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The Impact of Real Estate Factors on Voter Turnout: Local Elections in Korea

Sangmin Lee
Department of Real Estate, Konkuk University, Seoul, South Korea

Yeonjae Lee*
Department of Real Estate, Konkuk University, Seoul, South Korea
E-mail: cerisier@konkuk.ac.kr

Minwoo Kim
Department of Real Estate, Konkuk University, Seoul, South Korea

Seungwoo Shin
Department of Real Estate, Konkuk University, Seoul, South Korea

This study investigates the factors that affect voter turnout in local elections in Korea by using a panel fixed effects model. Cross-sectional analyses for each election compare the influence of these factors over time. In the panel fixed effects model, the coefficients for non-urban and urban areas point in the opposite directions. From an urban perspective, owner-occupied housing rates positively affect voter turnout, while apartment resident rates negatively affect it. Thus, increasing apartment supply without a rise in owner-occupied status can reduce voter turnout. Among the social factors, an aging population positively affects turnout, while an increase in foreigners has a negative effect. With urbanization continuing globally, promoting housing finance markets and effective housing supply policies to increase owner-occupied housing can enhance housing welfare and democratic development.

Keywords

Real estate, Voter turnout, Local elections, Panel model, South Korea

*Corresponding author

1. Introduction

It is difficult to directly implement the will of the people in a democratic system, so voting is the most important means of expressing their will. Article 24 of the Constitution of the Republic of Korea states that "all citizens shall have the right to vote under the conditions as prescribed by Act", and Article 15 of the Public Official Election Act specifically states that citizens may exercise their right to vote in the election of the president and members of the National Assembly and in the election of councilors and mayors of local governments.

Local elections are held for local self-governance, where voters elect representatives to form local governments (Kim, 2010). Nevertheless, recent national local elections (hereinafter referred to as local elections) reported a voter turnout of around 50% (National Election Commission of the Republic of Korea, n.d.). This is low compared to presidential elections, which have a turnout rate of over 70% (63% in the case of the 17th presidential election). A low voter turnout weakens representativeness and undermines the foundations of democracy (Park, 2014). Voting behaviour in Korea shows different patterns before and after 2002. Before 2002, social variables, such as region, ideology, and generation, had a strong influence (social voting). but after 2002, a trend of "economic voting" emerged in which voters are more likely to evaluate the economic performance of the ruling party (Lee and Kwon, 2019). As the trend towards economic voting intensifies, it is important to examine household wealth, which may have an impact.

Korean household assets comprise financial assets (35.6%) and non-financial assets (64.4%) (Korea Financial Investment Association, 2022),with most non-financial assets in the form of real estate. Housing is both a consumption good and an investment good. On the investment side, housing investment performance depends on local economic conditions (Yinger, 2015). The utility of housing as a consumer good is directly related to the provision of public goods by the local governments. Assets, such as property, are acquired by accumulating income over a long period of time (Lewis-Beck and Nadeau, 2011); consequently, economic interest in property can be expressed through the voting behaviour of citizens.

This study examines how real estate assets affect voter turnout in local elections and makes policy recommendations based on the findings. Specifically, if real estate factors affect voting behaviour, the vitalisation of the housing finance market and effective housing supply policies could contribute to the development of democracy and housing welfare (Manturuk et al., 2009).

Our study takes the voter turnout in six national local elections from the third local election in 2002 to the eighth local election in 2022 as the dependent variable and conducts six cross-sectional regression analyses, one panel fixed effects model analysis, and machine learning analyses. In particular, we analyse

the impact of real estate factors – urban dummy, property tax, land price change rate, and the ratio of owner-occupied (apartment+non-apartment) and apartment residents (owner+renter) – on local election turnout.

This paper is organised into five sections. Section 1 describes the background and purpose of the study. Section 2 presents the theoretical model, analyses previous studies, and describes the originality and contribution of the study. Section 3 covers the study design, data, variables, and research hypotheses. Section 4 presents the empirical analyses, which include descriptive statistics, panel fixed effects and cross-section regression analyses, and a predictive power comparison between the econometric and machine learning models. Section 5 concludes with a summary of the study, its limitations, and directions for future research.

2. Literature

2.1 Theoretical Background

This study is based on the utility theory of voting with some modifications of that in Downs (1957). We describe the voting behaviour of citizens in Equation (1):

$$R_i = E_i(B_i) - C_i \quad (1)$$

where R_i is the reward of voter i that can be obtained by voting, and B_i is the economic benefit that can be obtained if a voter i-supported candidate is elected. $E_i(B_i)$is the subjective expectation of voter i of the benefit, which is influenced by the size of the benefit $(B_i)$and the likelihood of the benefit being realised. Owner-occupied status increases voter turnout because it increases the benefit. Property owners are less likely to leave their neighbourhood (Rouwendal and Thomese, 2013) and feel a greater sense of belonging to their communities (Brown et al., 2003). This means that they are more likely to be interested in the development of their community. Their perceived influence on the outcome of the election is also important. The perception of being one of many voters will reduce the likelihood of achieving the benefit, thus leading to lower expectations. Downs (1957) argues that more participants in an election results in less individual influence; therefore, for every B_i, the value of $E_i(B_i)$is lowered, which reduces the willingness to vote. Conversely, belonging to a social network related to political reference groups may increase the likelihood of achieving the benefit. C_i is the cost of voting and includes the cost of travelling to the polls and information-related costs. Search costs can increase when there are many candidates or economic uncertainty increases. Equation (1) shows that for an individual to vote, the benefit of voting must be greater than the cost of voting.

Riker and Ordeshook (1968) point out that this assumption is too restrictive in view of the fact that a significant proportion of the electorate still participates in voting. They suggest that Equation (1) should be modified as follows:

$$R_i = E_i(B_i) - C_i + D_i \quad (2)$$

where D_i refers to the satisfaction of an individual voter with the act of voting or sense of duty for democracy. Satisfaction with the act of voting is higher among the elderly (Min, 2019), while a sense of democratic obligation is observed among highly educated voters (Biesta and Simons, 2009). Equation (2) suggests that property ownership increases the benefits of participating in voting in the communities and the political process, and is reflected in higher voter turnout. We build on this model to examine the effect of property factors, such as owner-occupied status (B_i). to examine how property factors affect voter turnout in local elections.

Gilderbloom and Markham (1995) show that home ownership increases voter participation. Manturuk et al. (2009) examine voter participation in economically and socially disadvantaged neighbourhoods and argue that owner-occupiers in disadvantaged neighbourhoods (e.g., non-urban areas) have higher voter participation rates than owner-occupiers in affluent neighbourhoods. Jiang (2018) analyses local election data in the United States and finds that owner-occupied status has a positive effect on voter participation. Son (2010) is among the first to analyse the effect of owner-occupied status on voter turnout in South Korea and finds that higher owner-occupied status and college graduation rates are associated with a higher voter turnout. Kang (2012) analyses data from the 18th National Assembly election in Korea and finds that renters tend to abstain from voting. Lee and Woo (2014) also conclude that the owner-occupied status rate has a positive effect on voter turnout in Korea.

However, the act of voting does not end with the act of going to the polling station (participation in voting). The benefits of voting are realised in three stages: a voter goes to the polling station, chooses a candidate, and determines later whether policies have changed (or not) according to their expectations. In other words, Equation (2) encompasses both voting participation and the choice of voters and policy change. Therefore, studying the participation of voters is the most important voting behaviour to examine as it is the basis for the next two stages. In this regard, Lee and Kwon (2019) conduct a panel analysis of four elections and show that owner-occupied status affects the election of conservative parties in Korea. Kim and Kang (2022) analyse local, general, and Seoul mayoral elections, and find that neighbourhoods with higher apartment sales prices are more likely to vote conservative. Park (2009) concludes that owner-occupiers tend to vote for the ruling party in Korea when house prices rise, while Kim and Kwon (2020) show that renters in Korea tend to punish any left-wing ruling party when house prices rise.

In line with previous studies, this study also sets a broader study period of six elections in a period of 20 years. Although the panel fixed effects model is the main methodology of our study, we use cross-sectional regression analysis for each election. In addition, by introducing an interaction variable with the urban dummy, we are able to distinguish between urban and non-urban areas and investigate how real estate variables affect local election turnout more meaningfully.

3. Research Design

3.1 Background of Study

Since the enactment of the Local Autonomy Act in 1988, local elections in South Korea have evolved significantly. The first local council elections were held in 1991, followed by the election of local government heads in 1995. This marked the beginning of simultaneous nationwide local elections, wherein both local government heads and local council members were elected concurrently. From 2010 onwards, the inclusion of the superintendent of education elections established the current system of each voter casting seven ballots (for metropolitan mayors, metropolitan council members, county mayors, county council members, and superintendent of education by metropolitan area). Since the first simultaneous nationwide local elections in 1995, these elections have been held every four years, except for the second election in 1998, where the term was limited to three years to create a two-year gap with the National Assembly elections. Therefore, Koreans have either local or general elections every two years. For mayors, a maximum of three consecutive terms is allowed.

The spatial scope of this study is 226 municipalities in Korea. However, the balanced panel consists of 177 municipalities after excluding municipalities with a single candidate and municipalities that have merged (no voting). The time span is from June 2002, when the third local elections were held, to June 2022, when the most recent eighth local elections were held. Therefore, the final number of panels selected is 1,062 (177 districts*6 elections).

The mayor of a municipality exerts significant influence over a community and has power over general affairs, local council affairs, financing, and budgets. Therefore, citizens vote for candidates whom they believe will reflect their views and maximise their interest. Given that voting is the most basic form of political participation, the dependent variable in this study is voter turnout to elect the mayor of a local government.

3.2 Research Hypothesis

The independent variables in this study include property, social, voting costs, and political factors. The property factors are an urban dummy variable, the

owner-occupier rate, apartment residents rate (64% of housing is an apartment) (Statistics Korea, 2022), an apartment renters dummy variable, the property tax portion, land value change rate, and the standard deviation of land value change rate. Non-urban areas tend to have a smaller population and a larger proportion of elderly than urban municipalities; therefore, we can expect a higher voter turnout in non-urban areas (Han and Kang, 2009). The owner-occupier rate, apartment residents rate, tax portion, and land value change rate should be positively correlated with voter turnout, consistent with previous studies (Kwak, 2007; Park, 2014; Jiang, 2018). However, while previous studies use the terms home ownership and owner-occupier interchangeably, our study uses only owner-occupier status as the independent variable. We assume that the relationship between the standard deviation of the land price change rate (risk, i.e., dissatisfaction) and voter turnout is positive. Holian (2011) argues that dissatisfaction is a driver of voter participation, so that an increase in risk leads to dissatisfaction, which increases voter participation. This is called the punishment effect (Shin, 2022). House prices are more important than land prices, but house price time series are often not collected for non-urban areas, which is a limitation of our study. The apartment renters dummy compares the share of apartment residents to that of owner-occupiers and is coded to assign a value of 1 to municipalities with a higher share of apartment renters. This variable is expected to be negatively related to voter turnout (Kang, 2012).

Social factors were selected as the ratio of college+graduates, percentages of the elderly and foreigners, population migration rate, and population size. According to the rational choice theory, more educated voters are more likely to participate in elections due to the lower cost of money and time associated with obtaining information about the candidates who are running for office (Jung, 2012). The proportion of the population aged 65 and older is likely to have a positive influence on voter turnout, because they have relatively more leisure time and therefore lower opportunity cost to vote (Lee and Woo, 2014). A higher population migration rate is expected to have a negative impact on voter turnout due to their lack of social ties and access to information. Foreigners are not eligible to vote in presidential or general elections under Korean law, but allowed to vote in local elections on a limited basis. A foreigner who has been a permanent resident (F-5 visa) for three years under Article 10 of the Immigration Control Act and is listed on the alien registration register of the local government under Article 34 of the Immigration Control Act is entitled to vote for local councillors and mayors under Article 15(2) of the Public Officials Election Act. Nevertheless, many foreigners do not know whether they have the right to vote at the time of an election and are relatively indifferent to elections compared to Korean voters (Cho, 2022). In areas with large populations, voters are less likely to participate in elections, because they feel that their single vote has less impact on electing their supported candidate (Jung, 2012).

We also add average temperature and precipitation on the election day as variables to measure the cost of voting. We infer that higher precipitation or higher temperatures will increase the cost of travelling and thus reduce voter turnout. As South Korea allows two days of early voting, we include them as control variables.

Political factors include the number of candidates, all the major political parties nomination dummy, an opposition party dummy, a female mayor dummy, the number of consecutive terms, and election competitiveness. A large number of studies have shown that a larger number of candidates increase the likelihood that there will be candidates with policies that individual voters support, and that more competitive elections increase voter turnout (Yang and Han, 2016). Whether or not a mayor belongs to an opposition party reflects the impact of the so-called "divided government" phenomenon on voter turnout. It is possible to identify whether voters who blame the ruling party for policy failures are more likely to vote for the opposition candidate, or voters who value policy continuity and stability are more likely to vote for the ruling party candidate (Jin, 1999). Table 1 summarises the variables described thus far.

Based on the findings of Manturuk et al. (2009), we analyse the effects of urban and non-urban areas separately. Therefore, we conduct a Chow test to compare the structural differences between the two regions ($F = 14.38$, $p = 0.000$). Since there are structural differences between urban and non-urban areas, it is inappropriate to simply pool them together. Therefore, we create an interaction variable between the urban dummy and property variables, namely, urban_percentage of elderly, urban_apartment residents rate, urban_apartment renters dummy, urban_owner occupied rate, urban_land value change rate, and urban_standard deviation of land value change rate.

3.3 Methodology

There may be endogeneity issues between the benefits in Equation (2) and sense of democratic obligation, and between property factors and political factors. For example, Kim and Kim (2021) find that homeowners tend to be more conservative than renters and voters become more conservative as the number of housing units owned increases. A panel data analysis can mitigate the endogeneity problem by accounting for changes in the decisions of the entities over time (Lewis-Beck et al., 2008).

This study uses both panel fixed effects (Hausman test, $Chi^2 = 160$, $p = 0.000$) and cross-sectional regression models via Stata 18.0 for the analyses. A comparison between the cross-sectional regression analysis of each of the six elections and the fixed effects model of the panel data allows for a more in-depth analysis of voting behaviour in local elections. Various Hausman-Taylor models are experimented but not reported as they all reject the hypothesis of the Hausman test.

Table 1 Variable Descriptions

		Variable (unit)	Variable description	Source
Dependent variable		Voter turnout (%)	$\text{Voter turnout}(\%) = \frac{\text{voters}}{Eligible\ citizens} \times 100$	National Electoral Commission
Independent variable	**Property factors**	Urban dummy	City=1, County=0	
		Owner-occupied rate (%)	Owner-occupied dwelling units (apartment+non-apartment) as a percentage of all households	Census
		Apartment residents rate (%)	Percentage of all households living in apartments (owner+renter)	
		Apartment renters dummy	Apartment renters dummy (If owner-occupied rate < apartment residents rate, then 1, otherwise=0)	
		Property tax portion (%)	Property taxes as a percentage of total local tax revenue	Korean Statistical Information Service (KOSIS)
		Land value change rate (%)	Average of the 24-month price change before election day	Korea Real Estate Board
		Standard deviation of land value change rate (%)	Standard deviation of the 24-month price change before election day	
	Social factors	Ratio of College+ graduates (%)	Ratio of the size of the graduate population with a 2-year college and higher degree to the size of the population aged 6 years old and older	Census
		Percentage of elderly (%)	Ratio of the size of the 65+ population to the size of the total population	KOSIS

(Continued...)

(Table 1 Continued)

		Variable (unit)	Variable description	Source
Independent variable	**Social factors**	Percentage of foreigners (%)	Ratio of the number of registered foreign nationals to the size of the resident population	KOSIS
		Population migration rate (%)	Ratio of the sum of net inflows and net outflows to the size of the resident population.	
		Population size (count)	Resident population size	
	Voting cost factors	Average temperature (℃)	Average temperature by municipality on election day	Korea Meteorological Administration
		Average precipitation (mm)	Average precipitation by municipality on election day	
	Political factors	Number of candidates (count)	Number of candidates in the election	National Electoral Commission
		Major political parties nomination dummy	Whether all the major political parties with 20 or more seats in the National Assembly have nominated candidates (nominated = 1, otherwise = 0)	
		Opposition party dummy	Opposition party affiliation of the incumbent municipal mayor (opposition party = 1, otherwise = 0)	
		Female mayor dummy	Whether the incumbent municipal mayor is a woman (woman = 1, man = 0)	
		Number of consecutive terms (count)	Number of consecutive terms of the incumbent municipal mayor immediately prior to the election	
		Election competitiveness (%)	The ratio of the difference in votes between the first and second place candidates to the total number of voters in the previous election.	

Regarding the independent variables, we construct variables to identify real estate, social and political factors, and voting costs. In particular, we distinguish between urban and non-urban areas, as Manturuk et al. (2009) show that voter turnout is higher in non-urban areas. To distinguish between the two areas, we construct an interaction variable with an urban dummy variable (e.g., urban dummy*owner-occupied rate). Following Kang (2012), we add a dummy variable to distinguish municipalities with a higher proportion of apartment renters from those with owner-occupiers. The owner-occupied status variable refers to voters who live in a single-family home or apartment and own the home, while the apartment residents variable includes apartment owners and renters. If the difference between the two is less than zero, we can confirm that there are a strictly positive number of apartment renters (apartment renters dummy). According to the 2022 Korea Housing Survey, 45.8% of low-income households (under 40% of median income) are owner-occupied, compared to 48.5% of renters, in contrast to 74.2% and 24.4% for high income households (over 90%). respectively. As low-income households are more likely to be apartment renters and face housing affordability issues, the apartment renters dummy can also be used to indirectly examine the relationship between household income and housing affordability issues and voter turnout. This innovative dummy variable allows us to extend the scope of our study beyond those of previous studies.

4. Estimation Results and Discussions

4.1 Descriptive Statistics

Descriptive statistics for the panel data are shown in Table 2. For details of the individual elections, please refer to Appendix A. The dependent variable, that is, voter turnout, is on average 58.99%, with the 8th election (2022) having the lowest turnout (55.81%) and the 7th election (2018) the highest turnout (63.76%). Among the independent variables, the variables that represent the property factors show that urban areas comprise 68.74% of all municipalities. The average owner-occupied rate is 62.08%, and the average apartment residents rate is 36.92%. The average apartment renters dummy is 23.07%, and average property tax portion is 11.17%. The mean of the land value change rate variable is 0.23%. Meanwhile, the standard deviation of the land value change rate is 0.26% on average.

Table 2 Descriptive Statistics (Panel)

Variable	Mean	Std. err.	Minimum	Maximum
Voter turnout (%)	58.992	10.075	35.205	86.999
Urban dummy	0.687	0.464	0.000	1.000
Owner-occupied rate (%)	62.084	13.921	30.684	91.482
Apartment residents rate (%)	36.921	19.596	0.000	79.707
Apartment renters dummy	0.231	0.421	0.000	1.000
Property tax portion (%)	11.172	6.085	0.150	33.130
Land value change rate (%)	0.227	0.234	-0.209	1.680
Standard deviation of land value change rate (%)	0.264	0.331	0.008	2.829
Ratio of college+ graduates (%)	22.889	10.241	4.688	61.204
Percentage of elderly (%)	16.032	8.032	3.041	41.495
Percentage of foreigners (%)	1.746	1.625	0.052	10.571
Population migration rate (%)	2.420	0.800	1.072	6.227
Population size (count)	242,689.4	218,257.1	9,082.0	1,203,000.0
Average temperature (℃)	20.156	1.415	15.020	22.682
Average precipitation (mm)	0.523	1.501	0.000	10.043
Number of candidates (count)	3.281	1.214	2.000	11.000
Major political parties nomination dummy	0.632	0.483	0.000	1.000
Opposition party dummy	0.643	0.479	0.000	1.000
Female mayor dummy	0.019	0.136	0.000	1.000
Number of consecutive terms (count)	0.544	0.686	0.000	3.000
Election competitiveness (%)	17.498	14.482	0.045	71.748
Urban_owner-occupied rate	55.559	10.370	30.684	82.532
Urban_apartment residents rate	46.293	14.548	0.000	79.707
Urban_apartments renters dummy	0.330	0.471	0.000	1.000
Urban_land value change rate	0.243	0.247	-0.209	1.454
Urban_standard deviation of land value change rate	0.298	0.358	0.013	2.146
Urban_percentage of elderly	12.499	5.555	3.041	33.428
Urban_population size	327,957.0	213,480.4	40,085.0	1,203,000.0
Count	1,062			

Next, we look at the variables that represent social factors. First, the ratio of college+graduates is 22.89% on average (maximum value is 61%). The percentage of the elderly is 16.03%, and foreigners is 1.75%, and the population migration rate is 2.42%. Finally, the average population of the municipalities is 242,689. The average temperature on election day is 20.16 ℃, and the average precipitation is 0.52 mm. Finally, for the political factors, the average number of candidates is 3.28, and all major political parties nominated candidates in 63.18% of the municipalities. On average, 64.31% of the incumbents are affiliated with the opposition party on election day, and only 1.88% of incumbents are women. The average number of consecutive terms held by incumbents is 0.54, and average election competitiveness is 17.50%.

If we look at the characteristics of the independent variables in the urban areas separately, we find that the average urban_owner-occupied rate is 55.56%, and the average urban apartment residents rate is 46.29%. The average number of urban municipalities with a higher proportion of apartment renters than owner-occupiers is 33.01%. The average land value change rate is 0.24% and standard deviation of the land value change rate is 0.30%. The percentage of elderly is 12.50%, and the population size is 327,957.

4.2 Panel Fixed Effects Model

The results of the panel fixed effects model are presented in Table 3. We first focus on the urban areas. The coefficient of the urban dummy is -45***, thus indicating that cities inherently have a lower voter turnout than non-urban areas. Among the property factors, the owner-occupied rate is negative (−0.258***) in non-urban areas and 0.4*** in urban areas, so overall, it is positive (0.142, 0.4-0.258) in urban areas. This phenomenon is probably influenced by one of the omitted characteristics of voters, that is, the age of voters. As real estate assets accumulate over time (Lewis-Beck and Nadeau, 2011). the elderly are more likely to be homeowners. Conversely, the younger generation faces affordability challenges in owning a home, as explained by the "Generation Rent" theory (Hoolachan et al., 2017). According to the Korea National Election Commission, voters aged 40 and above have consistently shown a turnout rate of over 50% in local elections from the 3rd to the 8th sessions. In other words, younger voters tend to be less active in participating in elections. In urban areas, municipalities with the top 10% with respect to the older adult population size have a higher owner-occupied rate compared to those with the bottom 10% (69.56% vs. 50.81%). and voter turnout follows the same pattern (60.10% vs. 45.95%). Therefore, it appears that in urban areas, homeownership rates positively influence voter turnout.

To investigate whether the lower voter turnout rate (below 50%) among voters aged 20-39 is related to their apartment resident status, we analyzed census data on the apartment resident status distribution of household by age. The results show that 46.20% of young adults (aged 20-39) are living in an apartment.

Young adults prefer to live in an apartment. When combined with urbanization factors, it is evident that urban areas have a higher apartment residents rate (46.29%) than non-urban areas (16.31%). Thus, as the apartment residents rate increases in urban areas, it may negatively affect voter turnout. Finally, the apartment renters dummies have opposite signs for non-urban (8.698***) and urban (−7.36**) areas and is positive (1.338) overall for urban areas. Taken together, an increase in owner-occupied rates in urban areas increases voter turnout (Kwak, 2007; Manturuk et al., 2009 Lee and Woo, 2014; Jiang, 2018). The supply of additional apartments in cities has a mixed effect with a negative apartment residents rate and positive apartment renters dummy. Overall, urbanisation and the supply of apartments that is not accompanied by an increase in owner-occupiers may reduce voter turnout in general.

The land values change rate differs between non-urban areas (4.406***) and urban areas (−4.392***). with urban areas being positive overall (0.014). Rising land prices increase voter turnout across municipalities. The standard deviation of the land value change rate has a different effect than the land value change rate variable, with urban areas having a positive (1.749*) effect, but overall, urban areas have a negative (−0.718**, -2.467+1.749) effect (Holian, 2011; Shin, 2022).

The effect of the percentage of elderly in non-urban areas is not significant, but positive in urban areas (0.215***). Ageing is predicted to increase voter turnout across the nation. For population size, there is no significant effect for non-urban (−0.0000***) and urban (0.0000***). Other factors, such as the percentage of foreigners (−0.238*). population migration rate (−1.986***). ratio of college+graduates (0.294***). and property tax portion (0.292***) perform as expected. Among the variables associated with voting costs, the effect of average temperature and average precipitation is not significant, which can be attributed to the benefit of early voting (Ka, 2016).

In terms of political factors, more candidates are associated with a higher voter turnout (0.172*); however, unlike previous studies (Lee and Woo, 2014), we find that the level of electoral competition in the previous election has a negative effect (−0.018***) on voter turnout. This is because the election interval is long (four years). candidates are often replaced, and incumbents who win previous close elections often have strong leadership positions, which discourages challengers from running and encourages newcomers to make just a name for future elections (Vowles et al., 2017). In addition, voters are more likely to go to the polls when the local government leader is a member of the opposition party (0.473**). The adjusted R^2 is 63.69% overall, 70.07% within entities, and 63.26% between entities.

Table 3 Panel Fixed Effects Model Estimation Result

Variable		Coefficient	Std. err.	t-value	P-value
Constants		96.092***	6.442	14.92	0.000
Urban_dummy		−45.038***	6.317325	−7.13	0.000
Owner-occupied rate		−0.258***	0.074	−3.51	0.000
Urban_owner-occupied rate		0.400***	0.084	4.79	0.000
Apartment residents rate		−0.466***	0.058	−8.06	0.000
Urban_apartment residents rate		0.232***	0.060	3.85	0.000
Apartment renters dummy		8.698***	2.907	2.99	0.003
Urban_apartment renters dummy		−7.360**	2.951	−2.49	0.013
Property tax portion		0.292***	0.037	7.96	0.000
Land value change rate		4.406***	1.278	3.45	0.001
Urban_land value change rate		−4.392***	1.204	−3.65	0.000
Standard deviation of land value change rate		−2.467**	1.049	−2.35	0.019
Urban_standard deviation of land value change rate		1.749*	1.024	1.71	0.088
Ratio of College+ graduates		0.294***	0.087	3.39	0.001
Percentage of elderly		−0.135	0.084	−1.6	0.109
Urban_percentage of elderly		0.215***	0.065	3.32	0.001
Percentage of foreigners		−0.238*	0.122	−1.95	0.051
Population migration rate		−1.986***	0.248	−8.00	0.000
Population size		−0.000***	0.000	−2.92	0.004
Urban_population size		+0.000***	0.000	3.03	0.003
Average temperature		0.061	0.107	0.57	0.570
Average precipitation		0.093	0.066	1.39	0.164
Number of candidates		0.172**	0.082	2.11	0.035
Major political parties nomination dummy		0.004	0.262	0.02	0.987
Opposition party dummy		0.473**	0.192	2.47	0.014
Female mayor dummy		0.823	0.706	1.17	0.244
Number of consecutive terms		0.191	0.130	1.47	0.142
Election competitiveness		−0.018***	0.007	−2.64	0.008
4th election dummy		−1.248**	0.572	−2.18	0.029
5th election dummy		0.977	0.980	1.00	0.319
6th election dummy		−0.875	1.064	−0.82	0.411
7th election dummy		0.527	1.524	0.35	0.73
8th election dummy		−8.324***	1.981	−4.20	0.000
N		1,062			
R^2	**Overall**	63.69			
	Within	70.07			
	Between	63.26			

Note: ***p <0.01, **p <0.05 and *p <0.1.

4.3 Comparing Panel Fixed Effects Analysis with Cross-Sectional Regression Analyses

The results of the election year cross-sectional regression models are shown in Appendix B. In this section, we focus on variables with coefficients that differ in direction or significance from the results of the panel fixed effects model. The cross-sectional analysis allows us to examine the characteristics of each year relative to the panel model that pools the data. Since local elections are understood to be local, unlike presidential or general elections, we do not expect much year-to-year variability in voting behaviour (Marien et al., 2015). However, the volatility is high enough so that the average turnout drops by about 8% from the 7th (63.76%) to the 8th (55.81%) elections.

The variables that differ from the panel analysis are the property tax portion and the apartment renters dummy variables. The property tax portion has a positive effect (0.292***) in the panel model but a statistically significant and consistently negative effect in the cross-sectional models. Since the panel analysis takes into account the temporal variation of the variables, it can be interpreted that an increase in the property tax burden leads to a more responsible taxpayer attitude, which increases voter turnout. Since Korea has a uniform property tax rate across the country, higher property tax portions are correlated with higher property values. Therefore, in a cross-sectional analysis, voters in more affluent areas may be less interested in local elections. This is because affluent neighbourhoods have higher levels of party unity in their voting practices (Yoon et al., 2015); in other words, voters in more affluent neighbourhoods vote for parties rather than candidates. The apartment renters dummy is significant in the panel analysis, but not in the cross-sectional analysis.

5. Conclusion

This study analyses the factors that affect voter turnout in national local elections by using a panel fixed effects model. Cross-sectional analyses are conducted for each election to compare the influence of the independent variables on voter turnout at different time points. We then compare the prediction performance of the panel regression and machine learning models. In this study, the dependent variable is voter turnout in the third to eighth local elections.

In a panel fixed effects model, the coefficients for non-urban and urban areas point in opposite directions. Interpreted in the aggregate from an urban perspective, the owner-occupied rate has a positive effect and the apartment residents rate is a drag on turnout. Thus, urbanisation and apartment supply that are not accompanied by an increase in owner-occupied status can reduce voter

turnout. Among the social factors, an aging population has a positive effect and an increase in foreigners has a negative effect on turnout.

These findings show that housing supply and ownership have a positive effect on voter turnout in the urban areas, which explicitly indicates that owner-occupied housing has a political effect on voting, in addition to the wealth accumulation effect of households (Lee and Woo, 2014). Given that urbanisation continues in many municipalities worldwide, promoting housing finance markets and effective housing supply policies to increase owner-occupied housing can contribute not only to housing welfare but also to the development of democracy (Manturuk et al., 2009)

Despite its significance, this study has some limitations. First, we have not conducted a structural analysis of social network capital because social media has been shown to influence electoral choices (Cha et al., 2020). In addition, apartments account for over 64% of all housing types in Korea in 2022, which means that residential apartments are an important part of the property market. Therefore, the challenge for future research is to differentiate the variables related to apartments, such as the value of a unit, size of apartment complexes and exact tenure structure of a unit.

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Appendix A: Descriptive Statistics by Election

Table A1 Descriptive Statistics 3rd-4th Elections

Variable (in units)	3rd election (2002)				4th election (2006)			
	Mean	SD	Min	Max	Mean	SD	Min	Max
Voter turnout (%)	56.284	12.958	35.205	86.999	57.763	10.889	40.354	85.372
Urban dummy	0.672	0.471	0.000	1.000	0.684	0.466	0.000	1.000
Owner-occupied rate (%)	61.004	14.200	31.658	88.394	61.877	13.456	34.542	88.056
Apartment residents rate (%)	29.257	18.105	0.000	77.142	33.738	18.698	0.000	79.664
Apartment renters dummy	0.107	0.310	0.000	1.000	0.158	0.366	0.000	1.000
Property tax portion (%)	3.614	2.289	0.150	14.584	8.132	2.786	1.388	20.252
Land value change rate (%)	0.369	0.349	-0.174	1.680	0.370	0.253	-0.005	1.393
SD of land value change rate (%)	0.562	0.447	0.065	2.829	0.281	0.252	0.017	1.429
Ratio of college+ graduates (%)	14.345	7.178	4.688	43.033	19.150	8.626	6.135	50.862
Percentage of elderly (%)	10.528	5.249	3.041	23.359	12.883	6.405	4.021	28.270
Percentage of foreigners (%)	0.568	0.512	0.094	4.502	1.263	1.087	0.186	6.171
Population migration rate (%)	3.166	1.012	1.327	6.227	2.730	0.828	1.186	5.490
Population size(count)	229,604.6	194,816.9	9615.0	1,019,711.0	234,349.2	205,761.9	10,235.0	1,068,906.0
Average temperature (℃)	19.836	1.480	17.675	22.682	19.969	0.712	18.625	21.446
Average precipitation (mm)	0.288	0.480	0.000	1.250	0.065	0.226	0.000	1.000
Number of candidates (count)	3.441	1.274	2.000	8.000	3.785	1.434	2.000	11.000

(Continued…)

(Table A1 Continued)

Variable (in units)	3rd election (2002)				4th election (2006)			
	Mean	**SD**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**
Major political parties nomination dummy	0.565	0.497	0.000	1.000	0.763	0.427	0.000	1.000
Opposition party dummy	0.638	0.482	0.000	1.000	0.831	0.376	0.000	1.000
Female mayor dummy	0.000	0.000	0.000	0.000	0.006	0.075	0.000	1.000
Number of consecutive terms (count)	0.621	0.486	0.000	1.000	0.503	0.762	0.000	2.000
Election competitiveness (%)	17.680	15.362	0.045	71.748	16.349	13.732	0.067	67.890
Urban_ owner-occupied rate	54.010	10.427	31.658	80.589	55.246	9.352	34.542	79.190
Urban_ apartment residents rate	38.015	14.652	0.000	77.142	42.920	13.967	0.000	79.664
Urban_ apartments tenant dummy	0.160	0.368	0.000	1.000	0.231	0.423	0.000	1.000
Urban_ land value change rate	0.409	0.369	-0.174	1.454	0.397	0.253	-0.005	1.393
Urban_ SD of land value change rate	0.668	0.439	0.067	2.103	0.284	0.241	0.019	1.429
Urban_ percentage of elderly	7.710	3.113	3.041	17.725	9.448	3.684	4.021	21.518
Urban_ population size	312,005.0	187,745.0	55,154.0	1,019,711.0	317,529.2	199,241.2	50,766.0	1,068,906.0
Count	177				177			

Notes: SD, standard deviation; Min, minimum; and Max, maximum

Table A2 Descriptive Statistics 5th-6th Elections

Variable name (in units)	5th election (2010)				6th election (2014)			
	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
Voter turnout (%)	59.542	9.025	44.382	81.636	60.791	8.087	47.953	81.514
Urban dummy	0.684	0.466	0.000	1.000	0.695	0.462	0.000	1.000
Owner-occupied rate (%)	61.412	14.586	30.684	90.682	61.412	14.586	30.684	90.682
Apartment residents rate (%)	38.680	19.298	1.520	79.707	38.680	19.298	1.520	79.707
Apartment renters dummy	0.282	0.451	0.000	1.000	0.282	0.451	0.000	1.000
Property tax portion (%)	10.310	3.522	2.731	23.081	15.177	5.461	4.713	29.328
Land value change rate (%)	-0.009	0.065	-0.209	0.272	0.090	0.044	-0.065	0.291
SD of land value change rate (%)	0.537	0.336	0.047	2.146	0.073	0.029	0.022	0.184
Ratio of college+ graduates (%)	22.654	9.008	8.671	55.493	22.654	9.008	8.671	55.493
Percentage of elderly (%)	14.702	7.013	5.245	30.911	16.594	7.228	5.987	33.517
Percentage of foreigners (%)	1.775	1.492	0.052	9.607	2.107	1.760	0.307	10.134
Population migration rate (%)	2.428	0.704	1.208	6.065	2.201	0.478	1.098	3.347
Population size (count)	239,537.1	211,461.8	10,521.0	1,072,845.0	249,244.1	227,382.8	10,559.0	1,164,817.0
Average temperature (℃)	18.399	0.844	15.020	19.021	21.318	1.222	17.160	22.583
Average precipitation (mm)	0.010	0.035	0.000	0.133	2.084	3.048	0.000	10.043
Number of candidates (count)	3.407	1.189	2.000	7.000	3.119	1.078	2.000	7.000
Major political parties nomination dummy	0.565	0.497	0.000	1.000	0.627	0.485	0.000	1.000

(Continued…)

(Table A2 Continued)

Variable name (in units)	5th election (2010)				6th election (2014)			
	Mean	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**
Opposition party dummy	0.305	0.462	0.000	1.000	0.667	0.473	0.000	1.000
Female mayor dummy	0.006	0.075	0.000	1.000	0.023	0.149	0.000	1.000
Number of consecutive terms (count)	0.424	0.550	0.000	2.000	0.508	0.692	0.000	3.000
Election competitiveness (%)	23.191	15.464	0.174	66.980	13.316	12.231	0.178	57.460
Urban_ owner-occupied rate	54.394	10.658	30.684	80.441	54.515	10.613	30.684	80.441
Urban_ apartment residents rate	48.128	13.794	18.342	79.707	47.926	13.773	18.342	79.707
Urban_ apartments tenant dummy	0.405	0.493	0.000	1.000	0.398	0.492	0.000	1.000
Urban_ land value change rate	-0.016	0.067	-0.209	0.190	0.094	0.047	-0.065	0.291
Urban_ SD of land value change rate	0.640	0.336	0.069	2.146	0.079	0.031	0.022	0.184
Urban_ percentage of elderly	10.992	4.074	5.245	23.778	12.926	4.317	5.987	26.165
Urban_ population size	324,893.1	204,756.8	48,669.0	1,072,845.0	335,057.7	223,181.3	47,246.0	1,164,817.0
Count	177				177			

Notes: SD, standard deviation; Min, minimum; and Max, maximum

Table A3 Descriptive Statistics 7th-8th Elections

Variable name (in units)	7th election (2018)				8th election (2022)			
	Mean	SD	Min	Max	Mean	SD	Min	Max
Voter turnout (%)	63.763	7.286	51.573	82.588	55.810	8.939	38.733	81.497
Urban dummy	0.695	0.462	0.000	1.000	0.695	0.462	0.000	1.000
Owner-occupied rate (%)	63.588	14.105	32.311	91.482	63.212	12.467	31.720	86.485
Apartment residents rate (%)	39.163	19.572	2.923	76.764	42.007	20.078	4.060	78.238
Apartment renters dummy	0.260	0.440	0.000	1.000	0.294	0.457	0.000	1.000
Property tax portion (%)	14.638	4.741	5.461	26.857	15.163	5.815	5.351	33.130
Land value change rate (%)	0.274	0.091	-0.130	0.667	0.268	0.102	0.024	0.521
Standard deviation of land value change rate (%)	0.087	0.043	0.029	0.404	0.042	0.022	0.008	0.138
Ratio of college+ graduates (%)	27.630	9.045	14.182	59.365	30.900	9.353	17.406	61.204
Percentage of elderly (%)	18.881	7.497	7.103	36.841	22.602	8.284	9.402	41.495
Percentage of foreigners (%)	2.380	1.891	0.321	9.708	2.382	1.733	0.244	10.571
Population migration rate (%)	2.116	0.438	1.241	3.526	1.881	0.382	1.072	3.042
Population size (count)	252,094.3	232,857.5	10,010.0	1,203,000.0	251,307.0	236,173.8	9082.0	1,185,044.0
Average temperature (℃)	20.340	0.968	16.560	21.420	21.074	0.869	19.744	22.388
Average precipitation (mm)	0.672	0.866	0.000	1.867	0.017	0.024	0.000	0.050
Number of candidates (count)	3.390	1.072	2.000	7.000	2.542	0.776	2.000	5.000
Major political parties nomination dummy	0.469	0.500	0.000	1.000	0.802	0.399	0.000	1.000
Opposition party dummy	0.610	0.489	0.000	1.000	0.808	0.395	0.000	1.000

(Continued…)

(Table A3 Continued)

Variable name (in units)	7th election (2018)				8th election (2022)			
	Mean	**SD**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**
Female mayor dummy	0.040	0.195	0.000	1.000	0.040	0.195	0.000	1.000
Number of consecutive terms (count)	0.678	0.749	0.000	3.000	0.531	0.798	0.000	3.000
Election competitiveness (%)	15.078	13.614	0.117	62.078	19.374	14.309	0.094	67.542
Urban_ Owner-occupied rate	57.286	10.865	32.311	82.532	57.827	9.791	31.720	79.526
Urban_ apartment residents rate	48.698	13.454	19.739	76.764	51.778	13.676	20.841	78.238
Urban_ apartments tenant dummy	0.366	0.484	0.000	1.000	0.415	0.495	0.000	1.000
Urban_ land value change rate	0.281	0.098	-0.130	0.667	0.294	0.104	0.024	0.521
Urban_ standard deviation of land value change rate	0.088	0.044	0.029	0.404	0.045	0.022	0.013	0.138
Urban_ percentage of elderly	15.165	4.630	7.103	29.188	18.523	5.242	9.402	33.428
Urban_ population size	339,000.5	229,638.3	43,510.0	1,203,000.0	338,518.7	233,988.0	40,085.0	1,185,044.0
Count	177				177			

Notes: SD, standard deviation; Min, minimum; and Max, maximum

Appendix B: Cross-Section Regression Model Analyses by Election

Variable	3rd election	4th election	5th election	6th election	7th election	8th election
Constants	68.535***	72.211***	82.267***	71.730***	66.149***	83.810***
Urban_dummy	-39.287***	-33.712***	-21.371	-15.774	-5.07	-31.676***
Owner-occupied rate	-0.15	-0.234	-0.064	-0.064	-0.002	-0.191
Urban_owner-occupied rate	0.033	0.249	0.274	0.306	0.103	0.206
Apartment residents rate	-0.240	-0.064	-0.021	0.018	-0.09	-0.288***
Urban_apartment residents rate	0.252	0.061	-0.084	-0.168	-0.023	0.171
Apartment renters dummy	-0.753	0.026	1.189	-3.409	-2.766	1.48
Urban_apartments tenant dummy	(omitted)	(omitted)	1.286	5.627	5.079	-0.373
Property tax portion	-0.033	-0.287***	-0.402***	-0.192***	-0.233***	-0.238
Land value change rate	-5.533	-2.11	1.554	5.493	22.245	-23.447
Urban_land value change rate	13.576***	-0.099	0.36	-16.497	-33.632***	12.843
Standard deviation of land value change rate	-0.044	-2.584	-3.347	2.023	-25.765	67.439
Urban_standard deviation of land value change rate	-6.392	3.81	5.477	20.977	21.964	-50.146
Ratio of college+graduates	0.182	0.271***	0.352***	0.454***	0.459***	0.349***
Percentage of elderly	0.545	0.922***	0.811***	0.841***	0.362	0.316
Urban_percentage of elderly	1.398***	0.242	-0.368	-0.478	-0.1	0.096

(Continued…)

(Appendix B Continued)

Variable	3rd election	4th election	5th election	6th election	7th election	8th election
Percentage of foreigners	-1.604	-0.423	-0.158	-0.394	-0.410	-0.801***
Population migration rate	-0.659	-1.598	-0.386	0.988	-2.316***	-3.397
Population size	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***
Urban_population size	0.000***	0.000***	0.000***	0.000***	0.000***	0.000
Average temperature	0.795	0.381	-1.141***	-0.986***	-0.228	-0.02
Average precipitation	0.217	-0.063	12.574	0.18	-1.022	68.719
Number of candidates	0.419	0.403	0.617	0.07	0.571	-0.099
Major parties' nomination dummy	-0.867	-2.054	-1.426	-0.074	-2.308***	-2.663***
Opposition party dummy	0.665	0.017	-0.506	1.410	-0.127	3.515***
Female mayor dummy	(omitted)	-3.72	4.019	-1.073	-2.492	0.586
Number of consecutive terms	0.028	-0.203	1.011	0.059	-0.45	0.078
Election competitiveness	-0.073***	-0.019	-0.082***	-0.068***	-0.003	-0.016

Note: ***p <0.01.