

## THE EFFECT OF SCHOOL CHOICE ON STUDENT'S ACADEMIC PERFORMANCE\*

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### *Abstract*

We test the effect of school choice on students' academic performance by exploiting the change in high school assignment program in Seoul, Korea from within-district randomization to open enrollment. Employing difference-in-differences methodology on administrative data of high school students' National Assessment of Educational Achievement test scores, we find no evidence that enhanced school choice improved average test scores in Seoul. However, we find differential effects across school types – regular high schools' test scores fell whereas newly converted selective private high schools' test scores rose substantially. Increased sorting across schools is shown to have adverse effects particularly on low-ability students.

*Keywords:* school choice, open enrollment, difference-in-difference, inequality, South Korea

*JEL Classification Codes:* I28, I24

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## I. *Introduction*

Without changing the amount of government resources allocated to schools or the quality of teachers, changing how students are assigned to schools alone can affect various student outcomes. Thus school choice is widely used as a policy tool in the hopes of improving student and school competitiveness and of better reflecting families' preferences over schools. Whether school choice can indeed achieve these goals, however, is highly controversial.

Proponents of school choice emphasize that allowing families to choose which school their children will attend would improve school-student match quality and also incentivize public schools to become more productive (Friedman, 1962; Hoxby, 2000). Opponents argue that school choice would segregate the student body along socio-economic status lines and high-ability students would benefit more from enhanced choice than low-ability students (Carnoy, 2000; Epple & Romano, 1998; Levin, 1998). Positive spillover from high-achieving students to low-achieving students would become much smaller if a few elite schools manage to cream-skim. On the other hand, there are also studies that find no or only small differences in achievement from expanded school choice (e.g., Rothstein, 2007).

In this paper, we examine the effect of school choice on students' academic performance by studying the introduction of open enrollment in Seoul, Korea. Seoul had effectively retained a within-district random assignment program for over three decades until 2009. With the onset of open enrollment in 2010, however, middle school graduates could apply to any high school in the city (regardless of school zone). The transition occurred without any phase-in or trial period, instantly affecting all students in Seoul regardless of demographics. School variety also increased as more regular high schools were encouraged to convert to those with greater freedom in curriculum and faculty choice (known as autonomous high schools). Such policy change in a large metropolitan area provides an undoubtedly useful experiment to investigate the effects (and side effects) of enhanced school choice.

To capture the effect of school choice, we use 2010-2012 data on second year high school students' National Assessment of Educational Achievement (NAEA) test scores in Korean, English, and math and exploit the fact that only students who entered high school after 2010 and lived in Seoul were affected by the policy. Difference-in-differences estimation indicates that, on average, the treatment effect is about -0.04 standard deviations in English and math – that is, school choice did not improve average student outcomes in Seoul.

In order to explore differential treatment effects within Seoul, we further investigate how school choice affects students by school type and their relative position in the test-score distribution. We find that first, regular high schools and existing elite high schools were hurt by the policy whereas newly converted private high schools gained. As a result, the gap in students' academic performance across schools widened in Seoul. Second, although we find a small increase in the relative achievement of high-performing students in Seoul, the drop in low-ability students' relative test scores is more prominent and is observed across a wider range of the test score distribution, particularly in math. This implies that the expansion of school choice may have adverse effects on the peer environment and learning atmosphere of disadvantaged students.

The rest of the paper proceeds as follows. In Section II, we briefly review existing studies related to our topic. Section III introduces institutional details of Korea's high school

assignment program. We then describe the data and empirical strategy in Section IV. In Section V, we assess how expanded school choice affects students' academic performance. Section VI concludes.

## II. *Literature Review*

The literature on the effect of school choice on student outcomes has largely mixed findings (Belfield & Levin, 2002; Gamoran, 1996; Goldhaber, 1999; Goldhaber & Eide, 2002). For instance, studying three recent choice reforms in the U.S. – vouchers in Milwaukee, charter schools in Michigan, and charter schools in Arizona, Hoxby (2003) finds that regular public schools boosted their productivity when exposed to competition. Also, Lavy (2010) examines the effect of a program in Tel-Aviv that terminated inter-district busing integration and allowed free choice among public schools, and finds that school choice significantly reduces drop-out rates and increases cognitive achievements of high school students.

Other studies, however, find no systemic benefits of school choice on academic achievement. In the Chicago Public Schools setting, Cullen *et al.* (2006) show that lottery winners only experience improvements on nontraditional measures such as arrest rates, but not on traditional academic measures. Similarly, Hsieh and Urquiola (2006) find no evidence that choice improved educational outcomes when Chile introduced vouchers to any student wishing to attend private school.

There is also evidence that disadvantaged groups are disproportionately affected by the downside of school choice (Burgess & Briggs, 2010; Carnoy, 2000; Hastings *et al.*, 2009). One reason is due to increased segregation. Godwin *et al.* (2006) study the change in assignment policy to open enrollment in Charlotte and find that the reform increased sorting across racial lines; African Americans were less likely to receive their first choice and their test scores declined. Another reason is due to differences in parents' resources and interest in school search. Long and Toma (1988), Coleman and Hoffer (1987), and Bifulco *et al.* (2009), for example, document that parents who select private schools (or opt out of assigned schools) have higher socio-economic status than parents who do not.

Lastly, there are a few papers that explicitly study the Korean educational context. One branch exploits the random assignment design *per se*. For example, Park *et al.* (2013) and Choi *et al.* (2014) exploit the random feature of school assignment in Seoul to estimate whether students in single-sex high schools obtain better educational outcomes than those in coed high schools. Similarly, Hahn *et al.* (2013) investigate whether private high schools outperform public high schools in Seoul using the 2010 NAEA data. Nam and Sung (2009) also look at whether private schools are more effective than public schools within the same school district by merging two test results given to 10th graders in 1997 and to 12th graders in 1999 by a major private institute.

Another branch focuses on the transition to the random assignment system in the early 2000s. For example, Hahn *et al.* (2008) compare high-ability students' outcomes, as measured by their entrance into top universities, in ten cities before and after the policy change and find that more students entered top universities under "sorting" than "mixing." Perhaps the paper that is the closest to our setup is Kim *et al.* (2008). They use difference-in-differences estimation to compare 2001 NAEA test scores of students in provincial cities that follow

random assignment with those that did not, and find that test scores in the latter are 0.3 standard deviations higher. They further suggest that sorting is beneficial to students above the median without any harm to those below the median. Although similar in design, we directly examine the change in school assignment program *within* Seoul and our findings deliver different messages about the potential impacts of school choice on average performance and educational inequality.

### III. *Institutional Background*

Education system in Korea consists of 6 years of elementary school, 3 years of middle school, 3 years of high school, and 4 (2-3) years of (junior) college. Currently, elementary and middle school education is compulsory, but more than 99.7 percent of middle school graduates continue onto high school as well. As of 2012, 1,589,290 (82.8 percent) students are enrolled in 1,804 academic high schools and 330,797 students (17.2 percent) in 499 vocational high schools (KEDI 2013).

In this study, we focus on students attending academic high schools, excluding vocational high schools and arts and physical education high schools, and distinguish four different types of academic high schools: regular, autonomous public, autonomous private, and special purpose.

Regular high schools – either public or private – are government-subsidized schools that closely follow the Ministry of Education’s guidelines and the national curriculum as specified by the Elementary and Secondary Education Act. Autonomous high schools, in comparison, are allowed more freedom in deciding their curriculum, rules, and teachers. The public ones are government-subsidized, and are usually initiated by the local government to promote opportunities for students in disadvantaged regions. The private ones do not receive any government funding and they can collect tuition up to three times larger than that of regular high schools. They are also allowed to make some modifications to the national curriculum and can operate optional curricula according to their educational objectives. Lastly, special purpose high schools specialize in a certain field – science high schools, foreign language high schools, and international high schools – and are comparable to traditional “elite” schools.

Until 1973, Korean high schools could select their students based on entrance examinations administered by individual high schools. Out of concerns for the growing inequality across schools and academic pressure on students, the Korean government introduced the No Middle School Entrance Examination Policy in 1968 and the High School Equalization Policy in 1974 in most urban areas. (See Nam & Sung 2009 for a review of this policy.)

Since the adoption of the Equalization policy, high school assignment followed within-district randomization. Except for some of the top students who were accepted by special purpose high schools, students were assigned to high schools in their school district via lottery (regardless of whether public or private). Although modifications to this system have been made in some cities, the original design persisted in Seoul.<sup>1</sup> Criticism increased, however, as

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<sup>1</sup> Modification to the equalization system includes allowing students to list a couple of schools that they prefer. In cities such as Busan, Daegu, Daejeon, and Gwangju, 30-50 percent of high school slots were filled randomly among the applicants while the remaining slots were allocated randomly without any consideration of students’ preference (Nam & Sung 2009).

TABLE 1. HIGH SCHOOL ASSIGNMENT IN SEOUL

	Early Stage	Open Enrollment		
		First Step	Second Step	Third Step
District Restriction	anywhere in Seoul	anywhere in Seoul	own school district	own or adjoining school district
School Types	Special Purpose Autonomous Private	Regular Autonomous Public	Regular Autonomous Public	Regular Autonomous Public
Assignment Method	School's own criteria	Lottery among applicants	Lottery among applicants	Lottery

*Notes:* High school assignment in Seoul since the education reform in 2010. Refer to text for details on each school type.

this system ignored the students' (and parents') right of school choice.

Hence in 2010, an education reform involving school competition and expanded parental choice was introduced in the capital city of Korea, Seoul, which is the largest city in Korea and one of the 10 most populous cities in the world. 15 percent of high schools and 20.3 percent of high school students in Korea are enrolled in Seoul as of 2010. Under the new regime, middle school graduates living in Seoul could apply to any high school in the city regardless of school district. Moreover, more regular high schools were encouraged to convert to autonomous high schools, increasing school variety.<sup>2</sup> The reform is unique in the sense that Seoul had maintained the original random assignment rule since 1974, in sharp contrast to other major cities that partly incorporated students' preferences since 1996. All at once, however, Seoul became the site of the most enhanced high school choice program in Korea as the Ministry of Education and the Seoul Metropolitan Office of Education closely cooperated to increase educational diversity, school accountability, and school competition.

High school assignment in Seoul now works as follows. Students who wish to attend special purpose or autonomous private high schools apply. Special purpose high schools select students based on their own criteria. In autonomous private high schools, 80 percent of entrants are randomly selected among applicants whose middle schools academic record is above the median. Students from low income or single-parent households are given priority for the remaining 20 percent of vacancies. This is the "early" decision stage. All remaining students (those who did not apply to these early high schools and those who did but were not selected), are then eligible for the next stage, which is open enrollment. (See Table 1.)

In the first step of open enrollment, students apply to two regular high schools of their choice *anywhere in Seoul* and can apply to up to one autonomous public high school. Students are selected via lottery and 20 percent of all slots in each high school are filled. In the second step, students who have not been assigned in the first step apply to two schools of their choice within their *own school district*. Again, students are selected via lottery and 40 percent of all slots in each high school are filled. In the third step, the remaining 40 percent of students are randomly assigned to schools within half an hour distance from their residence by public transportation in their *own or adjoining school district* considering commuting distance among

<sup>2</sup> A few regular high schools outside Seoul also converted to autonomous private high schools, but they comprised only 1.8 percent of all non-Seoul high schools by 2011. In contrast, in Seoul, a total of 12.2 percent of regular high schools converted to autonomous private.

the 11 school districts.

## IV. *Data and Empirical Strategy*

### 1. **Data**

The data we use are National Assessment of Educational Achievement (NAEA) test scores of high school students from 2010 to 2012.<sup>3</sup> The data is collected by the Ministry of Education and Korea Education and Research Information Service and is provided via EduData Service System (EDSS). NAEA, designed by the Korea Institute for Curriculum and Evaluation, is annually taken by second year high school students (11th grade) at the end of their first semester. The test covers the previous year's entire (10th grade) curriculum in three subjects: Korean, English, and math. Thus students who took the exam in 2010 are those that entered high school in 2009 – before the education reform in Seoul. Students who took the exam in 2011 and 2012 are the first and second cohort under the enhanced school choice system, respectively.

The advantage of this dataset is that it is a national achievement test. Unlike the College Scholastic Ability Test, for instance, which is taken only by students planning to go to college, NAEA is taken by all 11th graders in the same three subjects. Moreover, the primary purpose of conducting the NAEA annually is to track students' academic achievement over time and to identify those who fail to meet basic requirements. Thus the NAEA is designed to test the most essential skills in each grade level and is suitable for comparing results across cohorts.

As is generally true for administrative educational data in Korea, one of the limitations of this dataset is that we do not have access to student's detailed demographic characteristics, application records, or previous performance. However, we have information on individual's test scores, sex, cohort, and a few school-level variables including school type, administrative district in which the school is located, and unique school identifier, which allows us to examine the effect of school choice at the school level as well.

Concerned with the privacy of students and schools, EDSS randomly selects 90 percent of high schools in the country regardless of school type, and provides data for all students in those schools. Table 2 summarizes our estimation sample in Seoul by school type and cohort. In our sample, there are 202 high schools in total – 154 regular high schools, 15 autonomous public high schools, 24 autonomous private high schools, and 9 special purpose high schools. Note that not all autonomous high schools converted at the start of the new policy; 12 autonomous private and 7 autonomous public high schools converted in 2010, and the rest in 2011.

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<sup>3</sup> Until 2009, NAEA was given to 6th, 9th, and 10th graders. In this paper, we use the 2010-2012 data because the test was given to 11th graders instead of 10th graders since 2010.

TABLE 2. SUMMARY STATISTICS OF SCHOOLS AND STUDENTS IN SEOUL

	Regular	Autonomous Public	Autonomous Private	Special Purpose
Number of Schools	154	15 (7)	24 (12)	9
Number of Students	223,429	5,988	12,733	7,783
2009 Cohort	82,771	0	0	2,606
2010 Cohort	74,990	1,866	4,163	2,653
2011 Cohort	65,668	4,122	8,570	2,524

*Notes:* Number of schools and students in Seoul in the EDSS data by school type. Cohort refers to the high school entering year. The numbers in parentheses refer to the number of schools that converted to autonomous high schools in 2010.

## 2. Empirical Strategy

We are interested in analyzing the effect of expanded school choice on student's academic performance. Exploiting the change in policy that only applied to students in Seoul, we use difference-in-differences (DID) estimation. The “control” group consists of high school students living outside of Seoul and the “treatment” group consists of high school students living in Seoul. By comparing the difference in test scores before and after the new policy in the treatment group relative to that in the control group, we are able to capture the effect of school choice on students' test scores.

Hence, we estimate the following equation:

$$Y_{ict} = \alpha + \beta_0 Seoul_c + \beta_1 Post_t + \beta_2 (Seoul_c * Post_t) + \varepsilon_{ict} \quad (1)$$

The dependent variable is the NAEA test score of student  $i$  in region  $c$  and cohort  $t$ .  $Seoul_c$  takes the value of 1 if student  $i$  lives in Seoul, and 0 otherwise.  $Post_t$  is a dummy for the period after the new policy in Seoul, and equals 1 for cohorts 2010 and 2011. The main variable of interest is the interaction term,  $Seoul_c * Post_t$ , which is an indicator that the observation comes from the treated group after the policy change has occurred.

Furthermore, we look at the policy effect by school type – regular, autonomous public, autonomous private, and special purpose. Estimating the post-policy effect with school fixed effects and calculating the intraclass correlation coefficient within a multilevel model, we assess whether expanded school choice had differential effects across schools even within Seoul and whether inequality of students' academic performance at the school level increased as a result.

Throughout, we standardize all test scores. Because the education reform only applied to Seoul and had no direct effect on the academic performance of students in other regions, we use test scores of non-Seoul high schools (instead of the national sample) as the baseline for standardization.<sup>4</sup> That is, standardized test scores are calculated as individual score less non-Seoul average divided by standard deviation for each year and subject. Thus the raw score, which ranges from 100 to 300, is transformed to standard deviation units. By construction, the standardized scores of the non-Seoul sample have 0 mean and 1 standard deviation. (See Table 3 for summary statistics of test scores.)

<sup>4</sup> Whether we standardize test scores with regards to non-Seoul students or the whole sample does not change our results.

TABLE 3. SUMMARY STATISTICS OF TEST SCORES

	Raw test score				Standardized test score			
	Non-Seoul		Seoul		Non-Seoul		Seoul	
	Mean	Std	Mean	Std	Mean	Std	Mean	Std
<i>Panel A: Cohort 2009 (Non-Seoul=360,669, Seoul=85,754)</i>								
Korean	203.8	29.2	199.8	33.7	0	1	-0.137	1.153
English	202.7	30.7	203.0	35.3	0	1	0.007	1.150
Math	201.4	34.7	199.7	38.3	0	1	-0.051	1.103
<i>Panel B: Cohort 2010 (Non-Seoul=354,747, Seoul=84,060)</i>								
Korean	208.4	24.0	204.9	28.2	0	1	-0.146	1.175
English	211.1	25.0	210.4	29.8	0	1	-0.028	1.190
Math	203.9	30.5	201.0	34.5	0	1	-0.096	1.133
<i>Panel C: Cohort 2011 (Non-Seoul=350,873, Seoul=81,915)</i>								
Korean	207.7	25.5	204.4	30.4	0	1	-0.128	1.191
English	212.1	24.3	211.3	29.7	0	1	-0.033	1.222
Math	204.0	30.4	201.5	34.9	0	1	-0.083	1.149

*Notes:* Mean and standard deviation of NAEA test scores by cohort and subject. Raw test scores range from 100 to 300. Standardized test scores are calculated as individual score less non-Seoul mean divided by standard deviation for each year and subject.

## V. Results

### 1. Student's Academic Performance

To measure the effect of school choice on student's academic performance, we run an OLS regression using the DID estimation strategy mentioned above (Equation 1). Table 4 reports the results separately by subject. The coefficient on the interaction term between *Seoul* and *Post* is the DID estimate. The coefficient is near zero for Korean, -0.038 for English (although statistically insignificant at the 10 percent level with a p-value of 0.104) and -0.038 for math (statistically significant at the 10 percent level with a p-value of 0.079), implying that test scores are lowered by about 4 percent of one standard deviation in English and math. The result suggests that expanded school choice in Seoul did not improve academic performance on average. In fact, it may have resulted in a decrease in average performance of high school students in Seoul compared to those in non-Seoul regions.

Although our DID estimation result suggests that expanded school choice in Seoul did not translate into better academic performance overall (as measured by students' academic performance), there may be heterogeneous policy effects depending on school and student characteristics. It is possible that some schools gained at the cost of others by attracting better students, for instance. To explore this possibility, we study changes in students' test scores by school type.

Figure 1 plots the standardized NAEA scores of students in cohorts 2010 and 2011 relative to that of cohort 2009 by subject and school type. Each data point corresponds to a high school in the sample, and is marked according to its type – regular (*Reg*), autonomous public (*APub*),



TABLE 4. EFFECT OF EXPANDED SCHOOL CHOICE

Variable	Korean	English	Math
Seoul	-0.137*** (0.032)	0.007 (0.039)	-0.051 (0.032)
Post-Policy Cohort	0.000 (0.007)	0.000 (0.007)	0.000 (0.007)
Seoul x Post-Policy Cohort	-0.000 (0.023)	-0.038 (0.023)	-0.038* (0.022)
Constant	0.000 (0.015)	0.000 (0.017)	0.000 (0.016)
N	1,318,018	1,317,822	1,317,886

*Notes:* Effect of expanded school choice on students' NAEA test scores. Dependent variable is standardized NAEA test scores, calculated as individual score less non-Seoul mean divided by standard deviation for each year and subject. Seoul x Post-Policy Cohort is an interaction term that equals 1 if the student was assigned to a school in 2010 or 2011 and resides in Seoul. \*  $p < .1$ ; \*\*  $p < .05$ ; \*\*\*  $p < .01$ .

autonomous private (*APrv*), and special purpose (*SP*). The 45-degree reference line indicates no change in mean standardized test scores between years.

There are a number of patterns that can be commonly observed across academic subjects. Regular high schools' mean test scores are dispersed near the reference line, although more are located below, meaning that test scores fell slightly after the change in school assignment. Autonomous public high schools are concentrated in the lower-left quadrant. Test scores in these schools were lower than the sample average from the 2009 cohort, but fell further after open enrollment. Similarly, special purpose high schools' test scores also fell post-reform although they are still 1-2 standard deviations above other high schools' mean test scores.

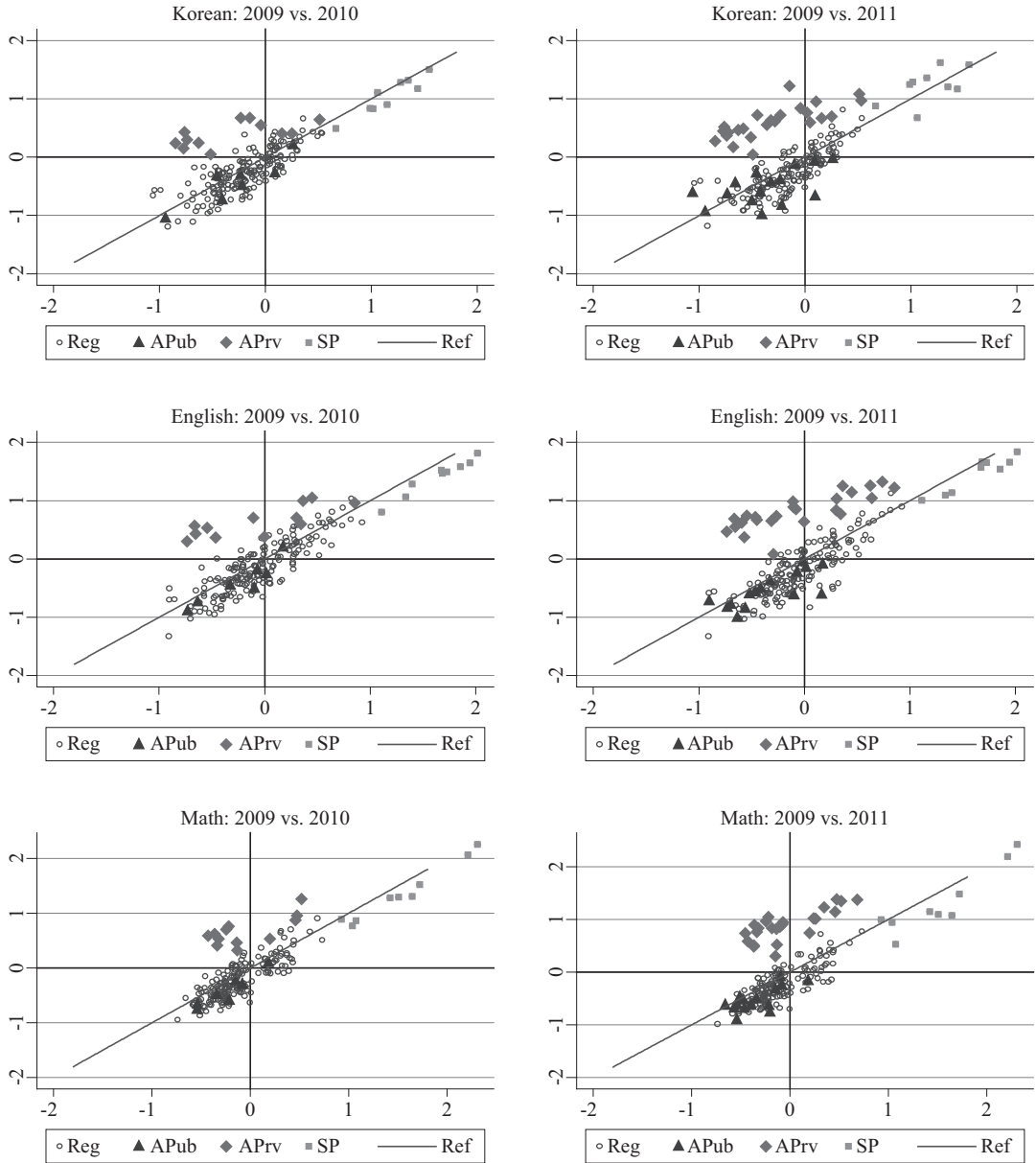
The most salient change is observed among autonomous private high schools. In all three subjects, autonomous private high schools' mean test scores are located above the reference line; on average, test scores of 2010 and 2011 cohorts increased relative to that of the 2009 cohort by about 0.6-0.9 standard deviations. Also, the difference in mean test scores compared to the 2009 cohort is larger for the 2011 cohort than the 2010 cohort. That is, the gain in test scores in autonomous private high schools increased over time.<sup>5</sup>

To explore the differential trends across schools more closely, in Figure 2 we plot test scores across cohorts according to school type. Note that for autonomous private (and public) high schools, we identify their year of conversion – those that became autonomous at the onset of open enrollment (from the 2010 cohort) and those that became autonomous the following year (from the 2011 cohort). We label them *APrv1* and *APrv2* (*APub1* and *APub2*), respectively.

The first observation to make is that the mean test score of autonomous private high schools is comparable to regular high schools' in the 2009 cohort. This is reassuring because it confirms that these high schools were not qualitatively distinct before the policy change. Even in the pre-treatment years, however, special purpose high schools fare better than regular high schools because they could select high-ability students in the “early” stage as mentioned in

<sup>5</sup> Note that the number of data points corresponding to autonomous private schools increased between 2010 and 2011. This is because some regular schools converted to autonomous private a year later than others, as described in Table 2.

FIGURE 1. CHANGES IN TEST SCORES BY SUBJECT



Notes: Mean standardized NAEA score in each school relative to the 2009 cohort's. *Reg* refers to regular high school, *APub* autonomous public high school, *APrv* autonomous private high school, and *SP* special purpose high school. Refer to text for details on each school type. Standardized test scores are calculated as individual score less non-Seoul mean divided by standard deviation for each year and subject.

Section II. Autonomous public high schools score lower than regular high schools because they were purposely initiated in disadvantaged regions.

The 2010 cohort is the first cohort of students affected by enhanced school choice (except in the case of APub2 and APrv2). As outlined in Figure 1 above, test scores of students in autonomous private high schools (APrv1) jump relative to the previous cohort by about 0.66 standard deviations in all three subjects. The increase continues onto the 2011 cohort, amounting to an increment of 0.85-0.92 standard deviations compared to the 2009 cohort.

Test scores in APrv2 – high schools that became autonomous private high schools from the 2011 cohort – also rise and become comparable to APrv1 by the 2011 cohort. One interesting observation is that even before becoming an autonomous private high school (from 2009 to 2010), APrv2's test scores are shown to increase slightly. This is probably because most of the schools that converted to autonomous private high schools were single-sex private regular high schools, traditionally sought after by good students.<sup>6</sup> Students could not state their preferences before open enrollment, but as of 2010, some of the high-ability students who were not accepted by APrv1 or special purpose high schools could have applied to these schools instead.

In the meantime, test scores of regular, autonomous public, and special purpose high schools declined, although levels differ. In particular, APub2 scores are on average about 0.07-0.15 standard deviations lower than APub1 throughout the sample period. This is probably because more competitive schools were first chosen to be autonomous by the Seoul Metropolitan Office of Education. APub2's test scores pick up slightly from 2010 to 2011, narrowing the gap with APub1, but it is still the case that their NAEA scores are lower compared to the initial period or regular public schools'. The finding suggests that the government's attempt to overcome (or at least partially alleviate) educational inequality by introducing more autonomous public high schools may not prove to be fruitful.<sup>7</sup>

These patterns are confirmed in a regression including school fixed effects, as presented in Table 5. The omitted group here is the 2009 cohort in regular high schools in Seoul. Exploiting the three years of test score data, we estimate how the test score time trend in each subject differs for autonomous public and private high schools. Here we exclude special purpose high schools in the estimation of a fixed effects model because their school type did not change throughout the sample period.

The coefficients on cohort dummies are negative and statistically significant, again indicating that test scores in regular high schools fell after the policy change and that the magnitude increased over time. Autonomous public high schools do not seem to present trends meaningfully different from this. The coefficient on *APrivate*, however, is statistically significant and positive. That is, when regular high schools converted to autonomous private high schools, the average academic achievement in the converted schools increases by 0.86-0.93 standard deviations across subjects.

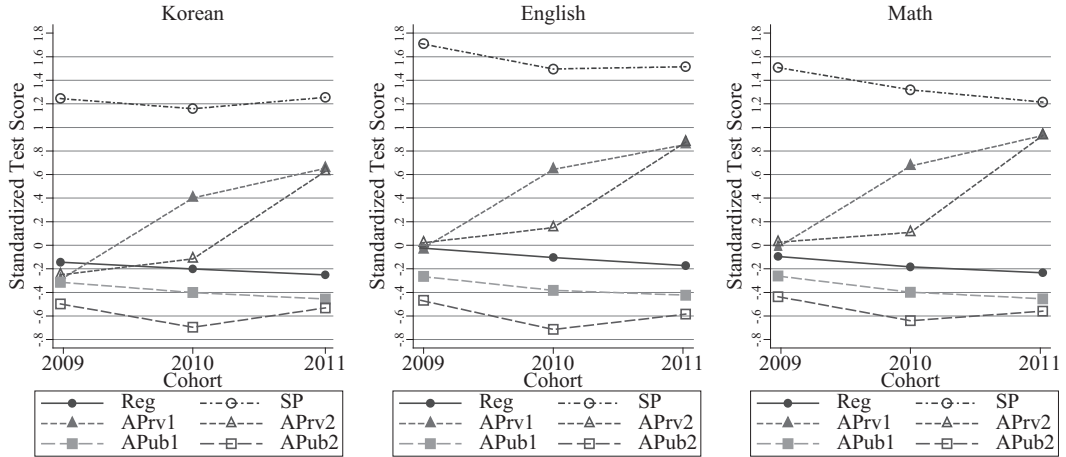
Special purpose high schools seem to lose some of their best students to autonomous

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<sup>6</sup> In Korea, single-sex schools and private schools are believed to be better academic environments for high school students and this belief is confirmed by recent empirical studies (e.g., Choi *et al.*, 2014; Park *et al.*, 2013; Hahn *et al.*, 2013).

<sup>7</sup> Our assessment of autonomous public high schools may be partial if the goal of these schools is in enhancing the overall educational environment of disadvantaged areas rather than improving their students' academic measures.

FIGURE 2. TEST SCORES ACROSS COHORTS BY SCHOOL TYPE



Notes: Effect of school choice on standardized NAEA scores in each subject by school type. *Reg* refers to regular high school, *APub1* (*APub2*) autonomous public high school that converted in 2010 cohort (2011 cohort), *APrv1* (*APrv2*) autonomous private high school that converted in 2010 cohort (2011 cohort), and *SP* special purpose high school. Refer to text for details on each school type. Standardized test scores are calculated as individual score less non-Seoul mean divided by standard deviation for each year and subject.

TABLE 5. EFFECT OF EXPANDED SCHOOL CHOICE WITHIN SEOUL, INCLUDING SCHOOL FIXED EFFECTS

Variable	Korean	English	Math
2010 Cohort	-0.060*** (0.005)	-0.084*** (0.005)	-0.095*** (0.005)
2011 Cohort	-0.092*** (0.006)	-0.133*** (0.006)	-0.123*** (0.006)
APublic	0.025 (0.020)	0.015 (0.020)	-0.014 (0.019)
APrivate	0.869*** (0.015)	0.865*** (0.014)	0.925*** (0.014)
Constant	-0.173*** (0.004)	-0.039*** (0.004)	-0.095*** (0.004)
N	242,150	242,097	242,118

Notes: Effect of expanded school choice on NAEA test scores among students in Seoul. Dependent variable is standardized NAEA test scores, calculated as individual score less non-Seoul mean divided by standard deviation for each year and subject. *APublic* (*APrivate*) is an indicator variable that equals 1 if the student's high school is autonomous public (private) high school. Refer to text for details on each school type. \*  $p < .1$ ; \*\*  $p < .05$ ; \*\*\*  $p < .01$ .

private high schools. Given the college admission process which incorporates a student's relative ranking within a school, some of the high-achieving students find autonomous private high schools more attractive than special purpose high schools because the former can provide less competitive environment. As the number of autonomous private high schools increased under the education reform, more of the high-ability students (among which could afford the

tuition) could enter these schools instead of regular and autonomous public high schools. As a result, the average test scores in the remaining schools fell.

In sum, school choice does not benefit all students (or schools). The average quality of students in autonomous private high schools increased at the cost of lowering the average quality of students in other high schools. The gain is not larger than the cost, resulting in weakly negative policy effects when Seoul high schools are considered altogether.

The results imply that expanded school choice does not only sort students by their academic ability, but that peer effects among students and interactions between teachers and students thereafter may cause the gap in academic performance to widen across schools. In fact, according to a 2011 survey of teachers in Seoul high schools, 57.2 percent of teachers respond that the composition of the entering student body changed such that the fraction of low-ability students increased and 47.2 percent of teachers report that the learning atmosphere in their schools has deteriorated after school choice expansion (Kim 2011).

## 2. Inequality

To investigate whether school choice resulted in larger inequality across schools in terms of student's test scores, we calculate the intraclass correlation coefficient (ICC) of NAEA scores in each subject and cohort using a two level hierarchical linear model without any explanatory variables included in the model. That is, we calculate how much of the total variance in students' test scores of one subject can be explained by variance in test scores between schools (as to within).

Table 6 presents the ICC estimates. The first row of each panel is the variance in NAEA scores at the school level, the second row is the variance at the student level, and the third row is the proportion of total variance accounted for by school level variation – ICC. In the case of Seoul, we observe an increase in ICC across years: from 0.135 to 0.203 in Korean, from 0.198 to 0.265 in English, and from 0.162 to 0.255 in math. That is, the proportion of total variance in test scores that can be attributed to differences between schools has become larger in Seoul. During the same period, however, ICC of test scores in non-Seoul high schools remained roughly constant, which provides indirect evidence that there was not a major change in educational system across cohorts outside Seoul.

Which students were affected most by the policy and the resulting inequality across schools? In Figure 3, we plot NAEA scores in Seoul high schools and non-Seoul high schools by percentile distribution. The x-axis is the relative ranking (percentile) and the y-axis is the difference in the standardized test scores between Seoul and non-Seoul high schools. Thus the horizontal zero line refers to no difference in test scores between the n-th percentile student in Seoul and the n-th percentile student outside Seoul.

Regardless of year and academic subject, one common observation to make is that the difference between Seoul and non-Seoul high schools is negative in the lower part of the test score distribution and positive in the higher part of the test score distribution. That is, there are both very-low ability and very-high ability students in Seoul relative to non-Seoul high schools. This is consistent with the higher student-level variance in Seoul high schools relative to non-Seoul high schools in Table 6. Specifically, relative to the 2009 cohort, the bottom 10th percentile of students' standardized test scores fell by 0.15 in English and 0.19 in math in 2011, widening the gap in test scores with the 10th percentile students outside Seoul. The relative

TABLE 6. INTRACLASS CORRELATION COEFFICIENT OF TEST SCORES

	Seoul			Non-Seoul		
	2010	2011	2012	2010	2011	2012
<i>Panel A: Korean</i>						
School level	0.181	0.215	0.292	0.291	0.298	0.286
Student level	1.158	1.170	1.143	0.778	0.776	0.781
ICC	0.135	0.155	0.203	0.272	0.278	0.268
<i>Panel B: English</i>						
School level	0.266	0.309	0.399	0.382	0.353	0.357
Student level	1.078	1.117	1.109	0.708	0.725	0.721
ICC	0.198	0.217	0.265	0.351	0.328	0.331
<i>Panel C: Math</i>						
School level	0.203	0.267	0.348	0.388	0.373	0.376
Student level	1.052	1.053	1.017	0.722	0.725	0.720
ICC	0.162	0.202	0.255	0.349	0.340	0.343

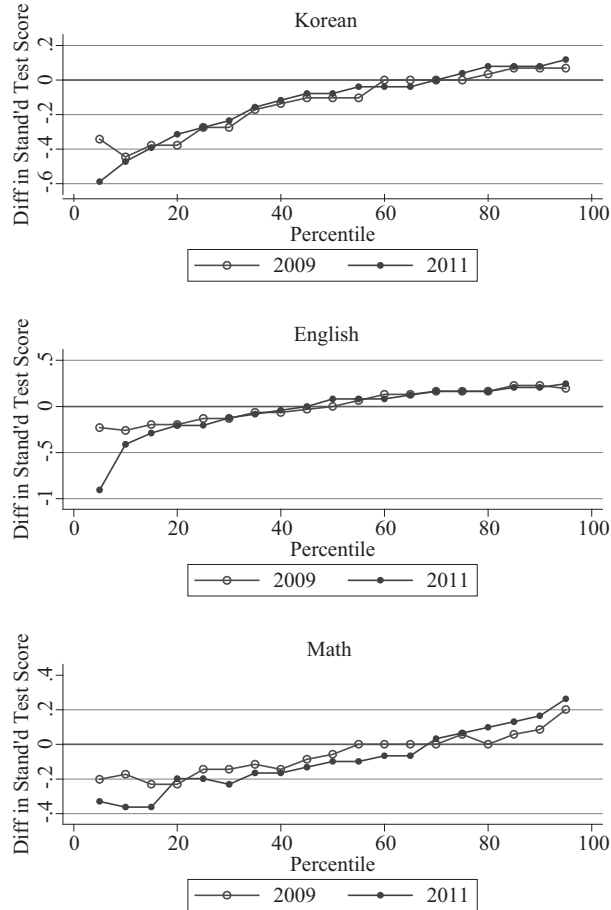
*Notes:* Intraclass correlation coefficient (ICC) of Standardized NAEA test scores by cohort and subject. Standardized test scores are calculated as individual score less non-Seoul mean divided by standard deviation for each year and subject.

drop in Seoul test scores is in fact observed further up the distribution, until the 25th percentile in English and 65th percentile in math.<sup>8</sup> To examine the distributional effects more precisely, we also present results from quantile regression analysis in Appendix Table 1. Consistent with Figure 3, policy impacts are negative for students in the lower tail of the distribution for English and math whereas mostly positive for student at the upper quantiles. In particular, after the reform, math test scores increased in Seoul (relative to non-Seoul) by 0.078 standard deviations at the 0.9 quantile.

In sum, the variance in students' test scores explained at the school level increased with the new school choice policy in Seoul as better students sorted themselves into autonomous private high schools and into traditionally preferred regular high schools (such as private and single-sex schools). Observing the full test score distribution, we find that the increased variance in Seoul is mostly driven by students in the bottom of the distribution – their test scores fell noticeably after the change in the school assignment program.

<sup>8</sup> Test scores of reading in the native language (Korean) seem to be less responsive to changes in policy compared to other subjects. This is also found in the value-added literature: test scores are more sensitive to teacher efforts for math than for language. This may be because schools and teachers ultimately have less influence over language development; students learn language skills from many sources, particularly their families, while they learn math skills primarily in school (*Learning about Teaching: Initial Findings from the Measuring Effective Teaching Program*, Bill and Melinda Gates Foundation, December 2010).

FIGURE 3. TEST SCORE DISTRIBUTION, SEOUL VERSUS NON-SEOUL SCHOOLS



*Notes:* Percentile distribution of NAEA scores in Seoul high schools relative to that of non-Seoul high schools. The x-axis refers to the percentile (from bottom 5th to top 95th) and the y-axis refers to the difference in test scores between Seoul and non-Seoul in each n-th percentile. Standardized test scores are calculated as individual score less non-Seoul mean divided by standard deviation for each year and subject.

## VI. Conclusion

High school assignment program in Seoul changed from within-district random assignment to open enrollment in 2010, and more regular high schools were encouraged to convert to autonomous high schools. As a result, families were allowed more choice (both in terms of location and school type) after the policy change. Special purpose high schools and autonomous private high schools could select their students among applicants in the “early” stage. Students who were not selected then could apply to any regular or autonomous public high school in the city regardless of school district.

This paper uses data on the National Assessment of Educational Achievement (NAEA) test scores of 11th graders over three years. Comparing students' test scores before and after the policy change and also in and out of Seoul, we find the following. First, overall, average test scores in Seoul did not improve after the reform. Second, there are differential effects across school type in Seoul such that autonomous private high schools' test scores increased substantially whereas other (regular, autonomous public, and special purpose) high schools' test scores fell. As a result, the gap in test scores across schools widened. Third, students at the bottom of the test score distribution were negatively affected by the reform in particular.

Although these results may not be extrapolated to all settings, they provide insight that could be relevant to a more general context. Enhanced school choice expands the choice set of parents and students, but it may lead to increased sorting rather than being a "tide that lifts all boats," aligned with other recent studies in the topic (e.g., Hoxby 2003). Policies rarely benefit everyone, but it is noteworthy that the most disadvantaged students may be hurt by school choice. Efforts to enhance productivity among regular schools through competition and in deprived areas through the introduction of autonomous public schools proved insufficient to alleviate the side effects of cream-skimming. In this sense, the specific structure of the school assignment program – whether some schools get the privilege of selecting students at the "early" stage – for instance, could be critical in determining the policy outcome.<sup>9</sup>

Our study is subject to the following limitations, suggesting areas for future research. First, the data spans three years, which may not be long enough to capture long-run effects. For example, it may take time for schools to respond to the new system by improving their competitiveness.<sup>10</sup> Second, we could not further test underlying mechanisms of our results because we lacked information on individuals' previous academic performance before high school or their application records (preference lists). Lastly, because two major changes – open enrollment and the conversion of some regular high schools to autonomous high schools – occurred at once, we were not able to identify each effect separately.

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<sup>9</sup> See Abdulkadiroglu & Sönmez (2003) and Pathak (2011) for a mechanism design approach to school choice issues.

<sup>10</sup> We thank the referee for pointing this out.



## APPENDIX

TABLE 1. DISTRIBUTIONAL EFFECTS OF EXPANDED SCHOOL CHOICE,  
QUANTILE REGRESSION

	Quantile				
	0.1	0.25	0.5	0.75	0.9
<i>Panel A: Korean (N=879,211)</i>					
Seoul	-0.445*** (0.014)	-0.274*** (0.016)	-0.103*** (0.000)	0.000 (0.000)	0.068** (0.030)
Post-Policy Cohort	0.194*** (0.014)	0.108*** (0.000)	-0.062*** (0.000)	-0.163*** (0.000)	-0.015 (0.028)
Seoul x Post-Policy Cohort	-0.026* (0.015)	-0.001 (0.019)	0.024*** (0.002)	0.039*** (0.000)	0.010 (0.032)
Constant	-1.396*** (0.014)	-0.643*** (0.000)	0.076*** (0.000)	0.726*** (0.000)	1.205*** (0.028)
<i>Panel B: English (N=879,015)</i>					
Seoul	-0.261*** (0.015)	-0.130*** (0.012)	-0.000 (0.002)	0.163*** (0.021)	0.228*** (0.008)
Post-Policy Cohort	0.055*** (0.000)	0.192*** (0.009)	0.059*** (0.015)	-0.065*** (0.024)	-0.232*** (0.011)
Seoul x Post-Policy Cohort	-0.151*** (0.015)	-0.075*** (0.017)	0.082*** (0.024)	0.002 (0.029)	-0.023 (0.023)
Constant	-1.296*** (0.000)	-0.774*** (0.000)	-0.024*** (0.000)	0.759*** (0.014)	1.379*** (0.000)
<i>Panel C: Math (N=879,079)</i>					
Seoul	-0.173*** (0.029)	-0.144*** (0.037)	-0.058*** (0.000)	0.058 (0.043)	0.087** (0.041)
Post-Policy Cohort	0.062*** (0.000)	0.070*** (0.003)	-0.000*** (0.000)	-0.054* (0.033)	-0.059*** (0.000)
Seoul x Post-Policy Cohort	-0.189*** (0.034)	-0.053 (0.037)	-0.041*** (0.000)	0.008 (0.043)	0.078* (0.043)
Constant	-1.282*** (0.000)	-0.763*** (0.003)	-0.099*** (0.000)	0.679*** (0.033)	1.343*** (0.000)

*Notes:* Effect of expanded school choice on students' NAEA test scores. Dependent variable is standardized NAEA test scores, calculated as individual score less non-Seoul mean divided by standard deviation for each year and subject. Seoul x Post-Policy Cohort is an interaction term that equals 1 if the student was assigned to a school in 2011 (as compared to those who was assigned to a school in 2009) and resides in Seoul. Bootstrap standard errors with 500 replications in parentheses; \*  $p < .1$ ; \*\*  $p < .05$ ; \*\*\*  $p < .01$

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