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The Effect of Population Aging on Local School Subsidies in Korea*

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The recent growth in local school subsidies in Korea offers a chance to test the effect of population aging on public education expenditure. In the existing literature, the intergenerational conflict model suggests a negative effect, although a growing number of studies are finding theoretical and empirical evidence of a positive effect. After controlling for the district fixed effect, the analysis of the Korean data shows that the elderly population share has a significant positive effect on the local school subsidy per pupil. This result is robust after instrumenting the real proportion of the elderly population by the predicted proportion, assuming no population mobility, to handle the possible bias caused by Tiebout sorting.

JEL Classification: H75, I22
Keywords: Population Aging, Local School Subsidy, Public Education Finance, Demographic Structure

I. Introduction

The Korean population is aging rapidly. In 1955, three years after the end of the Korean War, the size of the Korean population was 21.5 million, 3.32% of whom were over the age of 65. In the subsequent four decades, the proportion of the elderly remained much the same despite the population growth. However, in the mid-1990s, the country experienced population aging, and this trend is now

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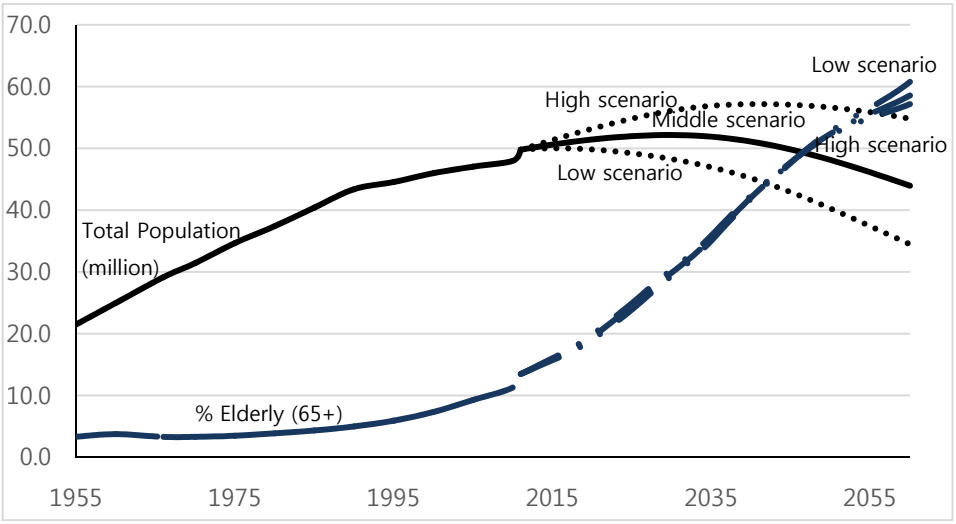
accelerating. In 2010, the proportion of the elderly in Korea was 11.3% of the population, and is expected to continue to grow.[1] According to the population projection based on the middle scenario by Statistics Korea, presented in Figure 1, the elderly will constitute about 30% of the population by 2030 and about 60%, by 2060. Furthermore, these predictions are not that different to those of the high and low scenarios.

[Figure 1] The predicted population aging in Korea



Source: *Population census, 1955–2010; Population projections for Korea: 2010~2060*.

Note: In the population projection, Statistics Korea defines low, middle, and high scenarios by the levels of the birth rate, life expectancy at birth, sex ratio at birth, and net migration inflow. For details, please see *Population projections for Korea: 2010~2060*, which is downloadable from the Statistics Korea website.

An emerging concern in public finance is the impact that population aging would have on the structure of public expenditure. Population aging is frequently expected to lead to a growth in the political power of the elderly. Such a trend could increase public spending on age-specific programs, such as healthcare, pension, and transfers, while reducing public school expenditure for children and their parents in the working age group. Indeed, these concerns are widespread in industrialized countries, motivated by a considerable number of studies in economics and other social science disciplines on the intergenerational conflict in public finance.

However, as extensive as the existing literature is on intergenerational conflict, there is little consensus on the possible effects that the growing proportion of the elderly will have on the spending for public education. Theoretical approaches

[1] The 1955 and 2005 population statistics are from each year's Population Census.

suffer from a variety of possible political equilibria among different age groups when the assumptions of the median voter theorem do not hold. Empirical studies have estimated a wide range of coefficients for the proportion of the elderly on school expenditure per pupil or per child, some of which are negative or positive, while others are close to zero. Cross-country or cross-state analyses typically show that the increasing proportion of the elderly would have a clear negative effect on school funding. However, the effect tends to become zero, and sometimes changes to positive when local-level data are analyzed. Recent studies have focused on the positive effect of the proportion of the elderly. These studies claim their results support the capitalization theory, according to which elderly voters care about the increase in property value afforded by improving the quality of local schools.

The recent increase in district school subsidies in Korea offers an opportunity to test the intergenerational conflict hypothesis at the local level. The baseline government funding for public education is equalized and highly centralized in Korea. However, in the late 1990s, the local governments were endowed with the authority to provide voluntary subsidies to local schools using their discretionary budget. Subsequently, in the early 2000s, there was considerable growth in district school subsidies. Currently, all Korean district governments provide school subsidies, although the amounts of subsidies per pupil and the purposes of the subsidies vary considerably. The recent growth in local school subsidies combined with the rapid population aging offers a chance to analyze the political economic role of population aging over a relatively short time span.

Using new panel data at the district level for 2002–2007 and 2009, this study estimates, for the first time in Korea, the effect of the proportion of the elderly on the school subsidy per pupil. There are several challenges in identifying this causal effect. First, many unobservable factors specific to each district may affect both the proportion of the elderly and school funding, thus causing a bias in the estimation. Second, the level of a subsidy is censored at zero when the district does not provide any school subsidy. Third, following the Tiebout theorem, the mobility of the elderly could lead to another bias in the estimation. To address these problems, the estimation results from various specifications, including fixed-effect, Tobit, and instrumental variable models, will be presented, compared, and extensively discussed.

The remainder of the paper is organized as follows. Section II introduces previous theoretical approaches to intergenerational conflict in public school finance. Section III reviews the findings from previous empirical studies. Section IV explains the institutional background of public school funding and local school subsidies in Korea. Section V describes the data and the identification strategy employed in this study. Section VI presents the estimation results, along with a discussion of the current theoretical and empirical literature. Section VII concludes the paper.

II. Theoretical Background

The intergenerational conflict model has long been proposed in public finance. Given limited tax revenue, elderly voters tend to prefer public spending on healthcare and pensions rather than education, as this provides them with a direct benefit. There are at least two reasons to justify this view. First, the elderly are less likely to have children of school age in their household, which minimizes the possibility of a direct benefit from public spending on schools. Second, despite the positive externality of education promoting economic growth, the elderly benefit less from this than the younger generations do because they have, on average, a shorter remaining life span.

When individuals in a certain age group vote for their own self-interest, the change in the demographic structure is likely to affect the allocation of tax revenue among government expenditure programs. Population aging increases the political power of the elderly, thus leading to an increase in healthcare and pension spending relative to public expenditure on education. The possible conflict among different age groups in the allocation of public resources is studied widely in economics literature.

However, not all theoretical models find that the elderly vote against generous school expenditure. First, there are several reasons that could justify the elderly's support for improving the quality of public education, which necessarily accompanies an increase in school spending. An example is the existence of intergenerational altruism, which results in elders' concern for the education of the young. Another is a positive externality produced by education. An improvement in school quality will increase productivity in the future, which may also increase transfer benefits for the elderly. If elderly voters are not myopic, they will support the school quality improvement projects that enable them to enjoy greater future benefits.[2]

The capitalization of school quality into property values offers another explanation for the positive effect of population aging on school expenditure. Usually, public schools only admit the children of the local residents. Hence, parents who demand high-quality education for their children move to towns with good schools, thus raising local demand for housing. As a result, the quality of local schools is capitalized into local property values through this channel. Thus, the elderly, many of whom are property owners, are likely to have an incentive to invest in local schools to increase the value of their property.[3]

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[2] For example, Kemnitz (1999) shows that population aging is linked to higher subsidies for schools when spillovers and externalities from education are considered.

[3] In Korea, though the baseline school expenditure per pupil is equalized, the district and regional governments have an authority to subsidize public schools using their discretionary budget. Thus, the local school subsidy that improves school quality can be capitalized into the property values. More

However, the mobility of elderly voters complicates the analysis of the relationship between population aging and school finance. When the moving cost is low and each locality has a policy on social spending programs, such as a subsidy for public schools or a local healthcare program, voters may choose to live in a community based on the expenditure levels in each social spending program, as proposed by Tiebout (1956). For example, the elderly who seek greater benefits from age-specific transfer programs, such as pensions and healthcare, may choose to live in a community where social spending is tilted toward such programs rather than local public schools, perhaps because of a low school-age population. The Tiebout-type sorting would add an extra negative effect to the pure causal effect of the proportion of elderly voters on local school expenditure per pupil.

Irrespective of whether the elderly benefit directly from improving the quality of local schools, the voting equilibrium is unlikely to be as straightforward as that suggested by the median voter theorem. Voters' preferences would not be single-peaked over the age horizon when there are other factors that characterize voters, such as income and wealth. In this case, the median voter theorem will no longer hold and changes in the relative size of the elderly population could affect the voting equilibrium, even though the median voter is not an elderly voter. For example, Levy (2005) shows that changes in the demographic structure may cause a political collusion between different groups, such as the rich and the young, on the provision of public education. Then, Gradstein and Kaganovich (2004) present a dynamic model in which aging intensifies both a positive and negative effect on school expenditure. Here, the elderly prefer to reduce education spending to a minimum level, as they are not likely to enjoy a future productivity increase from improved education. However, this may induce working adults or the parents of school-age children, who would like to secure their own benefits, to react and increase their demand for education. This, in turn, decreases the demand for other elderly-specific expenditure programs. If the latter effect is dominant, the increase in the proportion of the elderly can lead to increased investment in public education.

III. Previous Findings

The inconclusiveness of theoretical research on the effect of aging on educational funding has motivated a considerable number of empirical studies across the world. In the United States, several researchers investigated the issue using state, county, and school-district-level data. Similar research has also been conducted in Europe, with some papers reporting results from cross-country analyses, although no

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detailed explanation about the Korean public school finance system is in the following section. Go and Kim (2011) portray evidence for the capitalization of school characteristics into housing prices in Korea.

previous research has examined the case of Korea. However, much as in the case of theoretical research, there is little consensus in the findings of these empirical studies on the role played by elderly voters in terms of public school finance.

An exemplary work is Poterba (1997), which analyzed U.S. state-level panel data from 1960 to 1990 and found that educational spending per child decreased considerably when there were more elderly residents. However, other research that followed Poterba (1997) has not always found a similar result. For example, in their survey data analysis on local and state public school spending initiatives in California, Brunner and Balsdon (2004) found that older voters are indeed less willing to support school spending. However, the negative effect of older voters was weaker when the proposal was based on the local tax and spending scheme. The authors believe that this could be due to both capitalization and altruism, although neither of these two factors could be identified clearly in their research.

Another interesting result is that of Harris, Evans, and Schwab (2001). They first replicated the study of Poterba, and similarly found that the state-level analysis showed negative effects of population aging. Yet, when the district level variation was analyzed, the effect of the elderly population became very modest, although still negative. In the authors' view, this was because the elderly believe that the capitalization of school spending into housing values only happens at the local district level. On the other hand, Ladd and Murray (2001) analyzed county-level data and failed to identify either a positive or a negative effect of the elderly population on education spending per pupil. They suggested a source of endogeneity that possibly mitigates the negative effect of aging on school spending. The tax price of education could be heterogeneous, depending on the size of the population of school-age children. Thus, the elderly population might have an indirect effect on school spending if their distribution correlates with the distribution of children.

Recent research on the topic is more interested in investigating the influence of the elderly on school funding through property value capitalization or Tiebout-type sorting. Hilber and Mayer (2009) offered empirical evidence that the capitalization of school quality could explain why the elderly support greater education spending. According to their analysis of school-district-level data, the population share of the elderly is positively associated with school spending per pupil in districts where little land is available for the construction of new schools. Thus, there is a greater incentive to invest in existing schools to improve the quality. Figlio and Fletcher (2012) tried to control for the mobility of the elderly and Tiebout sorting. They constructed the predicted proportion of the elderly for 1970, 1980, and 1990 using 1960 census data, and used it as an instrument for the actual proportion of the elderly. Their instrumental variable regression results show that the share of elderly population in a school district is negatively associated with public school spending per child. Furthermore, the effect becomes greater in metropolitan areas where the

children of school age are predominantly non-white compared to the size of the elderly population.

At the same time, in recent literature exploring the relationship between income and preference for public education, the decisive voter is not easily identified, following the median voter theorem. Brunner and Ross (2010) investigated data from the California referenda on local education bond initiatives, and found a significant association between the income distribution of a school district and the share of favorable votes for school funding initiatives. However, the decisive voter's income level in this case was somewhat lower than the median.

The results of Brunner and Ross (2010) appear similar to those of Go and Lindert (2010), who investigated the mid-19th century northern United States. Their empirical results show that the rise in voting share was closely tied to the provision of public schools in the American rural frontiers, implying that the expansion of suffrage played a positive role in the early development of the American public schooling system. Similarly, Go (2009) also reported that the distribution of local property holdings was significant in determining local school funding, which was heavily dependent on property tax.

Researchers have also investigated the issue outside the United States, with varying results, although analyses of voters' preferences in a country tend to show that the proportion of the elderly has a clear negative effect on education spending. For example, Cattaneo and Wolter (2009) analyzed a survey of Swiss voters and found that the elderly prefer health and social security to education spending. Cross-country data analyses typically present a similar negative result, but some have indicated a positive association between population aging and school expenditure, especially in a dynamic setting. Sanz and Velázques (2007) analyzed panel data of OECD countries from 1972 to 1996 using the error correction model. They found that an increase in the relative size of the elderly population is only linked to a decrease in education spending in the short run. In the long run, the elderly effect disappears, possibly owing to the reaction of the young and working-age population who increase their demand for education. In another study using a cross-country panel analysis, Sørensen (2013) found that the share of the elderly population has a negative effect on education spending. Using panel data from 1985 and 2006, he ran fixed effect regressions on government spending from 22 countries, finding that the elderly tend to prefer healthcare and pension spending over education, but that the magnitude of the effect is moderate.

IV. District School Subsidy in Korea

An interesting dichotomy exists in the Korean primary and secondary school funding systems. The collection of school revenue is highly centralized, but the

expenditure system is localized. The principal reason for the dichotomy is the equalization of public school expenditure. While the majority of the initial funding for primary, secondary, and other post-secondary non-tertiary schools is provided by the central government, the remaining sizable portion is financed by local revenue. However, under the basic principle of equalization, the local school revenue collected by the mandatory contribution of regional governments is redistributed by the central government to the local school authorities based on enrollment.

A possible explanation as to why the Korean school finance structure is highly redistributive is the regional imbalance in the level of economic development. In Korea, business, industry, and the population are heavily concentrated in the Seoul and Gyunggi metropolitan areas. A few large cities, such as Busan, Inchon, and Ulsan, have some industry clusters, but most other regions are less developed and do not have a sufficient local tax base compared to the capital and its neighborhood. Therefore, the redistribution across regions has been indispensable in providing primary and secondary education of equal quality.

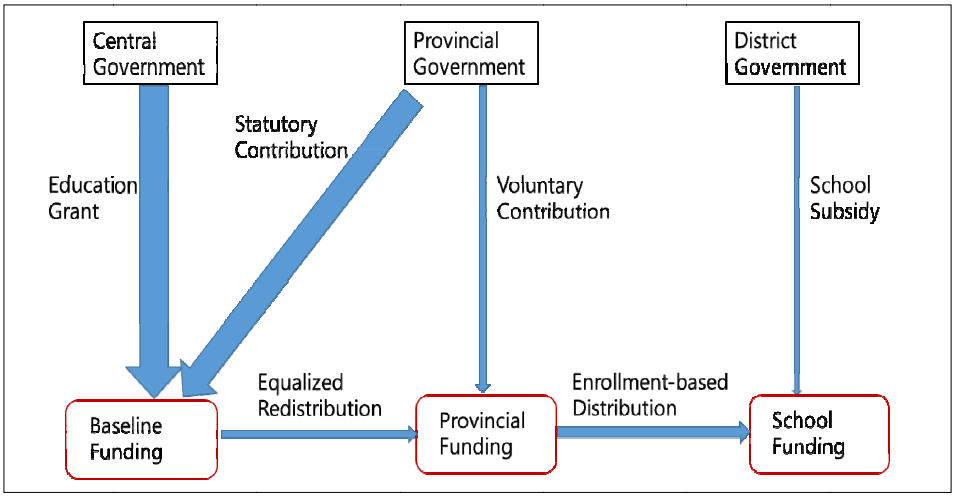
The redistributive funding system of Korean primary and secondary schools is actually composed of three different accounts: the central government account, the special account for education, and the elementary and secondary school account. Most of the central government account budget is spent on grants financing local education. In 2009, the total central government account budget was 38.7 trillion won (30.3 billion U.S. dollars, based on the annual average exchange rate[4]). Of this, 85.87%, or 32.7 trillion won (25.6 billion U.S. dollars), was spent on local education grants.

The major part of the Korean primary and secondary school finance is the special account for education, which is also known as the local school finance account. This account is managed by 16 metropolitan cities and provinces, representing the local autonomy of school administration and finance. The total budget of the special account for education was about 40 trillion won (31.6 billion U.S. dollars) in 2009. Of this, 76.5% was transferred from the central government, provincial governments contributed 18.5%, and the remaining 5% was financed by bonds, property income, and other sources.

More than half of the special account expenditure is for teachers' salaries and welfare expenses. Other school expenses are first transferred to 160 education district offices, then transferred again to each school, which constitute the elementary and secondary school accounts. In 2009, the total budget of the elementary and secondary school accounts was 8.3 trillion won (or 6.5 billion U.S. dollars). The financing structure of Korean public education is summarized in Figure 2.

[4] The annual exchange rate of the Korean won to the U.S. dollar in 2009 was 1,276 won to the dollar.

[Figure 2] Public primary and secondary school finance in Korea



School funding in Korea is equalized in the process of distributing the revenue from the central government to the local schools. The amount of school funding distributed to the regional special account, and later to the individual school accounts, is determined by a formula set by law. The formula considers the number of teachers, schools, and pupils, thus equalizing school funding per pupil across provinces, districts, and schools. In addition to the equalized distribution, the Korean law allows the central government to use at most 4% of the educational grant for special purposes. These mostly include projects on the contemporary national agenda set by the president, such as the war against shadow education, the education welfare project, and the school violence eradication project.[5]

The equalization policy has meant there has been little variation in per-pupil expenditure levels in Korean local public schools. However, local governments have recently been given the authority to provide a voluntary subsidy to their schools, which has driven increased inequality in public school funding.[6] Provincial and district governments can subsidize local schools in two ways. The local governments

[5] Thus, in general, the equalized school budget is independent of the local decision on a school subsidy. Moreover, because the annual apportionment of the educational budget precedes the local subsidy decision, the central government cannot strategically modify the amount of the school grant by considering local subsidies.

[6] In the early 2000s, there were 16 provincial governments in Korea, comprising 234 district governments. In 2014, these figures became 17 and 227, respectively, with the launch of the Sejong metropolitan autonomous city and the consolidation of some districts into a single large district-level city. The local education authority is basically organized at the provincial level, and each provincial education office has several district education offices that sometimes cover more than two district governments. However, the district education offices do not have any independent authority in school finance and administration, functioning only as a subsidiary branch of the provincial office.

may provide non-statutory transferred income to the special account for education, in addition to the legal mandatory contribution that is subject to equalization and redistribution. Alternatively, the district and provincial governments can provide a local school subsidy that directly subsidizes schools in the district.

In 2009, according to Kong and Lee (2010), the total amount of the non-statutory transferred income was 452 billion won (354 million U.S. dollars). Of this amount, 184.4 billion won was invested by the provincial governments, while the remaining 267.7 billion won came from the district governments. The total amount provided as local school subsidies was 937 billion won (734.7 million U.S. dollars). Again, district governments were the major providers, contributing 91%, or 853 billion won, while the provincial governments funded 84 billion won.

The history of local school subsidies in Korea dates back to the mid-1990s, with the reintroduction of local elections for mayors, governors, and representatives. However, local school subsidies were not popular in the 1990s, for at least two reasons. First, the local autonomy had not yet developed sufficiently to invigorate the local school funding project. Second, the central government did not want local governments to provide such voluntary subsidies, as the local revenue was highly dependent on the income transferred from the central government. Beginning with the case of the Yuseong district vs. the Korean government in 1995, several lawsuits on the provision of local school subsidies eventually brought about the legalization of these subsidies. The law first allowed the district school subsidy in 1996, requiring an endorsement by the provincial government. The endorsement requirement was repealed in 1999, and provincial governments were given the authority to provide provincial school subsidies in 2007.

Currently, Korean law allows provincial and district governments to provide local school subsidies in the following six categories: 1) school lunch equipment and facilities; 2) computers and other information technology education infrastructure; 3) the school curriculum; 4) local lifelong education; 5) the physical training or cultural event facilities shared by local residents; and 6) other school improvement projects. The first and second categories help schools replace old equipment. The third category, the subsidy for the regular curriculum, has predominantly been used to hire native English assistant language teachers and to manage extracurricular programs. The subsidy for local lifelong education has not been popular in Korea. The sixth category subsidizes various school expenditure programs, but the majority is related to scholarships, exemptions of school lunch fees for pupils from low-income families, and subsidizing purchases of organic or environmentally friendly produce for school meals.

Some legal restrictions apply to providing a local school subsidy. A local government cannot issue a bond for any local school subsidies. A local government cannot provide a subsidy for schools when the locality fails to contribute to any matching fund program provided by the central or provincial government. A locality

also cannot provide a local school subsidy when it cannot pay employees' salaries from its local tax and non-tax revenues.

[Table 1] District school subsidy per pupil

(Thousand Korean won)		2002	2003	2004	2005	2006	2007	2009
Total subsidy	Mean	18.67	27.80	37.69	51.39	104.44	228.38	171.01
	S.D.	(25.33)	(37.30)	(55.64)	(57.61)	(154.26)	(274.49)	(162.13)
	Obs	202	208	221	228	232	230	232
Subsidy 1	Mean	6.00	4.82	6.68	10.61	8.76		11.36
(School lunch)	S.D.	(8.81)	(6.41)	(10.39)	(21.41)	(15.04)		(22.98)
	Obs	64	72	82	90	117		140
Subsidy 2	Mean	2.55	4.21	5.14	4.37	6.22		5.95
(Computers)	S.D.	(3.04)	(5.53)	(8.92)	(5.52)	(9.61)		(7.24)
	Obs	49	68	69	83	97		113
Subsidy 3	Mean	0.62	1.06	1.49	1.45	7.96		40.05
(Curriculum)	S.D.	(0.66)	(3.06)	(2.48)	(2.36)	(17.88)		(54.46)
	Obs	54	44	81	79	111		218
Subsidy 4	Mean	1.68	1.11	1.09	2.48	2.49		3.10
(Lifelong education)	S.D.	(4.55)	(1.71)	(1.77)	(6.43)	(6.13)		(9.38)
	Obs	40	36	44	38	75		90
Subsidy 5	Mean	14.05	18.93	16.71	15.78	26.05		33.35
(Facilities)	S.D.	(26.31)	(30.05)	(24.31)	(28.22)	(41.18)		(41.75)
	Obs	87	123	117	138	163		163
Subsidy 6	Mean	9.84	13.60	25.14	36.26	76.14		101.18
(Others)	S.D.	(12.68)	(20.59)	(43.48)	(49.40)	(148.44)		(121.39)
	Obs	197	201	211	221	227		227

Note: The subsidies are converted into real values in 2005 Korean won using the consumer price index. The number of observations is the number of districts that provided a non-zero subsidy in each category for the year. The total number of districts is 234. Subsidy 1 is for school lunch equipment and facilities. Subsidy 2 is for computers and other information technology infrastructure. Subsidy 3 is for the school curriculum. Subsidy 4 is for local lifelong education. Subsidy 5 is for physical training or cultural facilities that can be also used by local residents. Subsidy 6 is for other school improvement projects. S.D. is the abbreviation of the standard deviation.

Table 1 shows the average school subsidies per pupil made by the 230 Korean district governments from 2002 to 2009.[7] As shown, 86% of the districts have provided school subsidies since 2002. The average subsidy per pupil in 2002 was only 18.67 thousand won,[8] but the scale and scope of the subsidies have increased

[7] No data is available for 2008, and category-level subsidy data are missing for 2007. The average subsidy in 2007 looks irregularly high, as the source for these data is different to the other years. The collection of data is explained in detail in the following section.

[8] All subsidy amounts are converted to real values in 2005 Korean won, based on the consumer price index.

dramatically since then. The average subsidy per pupil doubled in the subsequent two years, eventually reaching 171.01 thousand won in 2009, with an annual growth rate of 37.2%. The purpose of the subsidy has also diversified. In 2002, many districts used the school subsidy for school improvement projects, rather than subsidizing new facilities, equipment, or curriculum management. By 2009, 96% of the districts provided subsidies for the regular school curriculum, and 71.8% of the districts subsidized the construction of physical training or cultural event facilities to be shared by local residents.

Though the baseline public school funding is equalized in Korea, the availability of local school subsidies has created inequality in spending per pupil across districts in recent years. The variation in local school funding allows us to investigate what has been driving the unequal rise of local school subsidies. As the amount of a district school subsidy is determined by the mayor and district council members who are elected in the local election, a political economy approach that considers the characteristics of local voters is valid in analyzing the determinants of district school subsidies.

The growth of district school subsidies has been accompanied by a rise in the proportion of the elderly population (see Table 2). In 2002, only 6.5% of the Korean districts had a proportion of elderly greater than 30%, but this increased to 18.5% of the districts in 2009. Over the same period, the percentage of districts in which the elderly comprised less than 10% of the population decreased from 24.1% to 6.9%.

[Table 2] Percentage of the districts by elderly (65+) population share

	The elderly (65+) population share			
Year	<10%	10~20%	20~30%	>30%
2002	24.1	41.8	27.6	6.5
2003	20.7	44.4	26.3	8.6
2004	18.8	42.3	27.8	11.1
2005	16.7	44.0	26.1	13.2
2006	14.2	47.4	24.6	13.8
2007	9.6	49.6	26.5	14.3
2009	6.9	49.1	25.4	18.5

V. Data and Specification

To analyze the effect of the changing demographic structure on public school finance, a district-level panel data set for seven years between 2002 and 2009 is constructed.[9] The time horizon of the data, seven years, is relatively short compared

[9] The panel does not include data for 2008, as school subsidy data for the year is not available.

to U.S. studies, which typically use data that cover several decades. However, both the rapid change in the age structure of the local population and the considerable expansion of local school subsidies have led to significant variations in the key variables in recent years, which allows us to study the role played by population aging in local public school finance.

The data include variables on the school subsidies, local government revenue, and demographic structure of the Korean local districts.[10] The total and categorical district school subsidy data for 2002–2006 and 2009 are collected from the web-based report by the Ministry of Education, Science, and Technology.[11] No publicly available reports contain categorical district subsidy data for 2007. However, the subsidy per pupil is available from the special report by Choon Jin Kim, a member of the National Assembly of Korea.[12] The number of schools and pupils at the district level is calculated using data from the Korean Educational Statistics Service. The resident registration population statistics provide the age-group population data. The revenue data of the district governments were collected from the local finance data provided by the Ministry of Government Administration and Home Affairs.

The summary statistics of the key variables used in the regression analysis are shown in Table 3. As shown, the average subsidy per pupil for each year is lower than shown in Table 1. This is because the subsidy of a district providing no subsidy was treated as zero when calculating the summary statistics reported in Table 3, while zero subsidies were excluded in the calculations for Table 1. The average population growth rates were negative before 2006, despite the positive population growth for the country, as they were simple unweighted averages of the district level population growth rates. The population growth rates in Korea ranged between 0.21 and 0.56 % for the period 2002–2009. The average proportion of the elderly (i.e., those aged 65 or older) was 16.65% in 2002, which grew to 20.40% by 2009. This is in line with the population aging shown in Figure 1 and Table 2. During the same period, the average proportion of children older than 5 and younger than 19 decreased slightly from 16.73% in 2002 to 15.22% in 2009. The average total district revenue per capita was a little lower than three million won in 2002, but became

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[10] The data set is an unbalanced panel of 228-230 school districts in each year. The total number of districts is 234.

[11] Since the 2013 reorganization of the Korean government, the Ministry of Education has been in charge of education in Korea. The Ministry of Education does not currently provide the district-level school subsidy data on the web.

[12] The average school subsidy per pupil in 2007 is a bit higher compared to the averages in 2006 and 2009, which is suspected to be caused by inconsistencies in the calculation of the number of pupils in each district. However, there is no way to check this. If the averages in 2007 become higher in a consistent way across the districts, no bias will be caused when year fixed effects are controlled for. In general, the regression results shown in the next section are robust, regardless of the inclusion of the 2007 data.

greater than four million won in 2009.[13] The fiscal independence index is the percentage of the district revenue that can be spent for discretionary expenditure, thus representing the district's own fiscal ability. The average fiscal independence indices of the Korean districts ranged from 69% to 78%.

[Table 3] Summary statistics

	2002	2003	2004	2005	2006	2007	2009
Subsidy per pupil	16.25	24.92	35.60	50.08	103.50	228.40	171.01
(thousand won)	(24.45)	(36.31)	(54.75)	(57.44)	(153.9)	(274.5)	(162.13)
Pop growth (%)	-0.777	-0.425	-0.534	-0.283	0.335	0.210	0.265
	(3.559)	(2.968)	(2.856)	(2.541)	(6.623)	(2.709)	(2.240)
65+ Elderly (%)	16.65	17.20	17.71	18.13	18.58	19.21	20.40
	(7.58)	(7.76)	(7.98)	(8.10)	(8.20)	(8.31)	(8.56)
6–18 Children (%)	16.73	16.61	16.46	16.29	16.21	15.97	15.22
	(2.57)	(2.67)	(2.82)	(2.91)	(2.99)	(2.97)	(2.91)
Tot rev per capita	2.952	3.426	3.315	3.333	3.597	3.763	4.320
(million won)	(2.548)	(3.169)	(2.710)	(2.708)	(3.226)	(3.212)	(3.455)
Fiscal independence	71.05	74.23	77.52	77.94	75.53	75.88	69.50
(%)	(11.87)	(9.333)	(7.782)	(7.253)	(9.576)	(8.119)	(9.767)
Companies per 1,000		70.77	70.81	68.46	70.07	72.04	
people		(39.99)	(40.20)	(40.20)	(38.61)	(38.33)	
Employees per capita		0.306	0.307	0.311	0.319	0.327	
		(0.222)	(0.219)	(0.226)	(0.232)	(0.235)	
Nurseries per 1,000		8.12	9.49	10.95	11.90	12.50	
children aged 0–4		(1.94)	(2.15)	(2.43)	(2.69)	(3.10)	
Car accidents per		16.87	14.70	13.43	12.80	12.05	
1,000 automobiles		(5.50)	(4.45)	(3.94)	(3.74)	(3.68)	

Note: Standard deviations are in parentheses. Subsidy and revenue are converted into real values in 2005 Korean won.

Table 3 also reports the averages and standard deviations of companies per 1,000 people, employees per capita, nurseries per 1,000 children aged 0–4, and car accidents per 1,000 automobiles. These four variables are used as placebo variables in the falsification tests. However, note that data for the four placebo variables are only available for five years from 2003 to 2007. Each placebo variable has its own yearly trend, representing various socioeconomic backgrounds, while not directly related to the demographic transition. Specifically, employees per capita and nurseries per 1,000 children aged 0–4 show a tendency to increase over time, while car accidents per 1,000 automobiles decreased during the period. In 2003, on average, about 30.6% of the residents were employed in the Korean districts, there were 8.12 nurseries per 1,000 children aged 0–4, and there were 16.87 car accidents

[13] The revenue figures are converted into real values in 2005 Korean won, based on the consumer price index.

per 1,000 automobiles. By 2007, these averages changed to 32.7% of residents, 12.5 nurseries, and 12.05 accidents, respectively. In the falsification tests, these variables are used to check if any change in the subsidy per pupil is driven by a spurious trend over time.

The unbalanced panel data of 234 Korean districts for seven years were first analyzed using the fixed effect model, following the specification of Poterba (1997). The baseline panel fixed effect estimating equation is as follows.

$$y_{it} = \alpha + \beta Elderly_{it} + X_{it}\gamma + \mu_i + \tau_t + \varepsilon_{it} \quad (1)$$

The dependent variable y_{it} is the real subsidy per pupil in district i and year t. Then, $Elderly_{it}$ denotes the proportion of the elderly population; X_{it} is a set of district-level time-varying covariates, including the population growth rate, the proportion of school-age children between the ages of 6 and 18, total revenue per capita, and the fiscal independence index; μ_i and τ_t are district and year fixed effects, respectively, that absorb all unobservable time-invariant or year-specific factors that might affect the amount of the subsidy per pupil.

One concern in using the per-pupil school subsidy as a dependent variable is that, in a few districts, no subsidy was provided in the early years. In 2002, as reported in Table 1, 32 districts did not provide a school subsidy. Since the number of districts with zero as the dependent variable is small, and ultimately disappear after 2005, censoring the dependent variable at zero does not cause a serious problem. However, the number of censored dependent variables significantly increases when the subsidy per pupil in each category is used as a dependent variable. Thus, the possible bias in the estimation needs to be checked using the Tobit regression results.[14]

Another issue in identifying the causal effect of population aging on the size of local school subsidies is the endogeneity problem caused by the mobility of the elderly. To deal with this problem, the proportion of the elderly is predicted assuming no migration, and is used as an instrument for the actual proportion, following Figlio and Fletcher (2012). The proportion of the elderly, without migration, for each district and year from 2002 to 2009 are predicted by applying the age-group level annual national population growth rates to the age-group level district population in 2001.

[14] The Tobit estimation requires using the panel random effect specification, as the estimator is biased and inconsistent in the fixed effect model. Therefore, in the next section, the Tobit results are compared and discussed with the random effect regression results and ordinary least squares results using the pooled data set.

VI. Results

The baseline result of the panel fixed effect model is presented in column (1) of Table 4. The proportion of the elderly population shows a clear positive effect on district school subsidy per pupil. Here, one percentage point increase in the proportion of the elderly leads to an increase in the subsidy of about 28 thousand won, which is 31.6% of the average school subsidy between 2002 and 2009. The fixed-effect estimator is greater than the coefficient estimate of the OLS regression using pooled data in column (2) and that of the panel random effect model in column (4), and shows that one percentage point increase in the proportion of the elderly is associated with a moderate increase of about six thousand won in the subsidy. If the time-invariant district-level unobservables are associated with the subsidy and the proportion of the elderly in the opposite direction, the estimation without the fixed effect may underestimate the causal effect of the proportion of the elderly on the subsidy per pupil.

[Table 4] The effect of aging on district school subsidies

Dependent variable = Real subsidy per pupil	(1) Panel FE	(2) Pooled OLS	(3) Pooled Tobit	(4) Panel RE	(5) Panel RE Tobit
Elderly (age 65+)	28.077**	6.946**	6.436**	6.668**	7.083**
	[5.525]	[1.305]	[1.279]	[0.995]	[1.002]
Children (age 6–18)	-6.629	2.583	3.609+	2.623	6.233**
	[9.172]	[2.131]	[2.117]	[2.246]	[2.290]
Pop growth (%)	9.116*	8.023**	5.864**	9.009**	6.822**
	[3.250]	[1.941]	[1.963]	[1.261]	[1.278]
Tot rev per capita	18.369*	15.318**	13.917**	14.743**	14.216**
	[7.195]	[2.732]	[2.642]	[1.717]	[1.725]
Fiscal independence	3.991**	3.402**	3.352**	3.040**	3.257**
	[0.960]	[0.460]	[0.449]	[0.380]	[0.380]
Constant	-665.519*	-369.540**	-444.941**	-336.852**	-488.534**
	[266.164]	[61.016]	[59.529]	[59.260]	[60.554]
R-squared	0.393	0.447			

Note: ** $p < 0.01$, * $p < 0.05$, + $p < 0.1$; robust standard errors in brackets; the number of observations is 1,622 from 234 districts. The number of left-censored observations with a zero subsidy is 75. All models include year dummies. The OLS and Tobit models using the pooled sample also control for region dummies.

The positive effect of the proportion of the elderly is not singular in the literature. As reviewed in the previous section, empirical studies typically find a negative association between population aging and school expenditure per pupil at the state or country level. However, with the exception of the recent research by Figlio and Fletcher (2012), which considers the mobility issue, a positive effect is frequently

found at the district level. This positive effect is rationalized by the capitalization theory that local school subsidies are capitalized into housing values by improving the quality of local schools. Hence, elderly voters who own property tend to support district school subsidies, as they benefit from higher property values.

The population growth rate, total revenue per capita, and the fiscal independence index show significant positive effects on the subsidy per pupil. Overall, these results are consistent with theoretical expectations. Local population growth is typically related to residential development projects, which cause a sizable influx of households with school-age children. Thus, the high population growth rate is likely to increase the political influence of parents of public school pupils. The positive effects of total revenue per capita and the fiscal independence index imply an income effect, as they guarantee the district greater funding for discretionary expenditure.

Though all districts have been providing school subsidies since 2008, some did not prior to 2008. For example, in 2002, 32 districts did not offer any school subsidies, and in 2003, 24 districts did not offer subsidies. Despite the small number of districts not providing school subsidies, there is a concern about possible bias caused by censoring the dependent variable at zero. To address this issue, Tobit regression results are also presented in Table 4. The Tobit model is applied to the ordinary least square and panel random effect estimations because the Tobit estimation cannot be used with fixed effects owing to the possible inconsistency and bias, as discussed in Greene (2004). Columns (2) and (4) of Table 4 show the ordinary least squares and panel random effect estimators and columns (3) and (5) show the Tobit results for the same specifications. The estimators appear mostly unaffected by the censoring, as the Tobit results are very similar to the ordinary least squares and random effect results.

To examine the positive effect of the proportion of the elderly on the subsidy per pupil more thoroughly, the subsidy per pupil in each category is also used as a dependent variable. Since most districts provide school subsidies only in a few categories, the concern about censoring the dependent variable at zero could be greater when category-level subsidies are used. Considering this problem, only the results from the random effect Tobit regressions are presented in Table 5. At first glance, the regression of the subsidy in each category seems to offer a mixed result. The proportion of the elderly continues to show a positive effect on the subsidy for the regular curriculum in column (3) and the subsidy for other school improvement projects in column (6). However, an increase in the proportion of the elderly is negatively associated with the subsidy for school lunch equipment in column (1) and for computers in column (2). The effect on the subsidy for local lifelong education in column (4) was minimal and statistically insignificant. The proportion of the elderly shows a positive effect on the subsidy for physical training and on cultural event facilities in column (5), while the statistical precision of the estimated

coefficient is not sufficiently high.

[Table 5] Panel random effect Tobit regressions by subsidy category

	(1) Subsidy 1	(2) Subsidy 2	(3) Subsidy 3	(4) Subsidy 4	(5) Subsidy 5	(6) Subsidy 6
Elderly (65+)	-1.180**	-0.749**	0.978**	0.050	0.537	3.635**
	[0.266]	[0.125]	[0.358]	[0.095]	[0.391]	[0.703]
Children (6–18)	-0.336	-0.888**	2.465**	0.306	2.633**	3.397*
	[0.572]	[0.255]	[0.824]	[0.213]	[0.902]	[1.594]
Pop growth (%)	0.965**	0.371**	1.479**	-0.026	2.415**	0.990
	[0.287]	[0.134]	[0.477]	[0.120]	[0.485]	[0.904]
Total revenue per capita	0.910*	0.399+	2.448**	0.023	2.921**	7.531**
	[0.437]	[0.213]	[0.608]	[0.168]	[0.668]	[1.237]
Fiscal independence	0.358**	0.195**	0.681**	0.007	0.182	1.789**
	[0.085]	[0.046]	[0.139]	[0.034]	[0.143]	[0.261]
Constant	-21.878	1.982	-146.823**	-14.769**	-93.510**	-268.054**
	[14.634]	[7.050]	[21.893]	[5.589]	[23.452]	[42.044]
Left-censored	832	918	808	1071	607	114
rho	0.318	0.291	0.0920	0.172	0.154	0.0954

Note: ** $p < 0.01$, * $p < 0.05$, + $p < 0.1$; robust standard errors in brackets; the number of observations is 1,392 from 234 districts. All models include year dummies. Subsidy 1 is for school lunch equipment and facility. Subsidy 2 is for computers and other information technology infrastructure. Subsidy 3 is for the school curriculum. Subsidy 4 is for local lifelong education. Subsidy 5 is for physical training or cultural facilities that can be also used by local residents. Subsidy 6 is for other school improvement projects. The dependent variables are subsidies per pupil in each category, which takes a real value in 2005 Korean thousand won.

The swing of the sign of the coefficients is likely caused by the nature of the subsidy in each category. The subsidies for the school kitchen and computer facilities typically help the school to replace old equipment, which would only marginally affect the quality of the school's education. However, the subsidy for the school curriculum, used to hire native English language teachers or to run extracurricular programs, is directly linked to the quality of instruction. The subsidy for other school improvement projects is also mostly related to assistance programs demanded by parents, including the purchase of environmentally friendly produce for school meals or making school lunches free for everyone. Thus, subsidies in the latter categories are more closely associated with demand by the parents of pupils. Therefore, they are more likely to attract families with school-age children into the district, which will consequently raise local property values. In sum, the category-level regression results are still consistent with the prediction of the capitalization theory.

A remaining concern is bias that could be caused by the migration of the elderly.

If elderly voters choose to live in a district where residents are more interested in spending public revenue on elderly friendly programs, such as healthcare and pensions, this will be less favorable towards school subsidies. In this case, a high proportion of elderly would cause a low subsidy per pupil. To address the inverse causality issue envisaged by the Tiebout-type sorting, the instrumental variable method is used for the robustness check. The instrument for the possibly endogenous proportion of the elderly is the predicted proportion of the elderly, assuming no mobility, following Figlio and Fletcher (2012). The instrument is calculated by applying the age-specific national population growth rates to the size of the population in each age group in 2001. The population mobility across districts is least related to the national population growth rate of each age group. Thus, the predicted proportion of the elderly is a good candidate for a valid instrument. The first-stage regression result shows that the predicted proportion of the elderly strongly explains the real proportion.[15]

The regression results using the instrumental variable method are reported in Table 6. The fixed effect estimation using the instrumental variable in column (1) still shows that the proportion of the elderly has a positive effect on the subsidy per pupil, while the magnitude of the effect is considerably greater than the fixed effect estimation result in column (1) of Table 4. Finding an intensified effect of the proportion of the elderly is reasonable because the Tiebout-type sorting suggests a negative association between the proportion of the elderly and subsidy per pupil. The instrumental variable method is also applied to the random effect model and the Tobit model using the pooled sample. The results are presented in columns (2) and (3). The estimators using the instrumental variable are slightly greater than the estimates in Table 4, which use the same specification without the instrumental variable. This reconfirms the expectation that the positive effect of the proportion of the elderly may be underestimated when the endogeneity issue caused by the Tiebout-type sorting is not addressed well.

[Table 6] Instrumental variable regressions

	(1) Panel IV FE	(2) Panel IV RE	(3) Pooled IV Tobit
Elderly (65+)	252.583**	6.848**	7.407**
	[29.636]	[0.858]	[1.254]
Children (6–18)	174.220**	5.854**	5.290*
	[25.597]	[1.866]	[2.662]

[15] The instrument also passes the weak instrument test and the underidentification test. The Cragg-Donald Wald F-statistic for the weak instrument test is 123.396. The Anderson canonical correlation LM statistic for the underidentification test is 114.152, of which the Chi-squared p-value is very close to zero when the degree of freedom is one.

Pop growth(%)	18.849**	6.188**	6.093**
	[2.526]	[1.197]	[1.231]
Total revenue per capita	0.965	13.314**	13.435**
	[5.092]	[1.474]	[1.680]
Fiscal independence	1.976**	2.999**	3.408**
	[0.761]	[0.344]	[0.405]
Constant	-7,229.157**	-443.256**	-486.317**
	[869.488]	[52.023]	[66.315]
(First stage regression: Dependent variable = % Elderly)			
Sim. % Elderly	0.507**	0.928**	0.930**
	[0.005]	[0.007]	[0.009]
R-squared	0.872	0.386	0.987

Note: ** $p < 0.01$, * $p < 0.05$, + $p < 0.1$; robust standard errors in brackets; the number of observations is 1,622 from 234 districts. The number of left-censored observations with a zero subsidy is 75. The first-stage regression includes the covariates in the second-stage equation and uses the same specification as in the second stage. The second-stage models include year dummies. The IV Tobit model using the pooled sample also controls for region dummies.

A further concern is that the positive effect of population aging on local school subsidies might be spurious, as both the proportion of the elderly and the subsidy have increased over time. However, according to the results of the robustness and falsification tests reported in Table 7, the findings in this study are hardly spurious. The first panel of Table 7 reports that the positive effect of the proportion of the elderly on local school subsidies survives with a similar magnitude when using the difference in the subsidy between consecutive years as a dependent variable in the same panel fixed effect regression specified in the previous tables.[16] Again, replacing the level of the proportion of the elderly with the difference between consecutive years does not change the result. The falsification test results in the second panel of Table 7 also rule out the possibility of a spurious relationship between population aging and local school subsidies. In the falsification tests, the proportion of the elderly in the panel fixed effect regression is substituted by four placebo variables. The placebo variables have their own yearly trends, but are not directly related to the demographic transition. These variables are companies per 1,000 people, employees per capita, nurseries per 1,000 children aged 0–4, and car accidents per 1,000 automobiles. Their descriptive statistics for each year are presented in Table 3. Since the placebo variables are only available for 2003–2007, the baseline regression result using the proportion of the elderly is also reported in the first column of Table 7. The result is straightforward. The positive effect of the proportion of the elderly on local school subsidies continues to stand out. However, none of the four placebo variables show a statistically significant effect on local school subsidies in

[16] The 2009 data were excluded in the robustness check using the two-consecutive-year difference forms, as the 2008 data are not available.

the same panel fixed effect model. This is because the positive effect of aging on school subsidies is not spurious, and is not caused by a simple time trend.

[Table 7] Robustness and falsification tests

I. Robustness tests (y = one-year difference in real local school subsidy per pupil)		
x =	Elderly (65+)	One-year difference in Elderly (65+)
Estimated effect	30.275**	23.860*
(Panel FE)	[10.858]	[11.143]

II. Falsification tests (y = real local school subsidy per pupil)					
x =	Elderly (65+)	Companies per 1,000 people	Employees per capita	Nurseries per 1,000 children aged 0–4	Car accidents per 1,000 automobiles
Estimated effect	57.338**	1.186	15.310	-2.504	-3.136
(Panel FE)	[11.184]	[1.557]	[120.557]	[4.026]	[2.452]

Note: ** $p < 0.01$, * $p < 0.05$, $^{+}$ $p < 0.1$; robust standard errors in brackets; all models include children (6–18), population growth (%), total revenue per capita, fiscal independence, and year dummies as the control variables, and are estimated by the panel fixed effect regressions. The robustness test used 1,160 observations from the 2002–2007 data, and the falsification tests used 1,148 observations from the 2003–2007 data.

VII. Conclusions

Intergenerational conflict in public resource allocation has been widely assumed and applied in economics research. There is also growing concern over the negative effect that population aging might have on spending for public education. Empirical results from previous studies are mixed. Typically, analyses of state- or country-level data confirm the negative effect, while studies using local-level data sometimes indicate the possibility of a positive effect. Using district-level panel data for seven years, this study conducted a first-ever examination of the effect of the proportion of the elderly on public school subsidies in Korea. Though central government funding for public elementary and secondary education is equalized in Korea, the recent expansion in local school subsidies in Korea offers us the chance to test the effect of the aforementioned demographic shift on public expenditure.

The results show that the proportion of the elderly has a considerable positive effect on the school subsidy per pupil in Korea. In addition, this effect was clearer and greater when the estimation controlled for the district-specific time invariant factors using the district fixed effects. The positive effect is backed by the capitalization theory, which states that elderly voters try to increase the value of their property by voting to improve the quality of local public schools. When the

subsidy is broken into the specific categories, the positive association between the proportion of the elderly and the subsidy linked directly to improving school quality and meeting the demands of parents of pupils is more clearly distinguished. The Tobit specification considering the censored dependent variable reconfirms the robustness of the positive coefficient estimates. When the bias possibly caused by the Tiebout-type sorting is addressed using the instrumental variable method, the magnitude of the positive elderly effect turns out to be even greater.

The findings in this study reflect how the political economy theory helps to explain the local school subsidy gaps among districts. However, the political economy equilibrium of the positive association between aging and district school subsidies may be a more complicated outcome than that proposed by the median voter theorem. While the elderly show a high turnout rate in elections, they would not be the population majority in the district. Thus, the decisive median voter of the district is not an elderly voter. In this case, the positive effect of the proportion of the elderly on school expenditure would be an outcome of a more complex voting equilibrium, such as collusion between non-elderly voting groups or a reaction by non-elderly voters to the increasing political influence of the elderly. Consequently, the increase in school subsidies could have been caused by the increase in the proportion of the elderly, and not by the elderly themselves.

The findings in this study invite further investigation of the following issues. First, the relationship between the demographic structure and local school subsidy should be analyzed in the long run, as the demographic transition will be clearer over a longer time horizon. The results from a long-run analysis would also enable a direct comparison with the results of previous studies. Second, follow-up research using nationwide data is required. The key welfare programs for the elderly, such as the national pension and medical insurance, are currently the duties of the central government. The role of local government in Korea in age-specific welfare spending is relatively limited. Hence, an analysis of intergenerational conflict at the national level may return different findings to those presented here, which are based on local data.

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