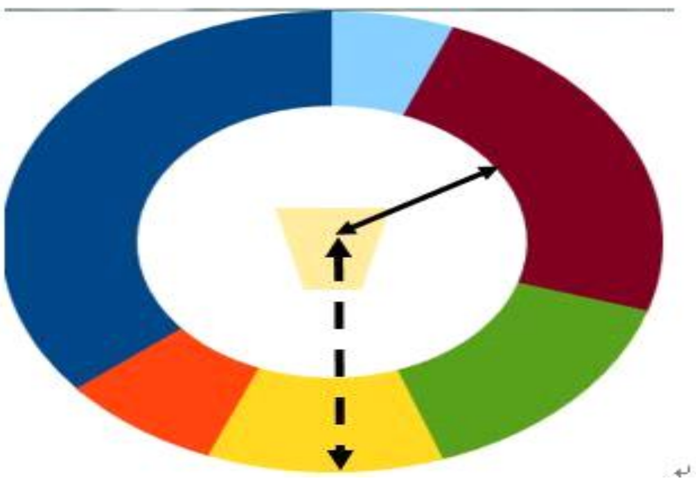

Table 6. The number of neighboring land lots used in gradient calculations

Statistics	Mean	STD	Max	Min	Zero Gradient*
Land lots	34.3	15.4	117	0	11

* If the land lot in question is too big to have surrounding land lots within the given radius criterion, it is assigned a gradient of zero.

**Reprinted from Shin and Kim (2018)

"We subtract the assessed values of the neighboring land lots from the value of the land lot in question. Lastly, we average out the differences (i.e., the gradients) without any standardization in this study. In short, our gradient is more similar to the Jacobian and Hessian matrices found in the optimization algorithm of mathematical function literature. Here, the output of a function is the assessed value of each land lot while both inputs are longitudinal and latitudinal coordinates of earth surface. However, we believe it is more intuitive in terms of location premium than that found in urban literature in that it directly measures the value differences between neighboring land lots."

"For each year, we again sample four different groups, HVHG, HVLG, LVHG, and LVLG. First, we sort both gradient and assessed value data in descending order and sample the top 50% quantile (median) of each group of data[8]. For example, for 2016 data, we sample 3,313 (51.1%) out of 6478 land lots[9]. Please refer to Table 12. Specifically, we extract the HVHG group (1,267, 20% of total) if we find a land lot in two data sets (top 25% of gradient and top 25% of assessed value groups) at the same time. If we find a land lot only in the top 25% of the gradient data column, we then classify it in the LVHG group (352). If we find a land lot only in the top 25% of the value data column, then we classify it in the HVLG group (345). The LVLG group (1,349, 21%) indicates that a land lot does not belong to the top 25% group but belongs to the top 50% quantile group with respect to tax-assessed value. We do not analyze those land lots with assessed value either equal to or below the median value. The correlation coefficient between the gradient and assessed value is .909, calculated by using data from 6,478 land lots in 2016."

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[8] The correlation coefficient of assessed value and gradients is 0.85. It is also proportional to the size of donut. If we use a smaller donut with 30 meter to 50 meter ranges, it will be 0.67.

9 The difference of 0.6% is from the 50% quantile of the gradient group, which is not found in 50% of the value group.

Table 7. Descriptive statistics: Four groups in 2016

Group mean	No. of lots	Average Value/m2	% of HVHG value
HVHG.2016	1,024	7,673	100%
HVLG.2016	595	6,054	79%
LVHG.2016	384	4,657	61%
LVLG.2016	1,275	4,609	60%

**Reprinted from Shin and Kim (2018)

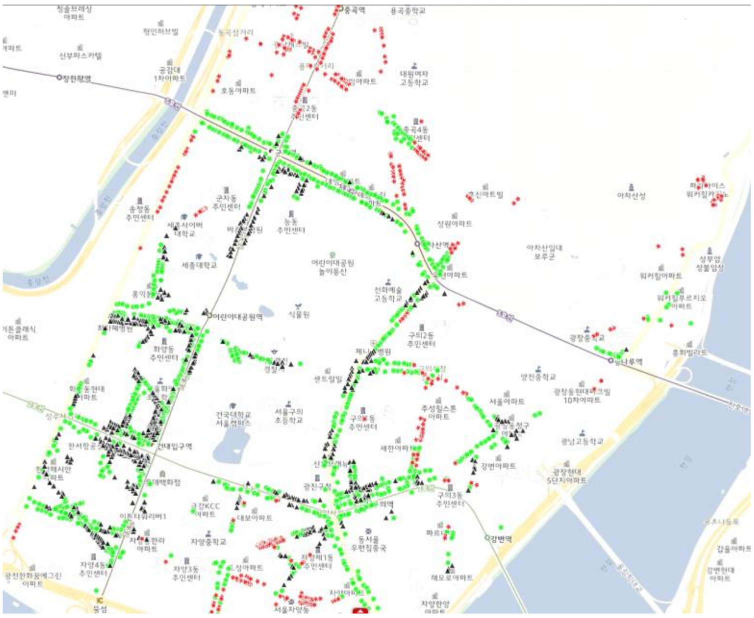
"We explain the economic intuition of the four groups. HVHG is the main center of the retail market trade area[10]. LVLG is also a meaningful trade area because the assessed value is strictly greater than half of the other commercially used land lots. This could be either the inner lot of the main center or the neighborhood shopping center of the mainly residential area[11]. The HVLG is also not difficult to interpret. This group is simply bordering the periphery of the main center—the worst house in the best neighborhood. The LVHG group is more difficult to interpret without knowing the historic path, that is, where it is from. It could be a deteriorating old main center. Its value is still decreasing (LV), but at a slower rate than that of the neighboring area (HG), the "old star." It could also come from LVLG and, thus, a newly rising market place, the "new star." We consider both cases, regardless of their origin, as islands on the visualization map. They are not well connected to the neighboring land lots, differing from the heavily clustered main center."

Figure 2. Visualizing the HVHG, HVLG, and LVHG groups: Year 2016

10 This is similar to "the best house in the best neighborhood" in residential areas.

11 Differing from the residential site where a quiet cul-de-sac has value, the corner lot is superior to the inner lot in retail areas.

Legend:



Green dot: HVHG group, Red star: LVHG group, Black triangle: HVLG group.

**Reprinted from Shin and Kim (2018)

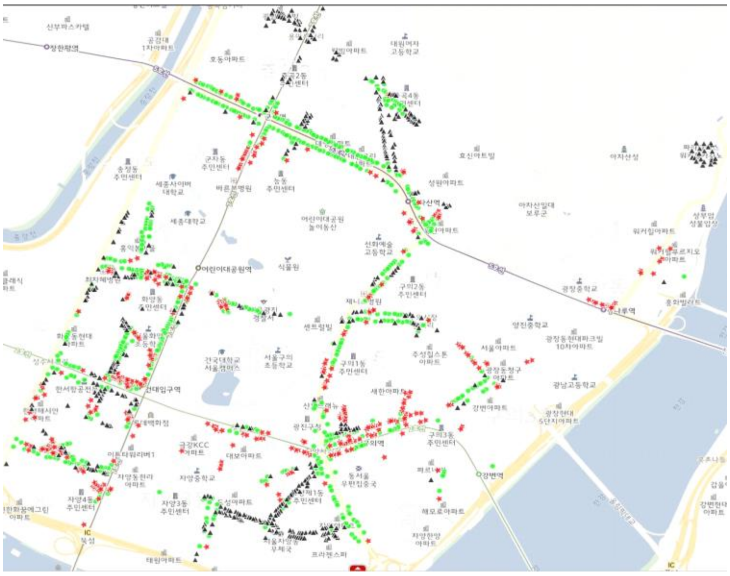
"We analyze land lots along two dimensions: assessed values and their gradients. The LVHG designation simply implies that the land lot in question enjoys a higher location premium (HG) compared with the modest surrounding land lots but a relatively lower assessed value (LV). Thus, we conjecture that an LV property can be upgraded to an HV property soon if the area continues to grow. In particular, this HG property will push up its own value faster than surrounding land lots in the (near) future (upward leveling hypothesis of higher gradients)."

"In contrast, the HVLG designation simply implies that the land lot under scrutiny has a higher assessment value (HV) but a lower location premium (LG) compared with surrounding land lots. Thus, we conjecture that an HV property can be downgraded to an LV soon because the land lot does not have a location premium (LG). In other words, the assessed value is temporarily overestimated and thus is about to decrease to some relative degree (downward leveling hypothesis of lower gradients)."

Figure 3. Visualizing the HVHG groups: Years 1993 and 2016

Legend:

Green dot: In the HVHG group for both years.



Red star: Shifted to the HVHG group in 2016 from not being in the HVHG group in 1993.

Black triangle: Drops out of the HVHG grouped in 2016 after being in the HVHG group in 1993.

**Reprinted from Shin and Kim (2018)

"We recognize in Figure 3 the parts of the district that currently include commercial use. We can also see that each road and subway station exerts a unique influence on the formation of retail market areas."

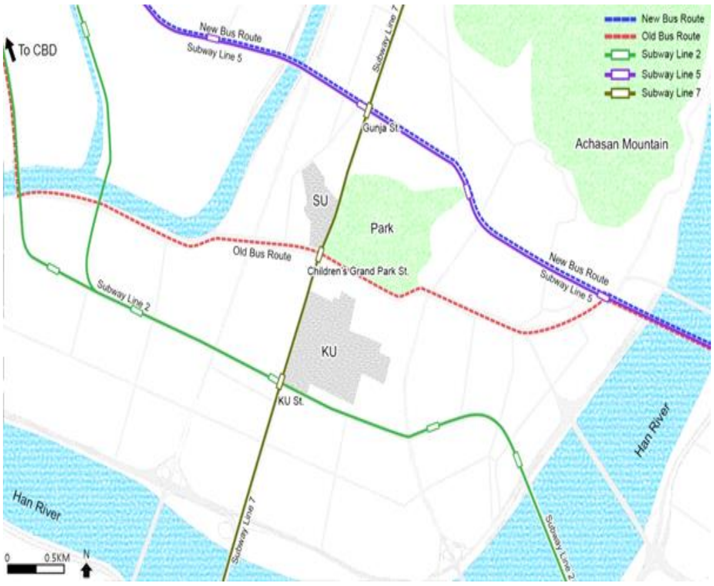
IV. Discussion

1. Investment analysis

Our simple investment hypothesis is as follows: if four hypothetical investors purchased four land groups (HVHG, HVLG, LVHG, and LVLG) respectively in January 1993, what will be the outcome in January 2016?

By analyzing annualized yields and standard deviations of 23 yearly return series, we test the mean variance theorem or the "no risk, no return" hypothesis, using the Sharpe ratio measure and the statistical t-test method. Additionally, we test whether the HVHG group outperforms the HVLG group (two HV groups). In other words, do steeper land value gradients (HG) show greater price appreciation sensitivity to growing demand? Similarly, with two HG groups (HVHG and LVHG), HV factors might show a significantly stronger price appreciation effect. If that is the case, the HVHG group will outperform the LVHG group. We also conduct two generic investment analyses explaining the impact of both size of land lot's assessed value and distance from subway station on the realized rate of returns.

Figure 4. Bus routes and three subway lines in the district



Legend:
"KU" is Konkuk University, while "SU" is Sejong University. "Park" marks the Children's Grand Park of Seoul. The Han River runs through the center of Seoul.
**Reprinted from Shin and Kim (2018)

For investment analyses, it is important to decide the initial investment year. We have experienced two global structural breaks: the Asian currency crisis in 1997 and the global financial crisis (GFC) in 2007. Thus, we choose four starting points for investment in the whole Gwangjin District: 1993, 2000 (after the Asian crisis), 2008, and 2010 (after the GFC).

Table 8. The likelihood of being an HVHG group member

From 1993 to 2016		2016	
		HVHG	Arrival rate (%)
1993	HVHG (1,135*)	658	58
	HVLG (337*)	81	24
	LVHG (358*)	66	18
	LVLG (1,385*)	128	9
From 2000 to 2016		2016	
		HVHG	Arrival rate (%)
2000	HVHG (1,143*)	829	73
	HVLG (453*)	85	19
	LVHG (372*)	34	9
	LVLG (1,232*)	49	4
From 2008 to 2016		2016	
		HVHG	Arrival rate (%)
2008	HVHG (1,038*)	963	93
	HVLG (578*)	49	8
	LVHG (386*)	6	2
	LVLG (1,258*)	1	0
From 2010 to 2016		2016	
		HVHG	Arrival rate (%)
2010	HVHG (1,047*)	981	94
	HVLG (560*)	25	4
	LVHG (380*)	10	3
	LVLG (1,277*)	4	0

* Within parentheses is the number of land lots in each listed group.

The arrival rates at the HVHG group in 2016 are between 0% and 94%, depending on both starting year and current group. Thus, the likelihood of arriving at an HVHG group in the (near) future from any of the current group states is dramatically different as expected. In the short-run (e.g.

from 2010 to 2016), the HVHG status seems to be maintained, 94%. However, in the long-run (e.g. 1993 to 2016) it seems not easy, 58%.

By the way, we fail to confirm the effectiveness of a simple one-year momentum strategy. This result is very analogues to Carhart's (1997) study on persistent mutual fund performance. In plain English, there is no hot hand in commercially used land lots in Gwangjin District (Hendricks, Partel, and Zeckhauser, 1993). In other words, in contrast to Grinblatt, Titman, and Wermers (1995), even a one-year momentum strategy fails to work. Please refer to Table 1 in an appendix for yearly performance of 4 groups.

From a land investor's perspective, a higher gradient (the locational premium) may not guarantee greater land price appreciation, at least in this well-established region. The mean return of HVHG (5.70%) is smaller than that of HVLG (5.71%)[12]. The arrival rate of joining the HVHG group in 2016 after being in the LVHG group in 1993 is 18%, which is also smaller than that of the HVLG group (24%) as shown in Table 8.

Next, the land lots in the LVHG group might be interpreted as being overvalued with respect to both assessed value and the resultant gradient measure compared with nearby land lots. Historically speaking, land lots in the LVHG group are deteriorating for some reason. In other words, although values are not high enough to rank among the top 25% value group in the district, the LVHG group includes relatively higher value land lots compared with those nearby, which are deteriorating faster. We conjecture that such an HG property will push up its value and help LVHG move into the HV group. However, this result is quite different from our initial conjecture.

Table 9. Annualized assessed value appreciation rate among four groups from 1993 to 2016

Groups	Mean return**	STD***	Mean return/STD
HVHG.1993 (1,135*)	5.70%	0.008	7.13

12 The difference is not statistically significant.

HVLG.1993 (337*)	5.71%	0.008	7.13
LVHG.1993 (358*)	5.54%	0.007	7.86
LVLG.1993 (1,385*)	5.62%	0.003	8.00

* Within parentheses is the number of land lots in each group. The HVHG group in 2016 should be independent of those in 1993.

** We calculate the annualized return of value/m2 by using the geometric average.

*** The STD is the simple standard deviation of annualized return series during the investment period, from 1993 to 2016.

We can also analyze the annualized assessed value appreciation rate using the Sharpe ratio measure, which is the mean return/STD. The LVLG group shows the largest value of 8.00 for 23 years of investment. Please refer to Table 9. Overall, the differences in mean returns between HVLG and other groups except HVHG group are statistically significant based on a paired t-test[13].

Table 10. Annualized assessed value appreciation rate among four groups from 2008 to 2016

Groups	Mean return	STD	Mean return/STD
HVHG.2008 (1,038*)	10.62%	0.004	27
HVLG.2008 (578*)	10.81%	0.006	18
LVHG.2008 (386*)	10.56%	0.002	53
LVLG.2008 (1,258*)	10.77%	0.003	36

* Within parentheses is the number of land lots in each group. The HVHG group in 2016 should be independent of those in 2008.

** We calculate the annualized return value/m2 by using the geometric average.

*** The STD is the simple standard deviation of annualized return series during the investment period, from 2008 to 2016.

If, however, we use data from 2008 to 2016, the result is not consistent with the previous one, where the LVHG group shows the best Mean return/STD performance, 53. Please refer to Table 10. Overall, the differences in mean returns between HVLG and other groups inclusive of HVHG group are statistically significant based on a paired t-test.

We also test the effects of both the value of land lot and distance from the station. For area size, we define the larger group as the top 30% or above in value of land lot and the smaller group as the bottom 30% (as in Fama and French, 1993). For the near-station group, we pooled all the land lots within a 200-m radius of four stations (KU, Gunja, Children's Park, and Guui). The remote-from-station group lies between radii of 200 and 400 m from the station. We perform the same paired t-test as above and find that both the smaller and remote from the station groups beat the other groups in a statistically significant manner.

Table 11. Annualized assessed value appreciation rate from 2008 to 2016

Groups	Mean return*	STD	Mean return/STD
Smaller Value (Bottom 30%)	10.9%	0.013	8
Larger Value (Upper 30%)	10.6%	0.004	27
Near four stations (200 m)	10.8%	0.006	18
Remote from four stations (200~400 m)	11.0%	0.006	18

* We calculate the annualized return value/m2 by using the geometric average.

In summary, the possibility of land price appreciation of the well-established HVHG group area is limited while the nearby HVLG area has a higher possibility of catching up with the price level if the market area continues to steadily expand in the long run. The market area of this district is composed of mostly small neighborhood retailers, such as restaurants, clothing stores, hair and nail salons, convenience stores, and cosmetics stores, whose sales growth potential is limited. A market area expansion in this district implies the entry of more similar neighborhood retailers within the border line, more competition, and, finally, lower sales, particularly for retailers housed in shops on HV group land. The possibility of decreasing sales due to new entries may prevent an increase in the market rental rate, which is an essential condition for land value appreciation.

13 It is because of very small standard deviation due possibly to appraisal smoothing.

2. Robustness

As Shin and Kim (2018) wrote, “It is generally accepted that the real estate market reflects only mid- to longer-term shocks due to large transaction costs and relatively longer time for market characteristics. Thus, using a longer-term rate of return, such as 5 years or 8 years, for investment analyses, we can be sure that any probable valuation bias caused by various short-term shocks will be adequately adjusted during the investment horizon by certified public appraisers themselves. As explained in Section 3 (II 3. Gradients), the value difference between two neighboring land lots may also mitigate possible bias. However, we should admit that there might be a serious tax assessment smoothing problem. We also acknowledge that our analyses certainly depend on the district selected, data used, choice of investment holding period, and events and policy changes occurring. However, based on practical viewpoints, these limitations could turn out to be a strong point: flexibility in application.”

V. Conclusion

We investigate 6,478 parcels of commercially used land parcels in Gwangjin District, which is one of 25 districts in Seoul, the capital city of South Korea, for the period 1993 to 2016.

Our innovative term of gradient is calculated by subtracting the assessed value of one land lot from that of another; simply put, the difference of assessed values of two land parcels within certain distance bands. We analyze whole land lots in this district currently used for commercial purposes (retail shops and small offices such as FIRE and clinics), along two dimensions: assessed values and their gradients. What we call the HVHG group consists of land lots with higher assessed values and higher gradients. The HVLG group consists of land lots with higher assessed values but lower gradients. We also consider LVHG (lower assessed values and higher gradients) and LVLG (lower assessed values and lower gradients) groups in our analysis. In short, the differences in mean returns between HVLG and other groups except HVHG group are statistically significant based on a paired t-test.

We test a couple of investment analyses. Our investment analyses control for the impact of both the size of land lot's assessed value and distance from subway station on the realized rate of returns. In summary, both the smaller and remote from the station groups beat the other groups in a statistically significant manner. In addition, a simple one-year momentum land investment strategy is again tested and the result is statistically not significant. Finally, we also visualize the retail market area and intertemporal changes in the market area.

As shown in Shin and Kim (2018), "This paper is subject to several limitations. First, the database might have a serious problem. Second, the 70- and 130-m radius condition used in gradient calculation and the top 50% (median) criterion for assessed value to group land lots into our four categories are arbitrary choices. However, from the applicability point of view, these criteria provide flexibility. Third, regarding applicability of the findings to land investment, we have not described the four land groups (HVHG, HVLG, LVLG, and LVHG) in a structural modeling fashion. We could further develop a structural model for four land groups with concrete variables such as distance to subway station, type of retail business, area size, corner lot dummy, and so on."

To facilitate the applicability of these and similar results, industry researchers can develop a smartphone application that combines other open government data, GIS technology, and other features. The application will cover 35 million land lots nationwide, yielding approximately 23 years of tax assessment valuation history. This application will also incorporate various cities, urban policies, periods, and so on. This smartphone application will give property investors a preliminary research tool for factors such as the location of a major commercial or market area, changes in that area, and changes in transportation infrastructure. This free and intuitive smartphone application service will increase market transparency. We expect our findings help improve transparency in this market place which is the basic requirement for a prudent investment. Finally such an increased investment will (re-)vitalize local economy.

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Appendix

Table 1. Yearly performances of 4 groups

	Y2001	Y2002	Y2003	Y2004	Y2005	Y2006	Y2007	Y2008	Y2009	Y2010	Y2011	Y2012	Y2013	Y2014	Y2015
HVHG	-0.377	0.020	0.203	0.127	0.072	**13%**	**11%**	0.033	-0.023	0.027	-0.002	**7%**	**7%**	0.028	0.066
HVLG	-0.235	0.024	0.203	0.237	0.038	0.077	0.072	0.119	-0.078	0.062	-0.018	0.041	0.039	0.077	0.062
LVHG	0.047	-0.027	0.255	0.121	0.033	0.115	0.103	0.069	0.026	-0.069	0.206	-0.099	-0.110	**29%**	**9%**
LVLG	-0.050	0.044	0.138	0.161	0.078	0.108	0.097	0.065	-0.006	0.006	0.021	0.063	0.059	0.067	0.015

*Yellow box: Highest performing group of the year but not next year

** **Red letter** box: Highest performer for two consecutive years.