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Private elementary schooling and achievement gains in South Korea*

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Abstract

Using longitudinal data for fifth graders from the Korean Education Longitudinal Study of 2013, we examined sector differences in student background characteristics. We also examined the effect of attending private elementary schools on achievement gains. To estimate the private elementary school effect more rigorously, we used propensity score matching approaches to address selection bias. We found that while private elementary schools largely served students from socioeconomically advantaged families, attending private elementary schools had a positive effect on English and mathematics achievement gains. We discussed implications of these findings for the potential role of private elementary schools in contributing to educational inequality in South Korea.

Keywords: private elementary schools, school effects, longitudinal research, educational inequality, propensity score matching, South Korea

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Introduction

In recent years, growing educational inequality has been a serious social issue in South Korea (hereafter, Korea) (Byun & Kim, 2010; Byun & Lee, 2021). In particular, increasing socioeconomic disparities in elite school enrollment in line with different levels of education have been suggested as one of the mechanisms through which educational inequality is intensified (Byun & Lee, 2021). Specifically, attending private elementary schools—international middle schools[1)]—special purpose or/and autonomous private high schools (hereafter "special" high schools[2)])—so called 'SKY'[3)] universities is now considered to be a key pathway to becoming an elite in Korea (Choi, 2016). Indeed, much research documents that special high schools serve largely children from upper-middle class families (Byun, Hwang, & Kim, 2012; Byun & Joo, 2012; Kim & Ryu, 2008; Park & Min, 2009) and attending these special high schools has a positive effect on academic achievement such as the College Scholastic Aptitude Test—a Korean version of the SAT in the US—and elite college enrollment (Byun, Hwang, & Kim, 2012). Recent literature also suggests that parents with higher socioeconomic status (SES) more desire to send their children to an international middle school than lower SES parents (Byun & Chung, 2016). By contrast, we know little about the role of private elementary schools in educational inequality in the Korean context largely because of a lack of nationally representative data on private elementary schools and students.

In this study, we address this research gap by using longitudinal data for a nationally representative sample of fifth graders from the Korean Education Longitudinal Study of 2013 (KELS:2013). To our best knowledge, this is the first study that uses longitudinal data to investigate the private elementary school effect in the Korean context. The longitudinal nature of KELS:2013 allows us to estimate the so-called value-added models that can capture the extent to which private elementary schools contribute to the achievement gains between fifth and sixth grade. In addition, we build on the counterfactual framework (Rosenbaum & Rubin, 1983) and employ a propensity score matching (PSM) method to address selection bias in estimating the private elementary school effect. The PSM approach has been suggested to be more effective than a conventional regression approach to address selection bias by mimicking the assignment process of a randomized experiment (Morgan & Winship, 2007; Rosenbaum & Rubin, 1983; Schneider et al., 2007). Finally, using the Rosenbaum bounds method (Rosenbaum, 2002), we additionally test to what extent our results for the effect of attending private elementary schools are robust against unobserved characteristics. In short, using longitudinal data and PSM, this study more rigorously assesses the effect of attending private elementary schools on academic achievement in Korea. As will be described later, since sending children to private elementary schools is costly, it is highly related to the financial means of parents. Therefore, if attending private elementary schools is found to make a difference in academic achievement, it suggests that private elementary schooling may contribute to educational inequality. In this regard, our study will provide important insights into the role of private elementary schooling in educational stratification in Korean society.

Background

Private schools in Korea

One unique feature of Korea's educational system is the heavy reliance on private schools at the secondary and tertiary level. Approximately 20% and 40% of Korean middle schools and high schools, respectively, are private, and approximately 94% of two-year colleges and 79% of four-year colleges and universities are private (Korean Educational Development Institute [KEDI], 2020). Most private schools in Korea, however, are much controlled by the government in terms of curriculum and student selection. At the middle school level, for example, most private schools have to follow a nationally standardized curriculum and they are, to a large extent, subsidized by the government (Byun & Kim, 2011; Byun, Schofer, & Kim, 2012). In addition, these private middle schools are not permitted to select their own students; rather, students are randomly assigned to schools on the basis of their place of residence, regardless of the school sector (Byun, Kim, & Park, 2012), as is also the case for most private general high schools. As a result, differences between private and public schools in socioeconomic and academic composition of the school are relatively small at the secondary level in Korea (Byun, Schofer, & Kim, 2012). Likewise, Korean private colleges and universities are to a large extent controlled by the state, especially in terms of student quotas, tuition, and student selection methods.

In contrast to the number of private schools at the secondary and tertiary levels, there are only 74 private elementary schools in Korea, representing 1.2% of the total elementary schools (i.e., 6,120) (KEDI, 2020). These private elementary schools are concentrated mostly in large cities. Specifically, while 59 out of 74 (80%) private elementary schools are located in major cities across the country, 39 (53%) are in Seoul, the capital and the largest city of Korea (KEDI, 2020). In addition, unlike most secondary private schools, private elementary schools charge tuition. According to the Ministry of Education,[4] the average private elementary school tuition was approximately US$7,800 in 2020 ranging from about US$400 to more than US$13,000. Yet, this does not include other expenses such as fees for the school bus, meal, textbook, school uniforms, and extracurricular activities. Because of the high cost of private elementary school education, private elementary school students are far more likely to come from socioeconomically advantaged families, compared to public elementary school students (Byun et al., 2017).

The admission process for private elementary schools also differs from that for private middle schools (Byun et al., 2017). Specifically, parents and their children are allowed to select and apply to a private elementary school in which they are interested. They are not allowed to apply to multiple private elementary schools, however. Each private elementary school randomly selects students from a pool of qualified applicants based on a lottery at which both child and parent must be present. All private elementary schools hold their lottery on the same day in order to prevent applicants from being admitted to more than one school. Such a lottery system ensures that everyone at least in the applicant pool has an equal chance of being accepted to a private elementary school. However, it has been reported that some private elementary schools grant special favors to selected parents and children during the admission

process. For example, one of the private elementary schools in Seoul unfairly accepted a child whose grandfather was the founder of that school (Lee & Chung, 2017). For public elementary schools, on the other hand, students are randomly assigned to their neighborhood schools within their school districts.

Finally, unlike most private secondary schools, private elementary schools have more autonomy than public elementary schools in coordinating their educational programs (Byun et al., 2017). For instance, private elementary schools incorporate extracurricular activities to regular school subjects and make art, music, and physical education mandatory subjects. The difference in curriculum between private and public elementary schools is the most distinct in English education. Many private elementary schools offer English immersion education from the first year at school in forms of after-school classes or even as part of their regular curriculum (Choi, 2019). By contrast, public schools are prohibited by law from teaching English until the third grade. As such, when it comes to English education, private elementary schools offer more flexible and customized curricula to better address the diverse and timely needs of parents and their children, compared to public elementary schools. By contrast, less is known about how other subjects, such as Korean and mathematics, are taught in private elementary schools.

Literature on private schools in Korea

While most Korean literature on private schools focuses on the secondary level, it offers mixed evidence on the private school effect on academic achievement. For example, using cross-sectional data for eleventh graders, Kim et al. (2007) found that students attending private *high* schools outperformed their counterparts attending public high schools on mathematics and English test scores, even after controlling for other variables. Using longitudinal data for seventh graders from KELS:2005, Kim and Lee (2013) examined the effect of attending private *middle* schools on academic achievement and found significant and positive effects. However, using data for twelfth graders from the Korean Education and Employment Panel (KEEP) of 2004, Byun and Kim (2011) found no significant sector differences in academic achievement, controlling for other variables. As such, evidence is inconclusive about the effect of attending private secondary schools on academic achievement in Korea.

Very limited research has empirically examined the effect of attending private elementary schools on academic achievement. Using longitudinal data for seventh graders from the Seoul Education Longitudinal Study of 2010 (SELS:2010), Byun et al. (2017) examined differences in academic achievement between private and public elementary school graduates during the middle school years and found no significant differences. However, their study is limited in that the data they used were drawn only from middle school students in Seoul. In addition, they focused on academic achievement during the middle school years rather than during the elementary school years.

Kim (2010) used cross-sectional data from the National Assessment of Educational Achievement to examine the determinants of academic achievement among elementary school students and found significant differences in English achievement by school sector. Her study, however, is also limited because SES, which is one of the most

important determinants of children's private elementary school enrollment and academic achievement (Byun et al., 2017), was not included in her statistical analyses. As a result, it is unclear whether the observed sector differences in English achievement are truly attributable to the private elementary school effect or whether they simply reflect preexisting differences (e.g., SES) between these two groups. In this study, we address these limitations of prior literature on private elementary schools by using nationally representative longitudinal data as well as PSM, both of which allow us to better estimate the private elementary school effect.

Data and methods

Data and sample

We used data from KELS:2013, conducted by KEDI, a government-funded educational research agency. KELS:2013 is an ongoing longitudinal study of a nationally representative sample of more than 7,000 fifth graders in Korea. KELS:2013 employed a two-stage stratified sampling design in which elementary schools were randomly sampled within each of four types of regions (i.e., Seoul, metropolitan cities, mid-size cities, and rural areas) proportionally to the student population size, and then students were randomly sampled within the selected schools.

It is important to note that KELS:2013 purposely *oversampled* private elementary schools to study better the educational outcomes among students attending this type of school. Specifically, a total of 7,324 fifth graders in 232 public and ten private elementary schools across the nation were sampled in 2013, and 99.5% (i.e., 7,287) of them participated in the base-year survey. In the first follow-up survey, 7,200 (98%) of the original 7,324 students participated. In addition to the students, separate surveys were administered for the first two years (i.e., 2013, 2014) to students' families, teachers, and school principals to collect a wide range of family, class, and school information. For this study, we included all individual fifth graders who participated in the base-year survey (N = 7,287). In this analytic sample, 364 students (5%) attended private elementary schools.

Measures

Private elementary school attendance

The key independent variable of interest was whether a student attended a private elementary school. This variable was derived from the base year school data.

Academic achievement

Academic achievement was measured by *gains* in Korean, English, and mathematics achievement between fifth and sixth grades. KEDI administered academic tests on these subject areas in both the base-year and first follow-up surveys in addition to the parent, student, and school surveys. KEDI provided test scores scaled by the item response theory model, which allowed us to examine achievement gains between fifth and sixth grades.

Covariates

Based on prior research, we controlled for a number of variables that might confound the private elementary school effect on academic achievement. For family characteristics, we included (a) parental education, (b) family income, (c) family structure, (d) number of siblings, (e) parental expectations for children's education, (f) parents' plan to send their child to special high schools, and (g) parental academic support. Parental education was measured by a categorical variable indicating parents' highest level of education (i.e., high school diploma or less, a two-year college degree, four-year college degree, or an advanced degree). We chose the higher of the father's and the mother's educational attainment. Family income was measured by self-reported monthly household income of the parents. We used the logged household income in order to address the issue of normality. Family structure was measured as a dichotomous variable where students from two-parent families were coded as 1 and otherwise 0. The number of siblings was retrieved from parents' report on the number of children that they had. Parental expectations for children's education was also based on parents' reports on how far they would like their surveyed child to go in school and was measured by a categorical variable indicating a two-year college degree (or less), a four-year college degree, and an advanced degree. Parents' plan to send their child to a special high school was derived from parents' reports on whether they planned to send their surveyed child to a special high school. Parental academic support was derived from parents' reports on how much (1 = not at all, 5 = very much) they had done the following things: (a) create an atmosphere conducive to learning at home, (b) monitor child's school work and homework, (c) teach child personally, (d) advise child on how to study, (e) pay attention to child's grade, (f) gather information to choose a private tutor or a cram school (or *hagwon*), (g) try not to be thrifty when it comes to child's education, (h) monitor child's everyday life and schedule, (i) encourage child to study, (j) address the needs of the child, and (k) obtain

information by meeting with other parents. We used the average of the responses from these 11 items (Cronbach's alpha = .84), where a higher value indicates a higher level of academic support by parents. All family characteristic variables were taken from the base year parent data.

For student characteristics, we included (a) gender, (b) daily study hours, (c) prior academic achievement, (d) the reception of private supplementary tutoring, and (e) educational expectations. Gender was based on students' reports on their sex (1 = female, 0 = male). Daily study hours were measured by students' self-reports on hours they spent studying each of Korean, mathematics, and English per day at the fifth grade (excluding hours spent on private supplementary tutoring). Prior academic achievement was measured by test scores on Korean, English, and mathematics tests administered at the fifth grade. Private supplementary tutoring was measured by a dichotomous variable indicating whether a student received private supplementary tutoring for each subject of Korean, English, and mathematics at the fifth grade. Finally, educational expectations were based on students' self- reports on how far they would like to go in school and was measured at the fifth grade by a categorical variable indicating a two-year college degree or less, a four-year college degree, and an advanced degree. All of the student measures were from the base year student data. In addition to these covariates, we included school location (Seoul, other metropolitan cities, mid-sized cities, and rural areas) as a proxy for the location of residence. This information was also from the base year school data.

Analytic strategies

One of the critical issues in the literature that examines the effectiveness of private schools is that it is unclear whether attending private schools has a causal effect on educational outcomes (Morgan, 2001). This is mainly because students who attend private schools systematically differ from those who attend public schools. In the Korean context, for example, literature suggests that students from higher SES families are more likely than students from lower SES to enroll in private elementary schools (Byun et al., 2017). These preexisting sector differences make it difficult to identify a causal link between private elementary schooling and academic achievement.

In an experimental setting, this selection issue can be addressed by randomization through which the treated group is similar to the control group in all characteristics except for the treatment assignment (Shadish et al., 2002). This random assignment, however, is infeasible in most social science research (Schneider et al., 2007). Most prior literature on the private school effect has used regression analyses with the inclusion of a narrow set of control variables (see Morgan, 2001), but this conventional approach is often ineffective to estimate a causal effect (Guo & Fraser, 2015; Morgan & Winship, 2007; Rosenbaum & Rubin, 1983; Schneider et al., 2007). While there are other alternative statistical methods that can help address selection bias (see Shadish et al., 2002; also see Schneider et al., 2007), this study used PSM, which seeks to mimic randomization, and thus has been widely used in recent educational policy research (Schneider et al., 2007).

Specifically, we first performed descriptive statistics of the covariates included in our analyses by school sector to examine differences in background characteristics

between students attending private elementary schools and students attending public elementary schools. Second, we estimated a logit model that predicts the likelihood of private elementary school enrollment in order to generate a propensity score using all covariates as independent variables. Third, we used the logit of the estimated propensity score to match treated (i.e., students who attended private elementary schools) and untreated (i.e., students who attended public elementary schools) participants, using one-to-one nearest neighbor within a caliper matching method (Guo & Fraser, 2015). This method selects the untreated participant that is the best match (i.e., nearest neighbor) for a treated participant among the untreated participants that are within the absolute distance of the propensity scores between the range for the size of the caliper (Guo & Fraser, 2015). Following Rosenbaum and Rubin's (1985) recommendation, we used a .25 standard deviation of the logit of the estimated propensity score as the caliper size. We then performed balance checks to examine whether there were still significant differences in the observed covariates after matching. After confirming that no significant differences were found in the observed covariates, we finally estimated the average treatment effect for the treated (ATT) because we were interested in the expected what-if difference in achievement that would be observed if we could educate a randomly selected private elementary school student in both a public elementary school and a private elementary school (see Morgan & Winship, 2007). Finally, we used the Rosenbaum bounds method (Rosenbaum, 2002) to conduct sensitivity analyses in order to test the extent to which the private elementary school effect, if any, was robust against hidden bias.

We replaced missing data for the variables included in our analyses using multiple imputations (see Table 1 for the percentage of missing cases for each of the variables). Following the recommendations (von Hippel, 2007), we included all of the dependent variables and covariates so that missing values for the covariates were predicted using existing values from the other variables. Given literature suggesting that accurate results typically can be obtained from two to 10 imputations (Schafer & Graham, 2002; von Hippel, 2005), we generated five imputed data sets using the chained equations approach with the Stata ICE module (Royston & White, 2011). We then conducted analyses with each imputed data set and averaged the estimates and standard errors by using Rubin's (1987) rule.

Results

Descriptive findings: Full sample

Table 1 presents descriptive statistics of the covariates included in our analyses by school sector. Note that χ^2 or t tests are usually used to examine the bivariate relationship among variables, but there is no consensus on how to combine χ^2 or t test results across imputed datasets. Therefore, in order to test statistically differences in the covariates by school sector, we conducted univariate linear and logit analyses for each of the covariates, depending on their scales, using the variable of private elementary school attendance as the independent variable. When it came to achievement gains, we found statistically significant sector differences in English achievement gains favoring

students attending private elementary schools. However, we found no statistically significant sector differences in Korean and mathematics achievement gains for the full sample.

We found significant sector differences in all covariates considered. For example, on average, parents of children attending private elementary schools had higher levels of educational attainment and family income, compared to those of children attending public elementary schools. Parents of children attending private elementary schools had higher levels of educational expectations and academic support for their children, compared to those of children attending public elementary schools. In addition, students attending private elementary schools on average spent more hours studying per day than students attending public elementary schools. Furthermore, on average, students attending private elementary schools had higher levels of prior academic achievement and educational expectations than their counterparts attending public elementary schools.

When it came to school location used as a proxy for the location of residence, we found significant sector differences. Specifically, more than 50% of private elementary schools that students attended were located in rural areas. This is inconsistent with national statistics (KEDI, 2020), which were described earlier. We suspect that this unexpected result is related to the oversampling of private elementary schools in KELS:2013. This result, however, would not affect our estimate of the private elementary school effect because we used PSM to find best matches between the treated and control participants based on the observed characteristics, including the location of residence.

In sum, descriptive results showed that students attending private elementary schools were more likely to come from advantaged families, compared to students attending public elementary schools. At the same time, these results showed significant sector differences in background characteristics, suggesting a selection issue.

Predictors of private elementary school attendance: Full sample

Table 2 presents results from the logit model where we regressed all covariates on the dichotomous measure of private elementary school attendance to obtain the predicted probability (i.e., propensity score) of attending private elementary schools. Results showed that family income, parents' educational expectations for their children, and prior English achievement were significantly related to the likelihood of attending private elementary schools, even when other covariates were simultaneously considered. Among the covariates, family income was found to be the most important predictor of children's private elementary school attendance. A one-unit increase in family income was associated with about 280% increase in the odds of children attending private elementary schools. Parents' educational expectations for their children were the second most important predictor. The odds of children attending private elementary schools for parents who wanted their children to earn a bachelor's degree and an advanced degree were 5.44 and 8.75 times, respectively, as large as the odds for parents who wanted their children to earn an associate's degree or less. As such, logit results not only confirmed the selection issue in studying the private elementary school effect, but also helped us understand which of the covariates was the most important factor to determine children's private elementary school attendance.

Table 1. Descriptive statistics for the variables included in analyses by school sector: Full sample

Variable	Private		Public		Total		% of imputed data
	M	*SD*	*M*	*SD*	*M*	*SD*	
Achievement Gains							
Korean	1.21	29.56	2.97	32.71	2.97	32.71	2.7
English***	17.20	25.23	10.53	28.21	10.53	28.21	2.8
Mathematics	9.68	29.87	4.38	32.52	4.38	32.52	2.9
Covariates							
Parental education							1.3
High school or less**	0.07	–	0.35	–	0.34	–	
Two-year college degree**	0.07	–	0.20	–	0.20	–	
Four-year college degree**	0.46	–	0.34	–	0.35	–	
Advanced degree**	0.40	–	0.10	–	0.11	–	
Family income***	6.67	0.61	5.97	0.58	6.00	0.61	4.6
Two-parent family**	0.95	–	0.90	–	0.90	–	3.4
Number of siblings**	0.99	0.74	1.20	0.79	1.20	0.79	1.1
Parents' educational expectations for children							6.8
Two-year college degree or less***	0.00	–	0.09	–	0.09	–	
Four-year college degree***	0.41	–	0.64	–	0.64	–	
Advanced degree***	0.59	–	0.27	–	0.27	–	
Parents' plan to send children to special high school**	0.33	–	0.20	–	0.20	–	5.0
Parent's academic support***	3.70	0.51	3.41	0.55	3.41	0.55	0.9
Female	0.51	–	0.51	–	0.51	–	0.0
Daily study hours**	2.59	1.68	1.94	1.58	1.97	1.59	0.9
Prior academic achievement							
Korean***	215.37	31.44	198.51	36.73	198.51	36.73	1.1
English***	227.89	28.98	199.05	38.35	199.05	38.35	1.2
Mathematics***	220.63	35.10	199.01	37.95	199.01	37.95	1.2
Private supplementary tutoring							
Korean	0.63	–	0.59	–	0.59	–	27.6
English*	0.84	–	0.74	–	0.74	–	14.6
Mathematics***	0.80	–	0.70	–	0.70	–	15.8
Educational expectations							0.7
Two-year college degree or less*	0.07	–	0.11	–	0.11	–	
Four-year college degree*	0.34	–	0.39	–	0.39	–	
Advanced degree***	0.29	–	0.19	–	0.19	–	
Don't know	0.30	–	0.30	–	0.30	–	
Location of residence							0.0
Seoul	0.21	–	0.20	–	0.20	–	
Other metropolitan cities	0.13	–	0.38	–	0.38	–	
Mid-sized cities	0.11	–	0.24	–	0.24	–	
Rural areas*	0.54	–	0.19	–	0.19	–	
N (%)	364 (5.0)		6,923 (95.0)		7,287 (100.0)		

Data source. Korean Educational Longitudinal Study of 2013.
Note. The estimates are an average of the results across five imputed datasets by using Rubin's rule.
***$p < .001$. **$p < .01$. *$p < .05$ (two-tailed tests)

Table 2. The logit model predicting the likelihood of private elementary school attendance: Full sample

Variable	B		*SE*	OR
Parental education				
High school or less (reference)	–		–	–
Two-year college degree	-0.03		0.72	0.97
Four-year college degree	0.77		0.76	2.16
Advanced degree	1.19		0.82	3.27
Family income	1.34	***	0.19	3.82
Two-parent family	-0.04		0.24	0.96
Number of siblings	-0.20		0.16	0.82
Parents' educational expectations for children				
Two-year college degree or less (reference)	–		–	–
Four-year college degree	1.69	*	0.80	5.44
Advanced degree	2.17	**	0.81	8.75
Parents' plan to send children to special high school	-0.17		0.20	0.85
Parent's academic support	0.19		0.11	1.21
Female	0.01		0.13	1.01
Daily study hours	0.11		0.06	1.11
Prior academic achievement				
Korean	0.00		0.00	1.00
English	0.01	*	0.01	1.01
Mathematics	0.00		0.00	1.00
Private supplementary tutoring				
Korean	-0.14		0.18	0.87
English	-0.35		0.25	0.71
Mathematics	0.28		0.30	1.32
Educational expectations				
Two-year college degree or less (reference)	–		–	–
Four-year college degree	0.03		0.26	1.04
Advanced degree	-0.25		0.23	0.78
Don't know	0.39		0.25	1.47
Location of residence				
Seoul	0.11		0.84	1.12
Other metropolitan cities	-1.53		0.99	0.22
Mid-sized cities	-1.46		1.07	0.23
Rural areas (reference)	–		–	–
Constant	-16.63	***	2.37	–
Log pseudolikelihood	-1020.645			
Pseudo R^{2a}	0.294			
N	7287			

Data source. Korean Educational Longitudinal Study of 2013.

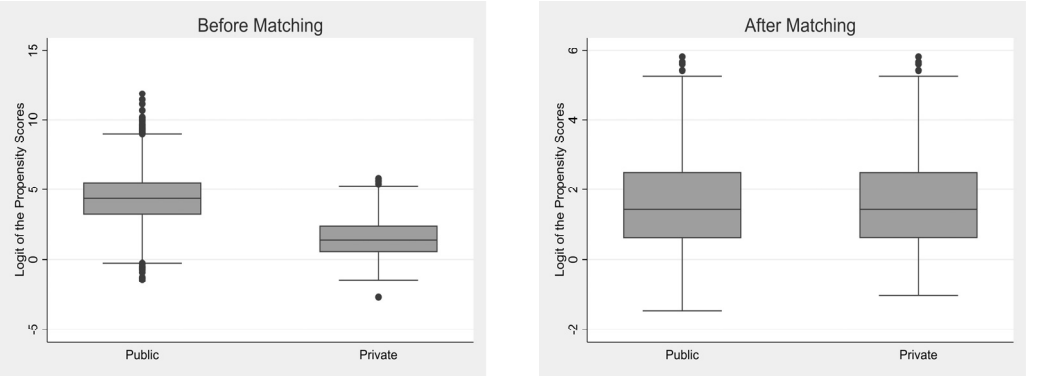
Note. The estimates are an average of the results across five imputed datasets by using Rubin's rule. Standard errors are corrected for clustering within schools.

[a]The estimate was based on the first imputed dataset.

***p < .001. **p < .01. *p < .05 (two-tailed tests)

Covariate balance checks: Matched sample

After generating the propensity score with the logit model described above, we performed one-to-one nearest neighbor matching with a caliper of width equal to .25 of the standard deviation of the logit of the propensity score to find best matches between the treated participants (i.e., students who attended private elementary schools) and the untreated participants (i.e., students who attended public elementary schools) using the psmatch2 module in Stata. Figure 1 depicts the distributions of the logit of the estimated propensity scores in the treated participants and the matched untreated participants before and after matching using the first imputed dataset. As can be seen, the distributions of the logit of the estimated propensity scores were very similar between the treated participants and the matched untreated participants after matching, compared to those before matching. This suggested few differences in the observed covariates between the two groups after matching.



Note. Boxplots are based on the first imputed dataset.

Figure 1. Sector differences by the distributions of the logit of the estimated propensity score before and after matching

We also statistically tested the extent to which the treated participants and matched untreated participants were balanced on the observed covariates, and presented the results in Table 3. Note that because the matched sample sizes slightly differed across the imputed data due to differences in the area of common support, we present balance check results using the first imputed dataset. Results showed no statistically significant sector differences in all of the covariates. Results also showed a substantial reduction in absolute bias for most of the covariates. Although we found an increase in absolute bias for gender (-164.8) and the "don't know" category for children's educational expectations (-2,322.7), there were no statistically significant sector differences in these two covariates. Together, balance check results suggested that unlike the full sample, there was no serious selection bias for our matched sample.

Table 3. Covariate balance check: Matched sample

Variable	Private M	Public M	% reduction in absolute bias
Parental education			
High school or less	0.07	0.09	96
Two-year college degree	0.07	0.07	95.9
Four-year college degree	0.48	0.42	57.7
Advanced degree	0.38	0.42	88.5
Family income	6.61	6.63	97.9
Two-parent family	0.95	0.93	66.3
Number of siblings	0.98	1.00	91.5
Parents' educational expectations for children			
Two-year college degree or less	0.00	0.00	96.7
Four-year college degree	0.41	0.40	96.6
Advanced degree	0.59	0.60	96.7
Parents' plan to send children to special high school	0.34	0.32	88.5
Parent's academic support	3.69	3.68	96.4
Female	0.52	0.49	-164.8
Daily study hours	2.57	2.60	94.1
Prior academic achievement			
Korean	215.12	214.88	98.7
English	227.58	227.67	99.7
Mathematics	220.46	220.98	97.7
Private supplementary tutoring			
Korean	0.62	0.63	88.5
English	0.84	0.84	97.3
Mathematics	0.81	0.80	95
Educational expectations			
Two-year college degree or less	0.07	0.06	81.7
Four-year college degree	0.34	0.36	75.1
Advanced degree	0.29	0.30	89.1
Don't know	0.30	0.28	-2322.7
Location of residence			
Seoul	0.22	0.21	14.7
Other metropolitan cities	0.14	0.16	91.1
Mid-sized cities	0.12	0.09	82.4
Rural areas	0.53	0.54	96.9
N	351	351	

Note. The estimates are based on the first imputed dataset.

PSM estimates of the private elementary school effect: Matched sample

Table 4 presents PSM estimates of the average treatment effect of attending private elementary schools on academic achievement for the treated participants (i.e., ATT). Results showed statistically significant sector differences in English and mathematics achievement gains among those students who would be likely to attend private elementary schools. Specifically, students who would be likely to attend private elementary schools would gain approximately 9 and 8 points more in English and mathematics achievement, respectively, between fifth and sixth grades, if they attended private elementary schools,

rather than public elementary schools. However, there were no significant ATT on Korean achievement gains.

Table 4. Propensity score matching estimates of the private elementary school effect for the treated: Matched sample

Achievement Gains	Private	Public	Differences	SE	*t* statistics	
Korean	1.45	2.46	-1.01	2.36	-0.43	
English	16.88	8.28	8.60	2.37	3.63	***
Mathematics	9.49	1.92	7.57	1.69	4.47	***

Note. The estimates are an average of the results across five imputed datasets by using Rubin's rule. Sample sizes vary depending on the imputed data, ranging from 698 to 708, due to differences in the area of common support.

***$p < .001$ (two-tailed tests)

Although we do not present results here, we conducted a series of supplementary analyses to test the robustness of these results by using different caliper sizes as well as other matching algorithms, such as stratification, kernel, and weights, and found very similar results reported here, suggesting the consistent and unbiased estimate of the private elementary school effect. We also tested heterogeneity in the average treatment effect on English and mathematics gains to examine who would benefit most from attending private elementary schools and found no statistically significant heterogenous effects. In other words, regardless of the propensity to enroll in private elementary schools, all students would benefit from attending private elementary schools in terms of increased gains in English and mathematics achievement. These supplementary results are available from us upon request.

Sensitivity analysis

Table 5 presents results from the sensitivity analyses of the private elementary school effect on English and mathematics achievement gains for the treated participants using the Rosenbaum bounds method (Rosenbaum, 2002). Note that because there is no consensus on how to combine sensitivity analysis results across the imputed datasets, we present results for each of the five imputed datasets. Γ indicates odds ratio, denoting the Rosenbaum bounds estimate of the magnitude of hidden bias that would predict the treatment status (i.e., private elementary school enrollment). On the other hand, *p*-critical denotes the *p*-value where the PSM estimate turns out to be statistically nonsignificant, calling into question our finding of the positive elementary school effect on English and mathematics achievement gaps. Sensitivity analysis results for the first imputed data, for example, suggested that the magnitude of hidden bias (i.e., Γ) that could nullify the positive private elementary school effect on English achievement gains should be between 1.3 (*p*-critical = 0.017) and 1.4 (*p*-critical = 0.063). This magnitude of hidden bias should be equivalent to or larger than the effect of private tutoring on mathematics (OR = 1.32) (see Table 2). Likewise, the magnitude of hidden bias that could nullify the positive private elementary school effect on mathematics achievement

gains should be between 1.1 (p-critical = 0.013) than 1.2 (p-critical = 0.064). This magnitude of hidden bias should be larger than the effect of parents' academic support (OR = 1.21) (see Table 2).

Table 5. Sensitivity analysis using Rosenbaum bounds of the private elementary school effect across imputed datasets

	Imputed dataset									
	1		2		3		4		5	
Outcome variable	Γ	p-critical	Γ	p-critical	Γ	p-critical	Γ	p-critical	Γ	p-critical
English achievement	1.0	0.000	1.0	0.000	1.0	0.002	1.0	0.000	1.0	0.000
	1.1	0.000	1.1	0.000	1.1	0.021	1.1	0.000	1.1	0.000
	1.2	0.003	1.2	0.000	1.2	0.091	1.2	0.000	1.2	0.002
	1.3	0.017	1.3	0.002	1.3	0.244	1.3	0.000	1.3	0.014
	1.4	0.063	1.4	0.011	1.4	0.461	1.4	0.002	1.4	0.052
	1.5	0.162	1.5	0.038	1.5	0.675	1.5	0.011	1.5	0.138
	1.6	0.316	1.6	0.102	1.6	0.835	1.6	0.036	1.6	0.279
	1.7	0.498	1.7	0.212	1.7	0.928	1.7	0.090	1.7	0.454
Mathematics achievement	1.0	0.001	1.0	0.000	1.0	0.001	1.0	0.000	1.0	0.001
	1.1	0.013	1.1	0.004	1.1	0.008	1.1	0.002	1.1	0.011
	1.2	0.064	1.2	0.024	1.2	0.043	1.2	0.014	1.2	0.054
	1.3	0.189	1.3	0.092	1.3	0.142	1.3	0.059	1.3	0.165
	1.4	0.386	1.4	0.231	1.4	0.316	1.4	0.164	1.4	0.350
	1.5	0.603	1.5	0.426	1.5	0.529	1.5	0.333	1.5	0.565

Note. Γ is the odds ratio of differential treatment assignment due to an unobserved covariate. p-critical from the Wilcoxon signed rank tests.

Generally speaking, the magnitude of hidden bias that can nullify the positive private elementary school effect was found to be greater for English achievement than for mathematics achievement across the imputed datasets, except for the third imputed dataset. This result suggested that the positive private elementary school effect on English achievement gains might be less vulnerable to unobserved covariates, compared to the effect on math achievement. However, given that the overall magnitude of hidden bias that would call into question the significant private elementary school effect on both English and mathematics achievement gains appears to be relatively small, one might not be able to rule out the possibility that unobserved characteristics or hidden bias might explain the positive effect private school effect.

Discussion

Despite the potential implications of private elementary schools for educational stratification in Korean society, we know little about the role of private elementary schools in relation to educational inequality. In this study, using longitudinal data for a

nationally representative sample of fifth graders in Korea, we addressed this lack of scholarship by beginning to describe sector differences in family and student characteristics. As expected, we found that private elementary schools largely serve children from socioeconomically and educationally advantaged families. In particular, family income and parents' educational expectations for children were found to be the two most important factors that determine children's private elementary school enrollment. These findings suggest that affluent parents who want their children to achieve higher levels of education would be more likely to send their children to private elementary schools.

Next, we examined whether private elementary school attendance had a significant effect on achievement gains. Our PSM analyses showed that attending private elementary schools had a significant and positive effect on English and mathematics achievement gains, but not on Korean achievement gains. Although further research is needed to understand these inconsistent findings across school subjects, the positive private elementary effect on English and mathematics achievement gains may be attributable to their offering of more flexible and extended curricula that are tailored to students' needs, as well as their provision of more English classes from the first grade (Choi, 2019). Together, these findings suggest that while private elementary schools largely serve children from affluent families, they also provide them with academic benefits in terms of greater gains in English and mathematics achievement. Given that academic achievement, especially English achievement, plays in an important role in entering elite middle schools, high schools, and colleges (Byun, Schofer, & Kim, 2012), our findings suggest that private elementary schools may contribute to educational inequality in Korean society.

This study has several limitations that could be addressed in the future. First, using the longitudinal nature of KELS:2013, we were able to examine the private elementary school effect on academic achievement more rigorously by measuring the extent to which private elementary schools contribute to achievement gains between fifth and sixth grade. However, academic achievement measured at fifth grade itself could be part of the result of private elementary schooling. In this regard, we might underestimate the private elementary school effect on academic achievement. On the other hand, we might overestimate the private elementary school effect given that our sensitivity analyses suggest that the findings of the positive private elementary school effect could be sensitive to hidden bias. Accordingly, our results should be interpreted with caution.

Second, this study focused on estimating the private elementary school effect on learning. However, we did not fully examine mechanisms by which attending private elementary schools influences academic achievement. Literature on private schools in other countries suggests that peer effects resulting from school sorting and institutional features of private schools, such as greater autonomy and a more challenging academic climate, can be potential mechanisms by which private schools affect academic achievement (Torche, 2005). Building on this literature, we conducted a supplementary analysis to explore school-related factors that might explain sector differences in English and mathematics achievement gains by including student-teacher interaction, school climate, teacher support, and school violence. We found significant sector differences in these school-related variables that favor private elementary schools. In other words, students attending private elementary schools reported higher levels of student-teacher interaction and teacher support, a more positive school climate, and less school violence,

compared to their counterparts attending public elementary schools. However, we found that these school-related variables neither significantly related to English and mathematics achievement gains nor explained sector differences in English and mathematics achievement gains.[5] Therefore, future studies should further investigate mechanisms behind the positive private elementary school effect on English and mathematics achievement.

Finally, future studies should reveal what other consequences attending private elementary schools has for children's success later in life. We speculate that attending private elementary schools would increase chances of gaining admission to elite middle and high schools potentially through its positive effect on English achievement. However, more empirical research is needed to understand the role of private elementary schooling in elite middle and high school enrollment. We hope that this study will serve as a starting point for future research on private elementary schools.

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Footnotes

1) International middle schools are designed to accommodate academically talented students for foreign languages. There are only four international middle schools across the nation and they are all private.

2) Special purpose high schools are designed to accommodate academically talented students for particular areas, such as the arts, science, foreign language, while autonomous high schools are self-governing and self-financing schools whose curricula are tailored to their own educational goals. Each type of these schools constitutes approximately 7% of all high schools (KEDI, 2020).

3) SKY is an acronym referring to the three most prestigious universities in Korea: Seoul National University, Korea University, and Yonsei University.

4) For more information, see https://www.schoolinfo.go.kr/Main.do

5) These supplementary results are available upon request from the authors.