Widening Gap in College Admission

and Improving Equal Opportunity in South Korea[1,2]

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Abstract

As private education becomes widespread over the last decade in South Korea, the education gap among regions and social classes, noticeably widens. The recent global financial crisis exacerbates the problem as the rich continues to utilize more private education while the poor utilizes it less. For the first time, we confirm the widening gap in academic achievement and college admission in recent years by using source materials on Korea's College Scholastic Ability Test (CSAT) and students admitted to Seoul National University (SNU). We also present a simple theory that suggests as the influence of socioeconomic background and educational environment on the entrance exam score rises over that of innate talents, labor productivity of overall society appears to decline. Controlling for student talent by using the scholastic ranking of the 2nd year of middle school, we show that the socioeconomic status and learning environment exert a considerable influence on all college admissions criteria in this country. Finally, we discuss the importance of voluntary efforts by universities for expanding equal opportunity in higher education, as well as the government's response to the growing gap in college admissions.

1. Introduction

There has been increasing concern over the gradually slowing pace of intergenerational mobility in the Korean society. According to the *2011 Social Survey* from Statistics Korea, 41.7% believed that their children are very likely to reach a higher social and economic status than their own, whereas more respondents (43.0%) were more doubtful. This finding is considered an unprecedented case of inversion.[3] Growing negative expectations regarding social mobility are

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[1] This study is constructed mainly on the basis of an in-depth study of source materials on Korea's College Scholastic Ability Test (CSAT), students admitted to Seoul National University (SNU), and Young Chul Kim's earlier monograph, *Improving Equal Opportunity in Admission to Higher Education*, KDI Policy Study 2011-06, Korea Development Institute, 2011 (in Korean).

[2] All districts in this paper are referred to as 'gu' unless otherwise noted.

[3] A negative response regarding the possibility of climbing up the social ladder has been on a constant rise from 19.8% in 2003 to 29.0% in 2006 and then to 43.0% in 2011.

particularly relevant since family and regional backgrounds have been considered increasingly important to the academic achievement of children in South Korea.

A student's innate talents and his parent's social and economic status are regarded as being key to his academic achievement. The latter is obviously an important element since it is closely tied to the quality of parenting and mentoring and the amount of educational investment. In addition, where the student lives has a significant impact on performance as there are distinct differences among educational environments that affect the student's motivation to learn, total study time, and other peer-influenced factors or quality of role models. Particularly in the case of a country like Korea where students are heavily dependent on private education for college admission, wealthier neighborhood translate into more quality educational resources, infrastructure and opportunities, effectively altering the educational destinies of students because of where they live.

As private education became widespread over the last decade in the country, the education gap among regions and social classes noticeably widened while the competitiveness of public education weakened. Further, the growing education gap is hindering the pursuit of equal opportunity in education guaranteed by the Constitution. The growing education gap also works to prevent students from poorer families and regional areas with underdeveloped educational environments from fully developing themselves during their formative school years, significantly undermining the effectiveness of human resource development when viewed from the national perspective. Several efforts have been put forth to resolve the education gap including strengthening public education, restricting private education and implementing programs to upgrade the scholastic ability of less-developed regions. The education gap in secondary education directly leads to opportunity gaps in higher education, and not many studies actively deal with the issue of equal opportunity higher education admissions.

In this regard, this study provides an overview of the widening education gap at the entrance phase of higher education using source materials on Korea's College Scholastic Ability Tests (CSAT) and students admitted to Seoul National University (SNU) for the first time. The results are somewhat surprising in that according to our analysis on students entering SNU, the gap between Seoul and major regional cities as well as the gap among districts within Seoul greatly increased. When comparing data from 2000 and 2011, the SNU admissions rate of high school students in the Seoul area rose from 90 to 95 students per 10,000 students. But the admissions rate of students from six major regional cities such as Pusan, Daegu and Gwuangju dropped sharply from 70 to 43 students per 10,000 students, indicating a two-fold increase in the gap between Seoul and major regional cities in recent years. The gap among areas within Seoul was even more surprising. In districts with high admissions rates like Gangnam-gu and Seocho-gu, 173 and 150 students per 10,000 students, respectively, entered SNU. But for districts with low admissions rates like Guro-gu and Geumcheon-gu, only had 18 students per 10,000 students were admitted to SNU, indicating an approximately ten-fold admission gap between the rich and poor districts in Seoul. CSAT dataset analyses confirm other similar trends.

We also present a simple theory model that evaluates economic efficiency influenced by the admissions system and implications for the system's improvement. Assuming that labor productivity is determined by proper job placement of talented individuals, this study compares the labor productivity of meritocracy, the caste system and the complex system, which is a hybrid of the two systems, while simultaneously exploring specific measures that could enhance the labor productivity of a given society. The study concludes that the influence of socioeconomic background and educational environment on entrance exam scores surpasses that of the innate talents of individuals, and labor productivity of the overall society appears to decline. Using a simple theory model, the study proves that admission policies for giving preference to students from educationally disadvantaged regions could later help upgrade social efficiency as well as equality.

In addition, we conduct a full-scale empirical analysis on the gap in admission. The study conducts a quantitative analysis on the degree of influence on admission to the university according to socioeconomic status, educational environment during the school years and residential district. It is notable that we improve on the empirical findings of previous literature such as Bang and Kim (2002), Kim (2005) and Ryu and Kim (2006) by controlling for the students' innate talents. We use the scholastic ranking of the student during his second year of middle school as a partial proxy for innate intelligence given that private education typically occupies the years that follow for college preparation. Rankings or test results in later years would be heavily influenced by private investment in education. Through this analysis, we point out that both the socioeconomic status and learning environment exert a considerable influence on all criteria for admission to college and universities in South Korea, which include admission to four-year universities, the top 30 universities, and the nine prestigious universities, as well as CSAT results.

Finally, we discuss measures for developing Korea's higher education systems. The importance of voluntary efforts by universities is emphasized as a way to improve equal opportunity through programs such as those incorporating regional quotas and preferences to recipients of social care services. At the same time, we stress that strengthening the fairness and credentials of the Korean admissions officers is a prerequisite to consolidating the system itself and securing equal admission opportunities based on students' potential and talents. We also propose setting up a standing government organization that directly monitors and addresses the admissions gap among regions and social classes.

This paper is organized as follows: Section 2 discusses the widening gap in college admissions between capital and rural areas, and among different districts in the metropolitan cities in South Korea. Section 3 introduces a simple model that evaluates the college admissions system and its relevance to economic efficiency. Section 4 intensively analyzes differences in admissions outcomes according to variables such as socioeconomic status, learning environments and regions. Section 5 contains concluding remarks and suggestions for policy measures to close the widening gap in admissions in the Korean context.

2. The widening gap in college admissions in Korea

In this section, we discuss the phenomenon of Korea's widening admissions gap. The gap between capital and rural areas is examined first, followed by the gap among different districts in large cities.

2.1 Admissions gap between capital and rural areas

An analysis of source materials on Korea's College Scholastic Ability Test (CSAT) reveals that the gap in academic achievement has consistently widened between capital (Seoul, Gyeonggi province) and rural areas for the past several years. In Figure 1, Panel A. Mathematics shows the yearly achievement (evaluated on a scale of 1-9, also known as the stanine grading system) of students whose percentile rank on the CSAT Mathematics section are within the top 4%, (stanine score 1). This translates into the relative percentage of the stanine score 1 achievement of students in each region against the total percentage throughout the whole nation.[4] According to this figure, the stanine 1 students in Seoul accounted most recently for 127%, whereas others in the six metropolitan cities[5] accounted for merely 86%. In a comparison between Gyeonggi province and the other eight local provinces,[6] the former recorded 98%, and the latter recorded 86%. What is more concerning is that the gap between capital and local areas continues to widen at an alarming pace. The same trend is confirmed in the Panel B. Foreign Language (English) section.[7]

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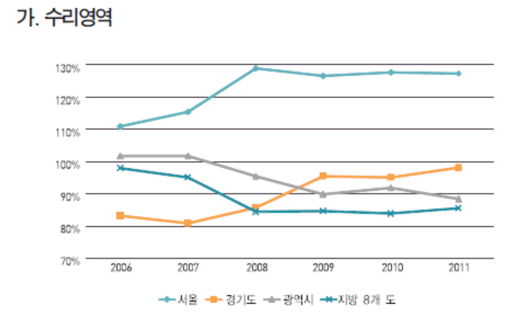
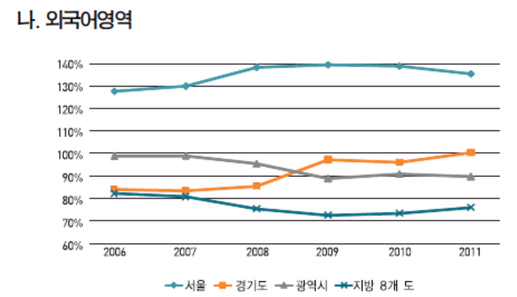
[4] In the CSAT, students with the stanine score 1 in mathematics accounted for 3.9% of the total. Among students from Seoul and Gyeonggi Province, stanine score 1 students accounted for 5.0% and 3.9%, respectively. Students from the six metropolitan cities and eight other provinces made up 3.5% and 3.4% of the score, respectively.

[5] Busan, Daegu, Incheon, Gwangju, Daejeon and Ulsan.

[6] Gangwon, Northern Chungcheong, Southern Chungcheong, Northern Jeolla, Southern Jeolla, Northern Gyeongsang, Southern Gyeongsang and Jeju.

[7] The stanine score 1 achievement in the foreign language section recorded 135% for Seoul against the nationwide average, which is 45%p higher than that for the six metropolitan cities (90%). Gyeonggi province as well recorded a high percentage of 100%, or 14%p higher than the other eight provinces. Between metropolitan and rural areas, the stanine score 1 achievement gap in the foreign language section is larger than that of the mathematics section.

[Figure 1] Year-on-Year Changes in CSAT Stanine Score 1 by Region

	A. Mathematics Seoul Gyeonggi province 6 metropolitan cities 8 local provinces
	B. Foreign Language Seoul Gyeonggi province 6 metropolitan cities 8 local provinces
주: 지역별 수능 1등급 성취도는 전국의 수능 1등급 비중 대비 각 지역의 1등급 학생 비중의 상대비율임. 자료: 대학수학능력시험 성적 원자료.	Note: The stanine score 1 achievement of students in the CSAT by region is the value gained by dividing the percentage of stanine score 1 students in each region by the total percentage for the whole nation. Source: Raw data on CSAT scores

The regional gap in CSAT achievement is linked directly to the gap in admissions to high-ranking universities. This study uses the admissions percentage for Seoul National University (SNU) as a barometer. The total number of SNU freshmen has fallen by approximately 1,200 over the past decade due to the reduction in the number of undergraduate courses. Accordingly, the number of high school graduates admitted to SNU fell to 50.2 per group out of 10,000 persons in 2011 from 58.3 in 2000. However, during the same period, Seoul posted a rise in the number of students admitted to SNU from 90.3 in 2000 to 94.9 in 2011. Gyeonggi province also sharply rose from 31.2 to 39.6. These trends are in contrast to the sharp decline (69.9 to 42.7) for the six metropolitan cities and (38.6 to 37.4) in the other eight provinces.[8]

When the relative percentage of admission to SNU by region against the national average is defined as 'relative admission percentage', admission to SNU by region indicates a shifting trend in Figure 2. The relative admission percentage of Seoul recorded around 155% in 2000, continuing to rise gradually to 189%. Gyeonggi province as well shows a continuous rise from around 55% until 2003 to nearly 80% today. In contrast, the six metropolitan cities display a continuous decline to 85% after peaking at 120% in 2000.[9] Meanwhile, when comparing admissions to high-ranking universities (as of 2008), Seoul marked 6.0%, 2.1% for metropolitan cities and 1.9% for small- and medium-sized cities, reconfirming a marked gap between Seoul and provincial areas.[10]

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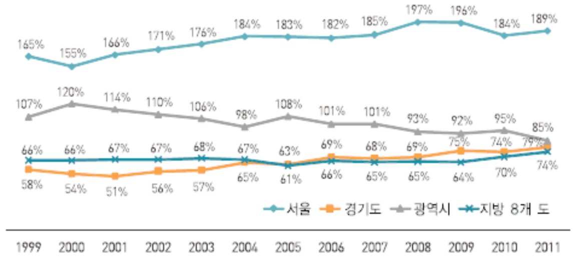
[8] As of 2011, admission to SNU per 10,000 persons in Seoul and the six metropolitan cities recorded 94.9 for Seoul, 43.7 for Busan, 42.9 for Daegu, 32.0 for Incheon, 56.6 Gwangju, 53.8 for Daejeon and 31.2 Ulsan. Gyeonggi and the other eight provinces recorded 39.6 for Gyeonggi, 46.3 for Gangwon, 32.1 for Northern Chungcheong, 39.9 for Southern Chungcheong, 44.4 for Northern Jeolla, 32.7 for Southern Jeolla, 34.8 for Northern Gyeongsang, 34.1 for Southern Gyeongsang and 41.5 for Jeju.

[Figure 2] Relative percentage of admission to SNU by region against the national average (Relative admission percentage)



Seoul
6 metropolitan cities
Gyeonggi Province
8 local provinces

Note: 1) Relative admission percentage is the value gained by dividing the regional number of high school graduates admitted to SNU per group of 10,000 students by the average number of those admitted to SNU per group of 10,000.
2) Based on the number of students admitted under quota
3) Number of high school students by region (2011): 122,000 in Seoul, 150,000 in Gyeonggi province, 182,000 in metropolitan cities, and 195,000 in 8 rural provinces.
Source: *Number of SNU Freshmen by High School* (data from National Assembly), each year

The widening gap in admissions between capital and rural areas is apparently driven by several reasons such as the weakening competitiveness of public education in the rural areas, poor quality of candidates from rural areas, and the widening economic divide between capital and rural areas. The growing dependency on private education for admission to college has been pointed out as another significant reason. In particular, monthly spending for private education per middle school student shows a gap of 60,000 won between Seoul and metropolitan cities (or between Gyeonggi and the other eight provinces), whereas that per high school student preparing for admission to college shows a gap of 175,000 won between Seoul (420,000 won) and metropolitan cities (245,000 won), according to Figure 3. The gap between Gyeonggi and the other eight provinces is as high as 116,000 won. Considering how institutions specializing in entrance exams are densely concentrated in the capital area, students in local areas are at a disadvantage when having to compete with these well-resourced candidates.[11]

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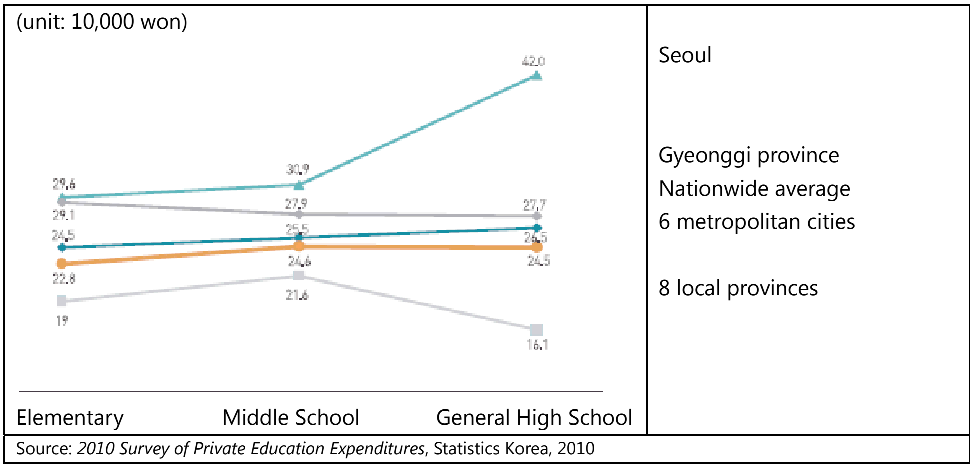
[9] As of 2000, the other eight provinces (66%) also posted a much higher percentage than Gyeonggi province (54%), but recent data shows an inverted gap of around 5%p.

[10] This is the result of follow-up studies on 2,000 students across the nation who were in the 3rd year of middle school in 2004, using the data from the Korean Education & Employment Panel. Refer to the note in Table 2 for the list of nine highly ranked universities that includes Seoul National Univ., Korea Univ., Yonsei Univ., etc.

[Figure 3] Monthly Private Education Expenditure per Student by Education Stage



Source: *2010 Survey of Private Education Expenditures*, Statistics Korea, 2010

2.2 Admissions gap among different districts in large cities

The admissions gap also continues to grow among different districts within large cities. Panel A in Figure 4 shows the comparison of the stanine score 1 achievement in mathematics in CSAT for 2002 and 2011 among different district education offices in Seoul alone.[12] The stanine score 1 achievement here refers to the relative percentage of the stanine score 1 achievement of student candidates (excluding graduates from special-purpose high schools) in each district against the total percentage (excluding graduates from special-purpose high school) of Seoul as a whole. As of school year 2002, the percentage of candidates who achieved the stanine score 1 in Gangnam and Seocho districts—which accommodate schools famous for their high rate of admission to top-ranked colleges and universities—turns out to be already 1.9 times more than the average for Seoul, which has since risen to nearly 2.3 times. On the other hand, the percentage of the stanine score 1 achievement in districts with lower-ranking schools recorded only 60% of the Seoul average in 2002, falling most recently to below 40%. This points to a growing polarization in which districts with high scores have only gotten higher, while those with low scores fell further by 20%p. As Panel B shows, such district gaps are even greater when it comes to foreign language scores.[13]

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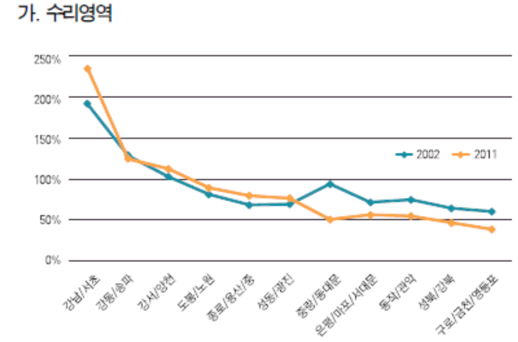
[11] Private education expenditure per student in the six metropolitan cities accounted for 78.2% of that in Seoul in 2003 (according to the Korea Educational Development Institute), but decreased continuously to 70.7% in 2010 (according to Statistics Korea).

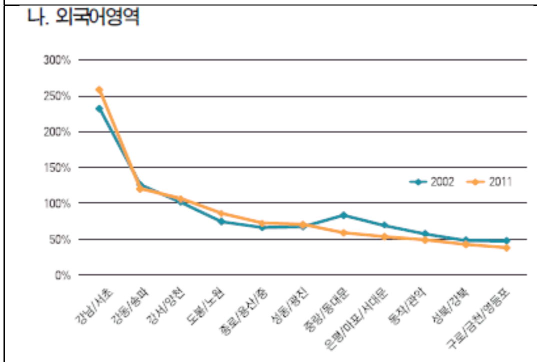
[12] The education administration in Seoul is composed of 11 district education offices, each of which has jurisdiction over 2 or 3 districts (gu) out of 25 autonomous districts in Seoul.

[Figure 4] Changes in Stanine Score 1 Achievement in CSAT Mathematics for 2002 and 2011 by District Education Office in Seoul


가. 수리영역

A. Mathematics.

Gangnam/Seocho
Gangdong/Songpa
Gangseo/Yangcheon
Dobong/Nowon
Jongro/Yongsan/Jung
Seongdong/Gwangjin
Jungnang/Dongdaemun
Eunpyeong/Mapo/Seodaemun
Dongjak/Gwanak
Seongbuk/Gangbuk
Guro/Geumcheon/Yeongdeungpo


나. 외국어영역

B. Foreign Language

Gangnam/Seocho
Gangdong/Songpa
Gangseo/Yangcheon
Dobong/Nowon
Jongro/Yongsan/Jung
Seongdong/Gwangjin
Jungnang/Dongdaemun
Eunpyeong/Mapo/Seodaemun
Dongjak/Gwanak
Seongbuk/Gangbuk
Guro/Geumcheon/Yeongdeungpo

주: 지역교육청 지구별 수능 1등급 성취도는 서울의 1등급 학생 비중 대비 각 지구의 1등급 학생 비중의 상대비율임. 단, 특목고 학생들은 표본에서 제외함.
자료: 대학수학능력시험 성적 원자료.

Note: 1) The stanine score 1 achievement of students in CSAT by district is the value gained by dividing the percentage of stanine score 1 students in each district of Seoul by the total percentage for Seoul as a whole. Special-purpose high school graduates are excluded from the sample.
2) Each district education office covers 2 or 3 administrative districts (gu) in the Metropolitan Seoul area.
Source: Raw data on CSAT scores

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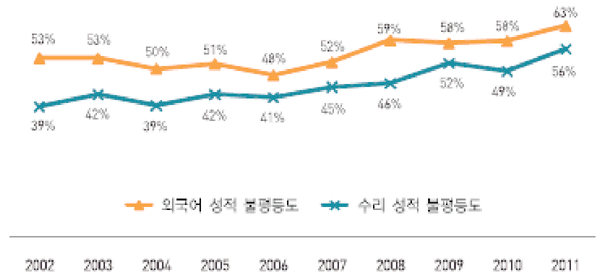
[13] Achievement in foreign language shows that the percentage of the stanine score 1 in Gangnam and Seocho was 2.3 times higher than the Seoul average in 2002, most recently rising to 2.6 times. The percentage of the stanine 1 score achievement in districts with low scores accounted for only 45% of the Seoul average in 2002, recently falling further to 40%.

Such a growing gap in achievement among different residential districts can be confirmed by calculating the degree of inter-district inequality (using the standard deviation of the stanine score 1 achievement between districts) (Figure 5). The inequality in mathematics has risen by as high as 17%p over a decade from 39% in 2002 to 56% in 2011. The foreign language field posted a rise of 10%p from 53% in 2002 to 63% in 2011. Alarmingly, this figure has already exceeded the 60% level.

[Figure 5] Degree of Inter-district Inequality of CSAT Stanine Score 1 Achievement within Seoul



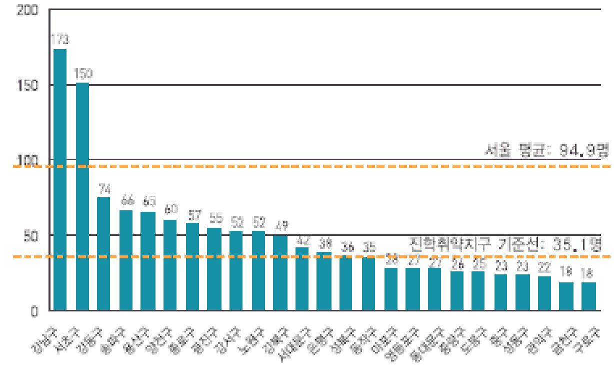
Inequality of foreign language scores

Inequality of mathematics scores

Note: Degree of inequality is gained by calculating the standard deviation of the stanine score 1 achievement between districts. Special-purpose high school graduates are excluded from the sample.
Source: Raw data on CSAT scores

Determining the admissions gap at highly ranked universities is done by using the rate of admission to SNU as a barometer. Figure 6 displays the SNU admission rate by district, which indicates the number of students admitted to SNU per group of 10,000 high school graduates (excluding those from special-purpose high schools) in each district (as of 2011). It shows that Gangnam and Seocho districts have 173 and 150 students, respectively, admitted to SNU, whereas lower-ranked districts have only 18 students, translating into a 9-fold gap. Also, considering that the average rate of admission to SNU recorded 50.2 students on a nationwide basis, the number of 'districts with a poor admission rate (35.1 students or less)' where their admission rates are even below 70% of the nationwide average accounted for 11 out of the total 25 districts.

[Figure 6] SNU Admission Rate by District in Seoul



Seoul Average: 94.9 students

Baseline for districts with poor admission rates: 35.1 students

Gangnam/Seocho/Gangdong/Songpa/Yongsan/Yangcheon/Jongro/Gwangjin/Gangseo//Nowon/Gangbuk/Seodaemun/Eunpyeong/Seongbuk/Dongjak/Mapo/Yeongdeungpo/Dongdaemun/Jungnang/Dobong/Jung/Seongdong/Gwanak/Geumcheon/Guro

Note: 1) SNU admission rate indicates the number of students admitted to SNU per group of 10,000 high school graduates.

2) Based on data on general high school graduates. Special-purpose high schools (science, foreign language, and art-specialized high schools) are excluded given their right to choose their own students.

3) Seoul average (94.9 students) and nationwide average (50.2 students) include the number of special-purpose high school graduates.

4) Baseline for districts with poor admission rates (35.1 students) is set to 70% of the nationwide average (50.2 students).

Source: *Number of SNU Freshmen by High School for 2011* (data from National Assembly) and Educational Statistics by Korean Educational Development Institute (KEDI)

Examining the change in the admission gap in Seoul requires a year-to-year comparison of SNU freshmen originating from high schools in Seoul by school district (Figure 7). Above all, it should be noted that the percentage of special-purpose high school graduates has risen sharply from 22.8% in 2002 to 40.5% in 2011, even though the number of graduates from 15 major special-purpose high schools accounts for only 3% of the total number of high school graduates in Seoul.[14] This phenomenon is a clear testament to the growing inequality between residential districts given that more than half of all special-purpose high school students are from the three districts near Gangnam (Gangnam-gu, Seocho-gu and Songpa-gu) and a few other areas (Yangcheon-gu, Gwangjin-gu and Gangdong-gu) well known for their overheated private education markets.

In addition, the percentage of SNU freshmen from high schools located in three districts near Gangnam and special-purpose high schools – all in Seoul – increased from 56.2% in 2002 to 65.7% of total freshmen in 2011. Adding the graduates of the other three superior school districts (Yangcheon-gu, Gwangjin-gu and Gangdong-gu) raises the percentage up to 74.3%, meaning that approximately three out of four SNU freshmen from Seoul are from special-purpose high schools or one of the six top-ranked school districts. On the other hand, the percentage of SNU freshmen from the other 19 school districts in Seoul dropped from 32.5% in 2002 to 25.5% in 2011.[15] In particular, the percentage of SNU freshmen from the five lower-ranked school districts (Guro-gu, Geumcheon-gu, Jung-gu, Seongdong-gu and Jungnang-gu) remained at around the 3% level.

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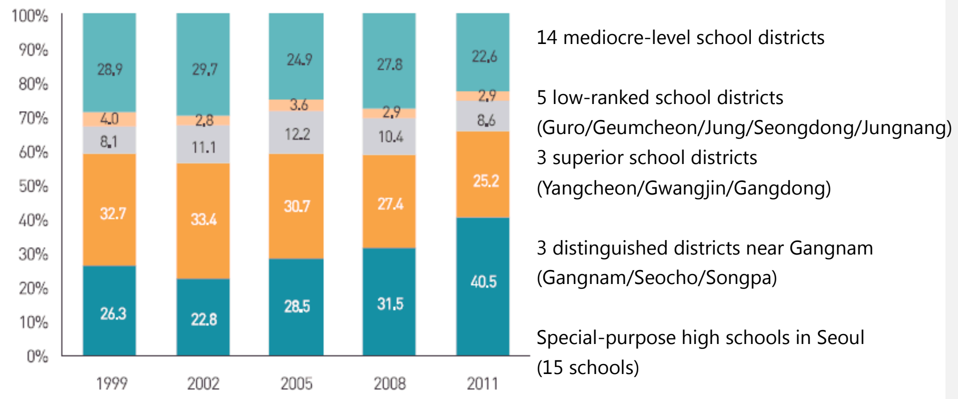
[14] In 2011, the number of special-purpose high schools in Seoul with one or more graduates admitted to SNU totaled 15 schools, including 3 science high schools, 6 foreign language high schools, 4 art high schools, 1 gukak (traditional arts) national high school and 1 global high school.

[Figure 7] Yearly Changes in School District Compositions of SNU Freshmen in Seoul



Source: *Number of SNU Freshmen by High School in 2011* (data from National Assembly)

Other large cities have indicated similar trends. The study also shows that “districts with poor admission rates” defined as 35.1 students or less exist widely in large cities across the nation. For instance, 13 out of 16 districts (gu/gun) in Busan, 6 out of 8 districts (gu/gun) in Daegu and all of the districts (gu/gun) in Incheon are considered to have poor admission rates. Gwangju with its relatively high academic achievement record is the only region that has not fallen into this category.

A widening gap in college admission in large cities is partly attributable to high performing students leaving the school district, contributing to a poor admission rate and the polarization of economic resources among different districts. However, there is no doubt that the admission gap is also the result of the increasing disparity in inter-district educational environments. Above all, a student’s educational environment and his or her school district are largely determined by his parents’ economic status. With increasing dependency on private education, family background has undeniably played an increasingly significant role in determining the outcome of college admissions.[16]

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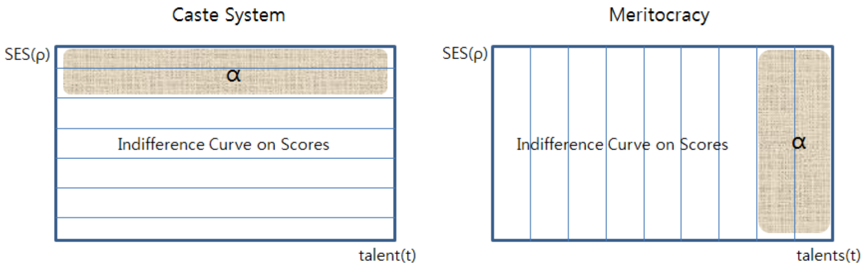
[15] In particular, the percentage of SNU freshmen from the five low-ranked school districts (Guro-gu, Geumcheon-gu, Jung-gu, Seongdong-gu and Jungnang-gu) has stayed at around 3% level.

3. A simple model on equal opportunity and social efficiency

In this chapter, we introduce a simple theoretical model that shows how inequities in educational opportunity may impede economic efficiency in a society. Let us start by supposing that a student's scholastic performance (s) is affected by his innate talent (t) and social and economic status (ρ). The main factors that determine social and economic status are parental income, their occupation and education level, and the amount of family wealth.

First, focus on how the social and economic backgrounds are connected to the student's scholastic performance. As many studies manifest (e.g. Kim (2011), entering one of the prestigious universities is regarded as a key step to achieving both social and economic success in Korea. This admission to a prestigious university heavily depends on the College Scholastic Ability Test (CSAT) score, which measures the scholastic performance of students. We may define two extreme types of societies. "Meritocracy" occurs when the CSAT score is determined by individual talent: $s=f(t)$. The other is the "caste system" society, where the CSAT score is determined solely by the individual's social and economic status: $s=f(\rho)$. For each type of society, we may draw an indifference curve [Figure 8]. The real world we live in would be somewhere between these two extremes, defined as a "complex society": $s=f(t,\rho)$.

[Figure 8] Indifference curves for meritocracy and caste systems



3.1 Basic model setup

For the sake of simplicity, it is assumed that there are only two types of universities – upper level and lower level universities. "α" denotes the share of students who enter the upper level universities, thus the share of students who enter the lower level universities is "1-α". Suppose that the graduates of upper level universities work in skilled sectors, and the lower level universities graduates work in unskilled sectors. Without loss of generality, the productivity base for workers in the skilled sector is one, and the productivity base for workers in the unskilled sector is normalized to be zero, which implies that equipment is properly provided to a worker in the skilled sector while no equipment is provided in the unskilled sector. When we assume that each worker's productivity is determined by his innate talent (t) times the productivity base, the labor productivity for the worker in the skilled sector whose innate talent is t should be t, and the labor productivity for the worker in the unskilled sector whose innate talent is t should be zero. That is, in the skilled sector, each individual's productivity is proportional to his level of innate talent but, in the unskilled sector, each individual's productivity remains at zero regardless of his level of innate talent.

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[16] A high school student in three districts near Gangnam spends 568,000 won, whereas other districts spend 381,000 won, resulting in a 1.5 times difference according to the *2010 Survey of Private Education Expenditures* released by Statistics Korea.

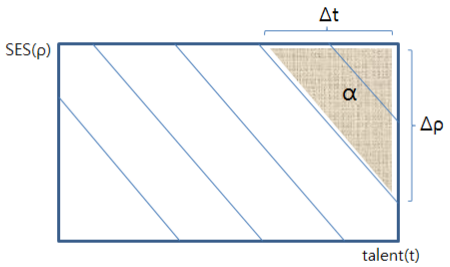
It is assumed that the individual level of innate talent (t) and the level of individual social and economic status (ρ) are both uniformly distributed with fixed support. That is, $t \sim U[0, \bar{t}], \rho \sim U[0, \bar{\rho}]$. Further, for the sake of simplicity, we assume that the uniform distributions for "t" and "ρ" are independent of each other (i.e. $t \perp \rho$). However, note that the following theoretical outcomes still work in the case of a positive relationship between the two terms. When we normalize the population size for each cohort to be one, we get $\bar{t} \cdot \bar{\rho} = 1$. Without loss of generality, the CSAT score is assumed to be a linear function of the innate talent (t) and the level of individual social and economic status (ρ). The marginal effect of increasing one unit of "t" for the CSAT score is set at k_t, and the marginal effect of increasing one unit of "ρ" for the CSAT score set at k_ρ. Therefore, the individual CSAT score can be expressed as the following function:

$$s = k_t t + k_\rho \rho. \tag{1}$$

Thus, $k_t = 0$ represents the caste system, and $k_\rho = 0$ is for the meritocracy. For the complex society, $k_t > 0$ and $k_\rho > 0$, in which we have the downward slopping indifference curve for the CSAT score as shown in [Figure 9]. Since the share of students who enter upper level universities is fixed as "α", the shaded area in [Figure 8] and [Figure 9] represents graduates of upper-level universities. When we denote Δt and Δρ for the width and height of the shaded area of the triangle in [Figure 9], $\Delta t < \bar{t}$ and $\Delta \rho < \bar{\rho}$ are satisfied if "α" is small enough. In the following discussion, we maintain the condition, under which we always have

$$\Delta t = \sqrt{\frac{2\alpha k_\rho}{k_t}}; \;\; \Delta \rho = \sqrt{\frac{2\alpha k_t}{k_\rho}}. \tag{2}$$

[Figure 9] Indifference curve and the share of upper level university graduates “α”



3.2 Implications of the model

Since the productivity of the workers in the skilled and unskilled sector is t and zero, respectively, the aggregate productivity of a cohort (π) for each type of society can be calculated using the following double integration method. First, the aggregate productivity of the cohort for the “Complex Society” (π*) can be derived as follows:

$$\begin{aligned} \pi^* &= \int_{t-\Delta t}^{\bar{t}} \int_{\rho'(t)}^{\bar{\rho}} t \; d\rho \, dt, \;\text{ in which } \rho'(t) = \frac{k_t}{k_\rho}(\bar{t} - \Delta t - t) + \bar{\rho} \\ &= \alpha\bar{t} - \frac{\alpha\Delta t}{3}. \end{aligned} \tag{3}$$

Note that the function ρ′(t) represents the corresponding level of ρ points for each value of t on the hypotenuse of the shaded right-angled triangle in [Figure 9], which connects $(\bar{t} - \Delta t, \bar{\rho})$ and $(\bar{t}, \bar{\rho} - \Delta\rho)$.

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The aggregate productivity for the caste society (π^c) can be calculated in a similar way. In this case, since the ρ′(t) is fixed as $\bar{\rho} - \alpha\bar{\rho}$ regardless of the value t, the aggregate productivity for the caste society (π^c) is derived as follows:

$$\begin{aligned} \pi^c &= \int_0^{\bar{t}} \int_{\rho'(t)}^{\bar{\rho}} t \; d\rho \, dt, \;\text{ in which } \rho'(t) = \bar{\rho} - \alpha\bar{\rho} \\ &= 0.5\alpha. \end{aligned} \tag{4}$$

Note that the above value of π^C is equivalent to $\frac{\alpha}{2\bar{\rho}}$, which means that the aggregate productivity of the society is a decreasing function of the value $\bar{\rho}$. Since the greater value of $\bar{\rho}$ represents the higher degree of disparity in terms of the individual social and economic status in the given society, the aggregate productivity is a decreasing function of the degree of disparity in the caste society. Similarly, the aggregate productivity for the meritocracy (π^m) can be calculated as follows:

$$\begin{aligned}\pi^{m} &= \int_{\bar{t}-\alpha\bar{t}}^{\bar{t}}\int_{\rho'(t)}^{\bar{\rho}} t\ d\rho\, dt,\ \text{in which } \rho'(t)=0 \\ &= \alpha\bar{t}-0.5\alpha^{2}\bar{t}. \end{aligned} \tag{5}$$

From the equation (5), the aggregate productivity for the meritocracy (π^{m}) is proportional to the value of $\bar{t}$. Thus the aggregate productivity (π^{m}) is greater when society has more talented individuals (i.e. the greater value of $\bar{t}$). Comparing the aggregate productivities of the caste society and meritocracy, we can refer to the following lemma:

(Lemma 1) The aggregate productivity of meritocracy is greater than that of the caste society

$$;\ \pi^{c} < \pi^{m}.$$

The above lemma can be directly derived from equations (4) and (5). It implies that the meritocratic society is always better than the caste society in terms of the productivity of the given economy. Comparing those two with the productivity of the complex society, we have the following lemma:.

(Lemma 2) The aggregate productivity of a complex society is greater than that of a caste society and lower than that of meritocracy.

$$;\pi^{c} < \pi^{*} < \pi^{m}.$$

Proof. For the proof for the lemma, note the following:

$$\pi^{*}-\pi^{C} = \frac{\alpha(3\bar{t}-2\Delta t)}{6} > 0 \quad (\because \Delta t < \bar{t})$$

$$\begin{aligned}\pi^{m}-\pi^{C} &= \frac{\alpha(-3\overline{t\alpha}+2\Delta t)}{6} \\ &= \frac{\alpha\left(-3\bar{t}\,\Delta t\,\alpha+2\Delta t^{2}\right)}{6\Delta t} \\ &= \frac{\alpha\left(-3\alpha\frac{\Delta\rho\, k_{\rho}}{\bar{\rho}\, k_{t}}+4\alpha\frac{k_{\rho}}{k_{t}}\right)}{6\Delta t} \quad (\because \text{equation (2) and } \Delta t k_{t} = \Delta\rho k_{\rho}) \\ &> 0 \quad (\because \Delta\rho < \bar{\rho})\end{aligned}$$

QED.

As the complex society shares the characteristics of both the caste society and meritocracy, the aggregate productivity of the complex society also lies between the aggregate productivities of the caste society and meritocracy. From the equation (2), the aggregate productivity of the complex society can be displayed as a function of k_t and k_ρ as follows:

$$\pi^{m} = \alpha\bar{t} - \sqrt{\frac{2\alpha^{3}k_{\rho}}{9k_{t}}} \tag{6}$$

Therefore, the aggregate productivity of the complex society is higher when the CSAT score is more affected by the student's innate talent (the greater k_t), and less by the socioeconomic status (the smaller). That is, the aggregate productivity of the complex society depends on the relative size of and of the society. Thus, we have the following proposition.

(Proposition 1) The aggregate productivity of a society is lower when the CSAT score depends more on social and economic status than individual innate talent:

$$\frac{\partial \pi^*}{\partial k_0/k_1} < 0.$$

These results imply a society where individual scholastic performance heavily depends on his private education, potentially resulting in a loss of economic efficiency. In this sense, the greater public investment on education for supporting students from poor social and economic backgrounds would be necessary to enhance human capital development, hence to improve the productivity of a society.

The amount of efficiency loss of a society due to the influence of socioeconomic background can be discussed when we define efficiency loss as the productivity gap between an ideal meritocracy and a complex society. That is,

(7)

Based on the above definition, we can derive the following corollary:

(Corollary 1) The degree of efficiency loss of a society is greater when the CSAT score depends more on social and economic status than individual innate talent.

All these results presented above imply that the widening gap in admission between regions and classes not only hinders social cohesion, but also undermines the efficiency of HR systems. Therefore, the expanded investment in public education and admission policies for giving preference to students from disadvantaged backgrounds could help upgrade to social efficiency as well as equality.

4. Empirical analysis of factors behind the college admissions gap

As discussed earlier, the widening gap in admissions among regions and economic classes has undermined the efficiency of national-level programs to foster human resources. The core role of national HR management is to help the talented complete high quality college education and encourage them to develop their full potential so that they may contribute to the progress of the nation and society. However, recent cases in college admissions demonstrate that not only has a family’s social and economic background served as a critical determinant to college admission, but so has the educational environment – or local infrastructure for private education in the neighborhood.

4.1 Relevant empirical works and a proxy for intelligence

One of the pioneering works on the issue of equal opportunity in college admissions is Sewell (1971). He empirically studies how a student's opportunity for college education is related to his family and social background, including parental income, level of education, and occupation. Based on Data from Wisconsin high schools, Sewell divides the students into four groups according to their socioeconomic status (SES) and finds that the students in the uppermost group have about four times of a greater chance to enroll in college. Later studies such as Cameron and Heckman (1998, 2001) and Cameiro and Heckman (2002, 2003) confirm social background as a key factor in deciding college education. According to the studies, poor surroundings restrain students and their intention to go to college because of their poor academic performance.

In South Korea, many studies have been published on the issue since the 2000s. Bang and Kim (2002) carried out an empirical study by using KLIPS (Korean Labor and Income Panel Study) Data. They reported that the higher the family's income and parents' educational levels, the greater the chance of college enrollment. Ryu and Kim (2006) gathered data from 207 high schools and found that the social background of the parents such as income and educational level were important determinants in their children's college enrollment. Kim (2005) studied the relationship between a student's scholastic performance as measured by CSAT scores and other characteristics such as gender, highest level of education attained by the parents, their occupations, the number of hours the student devoted to studying, and the area of residence. Kim found that the residential area of the student was an important factor in determining CSAT scores. Students who lived in big cities tended to achieve relatively higher CSAT scores compared to students from rural areas.

However, all of these studies might have been affected by an element of endogeneity since the analyses did not control for the students' abilities. That is, it is uncertain whether or not a student's better performance was because of his superior social background or his uncontrolled innate ability given that there was a positive correlation between the two factors. In this study, we try to improve the statistical reliability of the relationship between a student's social background and his scholastic performance as measured by CSAT scores in the 12th grade by controlling for each student's scholastic ranking in the 2nd year of middle school as a proxy variable for assessing the student's innate ability.

The 2nd year of middle school seems to be the best period for comparing intellectual abilities across students. Prior to this time, the students are too young to be compared in terms of intellectual ability using their performance on written examinations. Furthermore, a scholastic ranking for elementary school cannot be used because this is not generated in South Korea. Also, it is notable that the full-scale preparation of college entrance examinations often starts from the 3rd year of middle school for most families in Korea. Therefore, the scholastic rankings in high school cannot be used as a basis because they could be heavily affected by the parents' investment in private education or the educational environment of the residential area. Also, the scholastic ranking in South Korea reflects the GPA of all subjects in an academic year. This would be more reliable as a proxy for intelligence compared to cognitive tests like an IQ test, which only take place over several hours.

4.2 Factors affecting college admissions

Tables 1 and 2 are the result of an analysis of factors affecting college admission using data from the Korean Education and Employment panel. In the analysis, the following four key factors are examined: 1) intellectual ability ranking (per group of 100 persons) indicates the percentile of the student's ranking in his 2nd year of middle school; 2) indicators for socioeconomic status are established by reflecting household income, the father's educational background and occupational position; 3) educational environment index is established by equally reflecting the school's surrounding environment, classroom atmosphere, score level and overall economic status of the parents, based on teacher surveys from the panel; and 4) regions are classified into Seoul, metropolitan cities, medium and small cities and rural areas (eup/myeon districts).

Analysis 1 of Table 1 summarizes the OLS analysis on the gap between the stanine score during the 2nd-year of middle school and CSAT score during the 3rd year of high school, effectively reflecting the 'change in stanine scores'. Results show that the stanine score falls by 0.03 per drop in the decile ranking (1-10) of the socioeconomic background of parents, falling even further by 0.46 per drop in the educational environment index (on a 5-score scale). In addition, students residing in Seoul may experience a rise by 0.2 in the stanine score (compared to those residing in metropolitan cities). But those residing in small- or medium-sized cities or rural areas such as eup and myeon may experience a fall of 0.19 and 0.57, respectively, in the stanine score.

Analysis 2 is the result of the same analysis using the stanine score in the CSAT as a dependent score. The results are similar to those of Analysis 1. It is important to note that the analysis uses the school ranking of the 2nd-year of middle school as an independent variable in order to partly control for the intellectual ability of students before their full-scale preparation for the college entrance examination. According to the analysis, even after partly controlling for intellectual ability, drops in the decile ranking of socioeconomic status and educational environment indices led the stanine score in the CSAT to fall by 0.06 and 0.43, respectively. The scores also fell by 0.27 and 0.58, respectively, in small- and medium-sized cities and rural areas such as eup and myeon, compared to metropolitan cities.

[Table 1] Factors Affecting CSAT Achievement and Private Education Expenditure

(OLS Analysis)	[Analysis 1] Change in Stanine Scores (stanine score at CSAT – stanine score at 2nd year of middle school)	[Analysis 2] CSAT Stanine Score	[Analysis 3] Monthly Private Education Expenditure (10,000 won)
Intellectual Ability Ranking (per group of 100 persons)		0.05***	0.2***
Socioeconomic Status (10 deciles)	0.03*	0.06***	3.6***
Educational Environment Index (5-score scale)	0.46***	0.43***	5.7***
Base Region: Metropolitan Cities			
Seoul (capital city)	0.20*	0.00	13.4***
Medium and Small Cities	-0.19*	-0.27***	-1.1
Eup, Myeon (district)	-0.57***	-0.58***	-7.4***
Number of Observations	921	921	1,418
Coefficient of Determination (R^2)	0.102	0.539	0.301

Note: 1) CSAT stanine score is the average stanine score for three CSAT sections including Korean language, mathematics and foreign language (English). The school stanine score is the average of stanine scores in all curriculums. For the sake of interpretation, the stanine score is set in ascending order here, resulting in the stanine score 9 as being as the top score.
2) Monthly private education expenditure covers the period from the second semester of the 3rd year of middle school to the first semester of the 3rd year of high school.
3) ***, ** and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.
Source: Korean Education & Employment Panel, each year

Family background and neighborhood characteristics, coupled with a peer effect, role model effect, mentoring quality, future career plan, public education quality, private tutoring for college entrance examinations and total learning time contribute to gaps in achievement. For instance, as Analysis 3 shows, the amount of private education expenditure ends up being significantly different during the stage of entrance examination preparation, according to various factors in the student's background. In the analysis, the dependent variable Monthly Private Education Expenditure covers the period of full-scale preparation for college admission in South Korea, which is set in this study as the period between the second semester of the 3rd year of middle school and the first semester of the 3rd year of high school. Increases of 1 unit in the socioeconomic status and educational environment index results in the private education expenditure for college admission to rise by 36,000 won and 56,000 won, respectively, every month. Students in Seoul have to pay 134,000 won more than those in metropolitan cities, and those in rural areas such as eup and myeon are found to pay 74,000 won less.

In Table 2, analyzing the likelihood of getting admitted to college (based on students who were average in each variable) confirms the importance of background factors, too. Note that the numbers in the table report the marginal effects in the logit analysis. As for admission to a 4-year university, a 1 unit drop in socioeconomic status and educational environment indices equals a drop of 4.5%p and 9.9%p, respectively, in the likelihood of university admission. The figures fall even further to 0.4%p and 2.7%p for those areas ranking within 30th place (admission of general high school graduates only). In the case of students in Seoul, the likelihood of entering the top 30 universities and the top 9 universities increases by 1.5%p and 0.072%p, compared to students in metropolitan cities. On the other hand, the likelihood of students in small- and medium-sized cities and rural areas (eup and myeon) to enter a 4-year university falls by 9.3%p and 10.7%p, respectively, compared to students in metropolitan cities. The results confirm the strong influence of both socioeconomic status and educational environment on college admissions.

[Table 2] Factors Affecting the Likelihood of Admission to College

(Logit Analysis)	Likelihood of Admission to 4-year University (marginal effect)	Likelihood of Admission to One of the Top 30 Universities (marginal effect)	Likelihood of Admission to One of the Top 9 Universities (marginal effect)
Intellectual Ability Ranking (per group of 100 persons)	1.0***	0.4***	0.004***
Socoeconomic Status (10 deciles)	4.5***	0.4*	0.004*
Educational Environment Index (5-score scale)	9.9***	2.7**	0.015 [*]
Base Region: Metropolitan Cities			
Seoul (capital city)	[-25.9]***	1.5	0.072**
Medium and Small Cities	-9.3*	-1.5	0.001
Eup, Myeon (district)	-10.7**	-1.5	0.009
Likelihood of Average Students' Admission to College (%)	59.6	5.3	0.022
Number of Observations	1,030 (pure high schools)	750 (general high schools)	750 (general high schools)

Note: 1) The top 9 universities are Seoul National University, Pohang University of Science and Technology (Postech), KAIST, Yonsei University, Korea University, Sogang University, Sungkyunkwan University, Hanyang University and Ewha Womans University (Seoul campus only). The top 30 universities are based on the university ranking released by Joong-Ang daily newspaper in 2007

2) Regarding the likelihood of admission to a 4-year university, the coefficient of Seoul is quite low because many Seoul students opt to retake the CSAT and enroll in 2-year colleges in the capital area. More analysis is needed for interpreting this data.

3) ***, ** and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. [*] denotes the significance level

of 10% in a one-sided test.
Source: Korean Education & Employment Panel, each year

In the interest of brevity, we only reported the results of major analyses involving the four aforementioned key independent variables. However, it is notable that the main results are still robust even after controlling other individual characteristics such as monthly educational expenditure, hours of self-study, attendance of general high schools (rather than vocational high schools) and future career plan, all of which are also affected strongly by the four key background variables. Readers who are curious about additional analyses may refer to one of the author's working paper, *Improving Equal Opportunity in Admission to Higher Education* (Young Chul Kim), KDI Policy Study 2011-06, Korea Development Institute, 2011 (in Korean).

5. Concluding remarks

The widening gap in admissions among regions and classes and worsening social and economic mobility not only hinder social vitality and cohesion, but also increase social expenditures on welfare in the long-run and undermine the efficiency of the HR system, thereby posing a threat to the competitiveness of the national economy, as our theoretical model presents in section 3. This is why the government should put forth diverse efforts to ensure the equality of educational opportunities. Above all, government-level support measures need to be expanded with an aim to improving the academic ability of students in regions with poor educational systems and children from low-income households. Good examples of such governmental efforts in South Korea are to encourage students' learning attitudes through mentoring programs, to increase opportunities to learn by expanding after-school vouchers and to assist low-income students with active operation of local teen centers.

More action is also needed to further restrain the overheated private education market, considered the main culprit of the growing education gap. At present, private sector investment in private education is approximately 20 trillion won (government estimate) in South Korea, which is more than half of the government's investment in public education (approximately 39 trillion won). Curtailing demand for private education requires strengthening the competitiveness of public education such as diversifying curriculums to fit various levels of students. Also, simultaneous measures to reduce the expenditure for private education include promoting public broadcasting programs on CSAT (e.g. EBS CSAT channel) and diverse after-school programs.

Most importantly, more aggressive actions are needed in the process of college admissions. The college admissions system in Korea should be made up of more than today's singular role of assessing simple academic achievement. College admissions should be oriented toward a policy of effectively fostering talented human resources at a national level, as well as promoting equal educational opportunities guaranteed in accordance with the Constitution. The system should serve to select future leaders with potential to drive social development by priority, to bridge the gap in opportunities caused by different environments, and at the same time to increase social and economic mobility. To that end, the government needs first to examine certain policy measures.

First, the government should put forth efforts to stabilize the Equal Opportunity Program for College Admissions (launched in 2009), a flagship program for improving equal opportunity in South Korea. Currently, each highly ranked university in Korea selects about 70 students from lower income families through this program. The number appears to be on a slight rise every year, but still only accounting for about 2% of the entire freshmen class. Considering that universities face the additional challenge of helping these students adapt to campus life, it is important for universities to set up additional systems such as mentoring programs and more supplementary classes.

Second, it is necessary to promptly expand voluntary efforts by universities for improved equal opportunities through such measures as regional balanced admissions quotas and special consideration for recipients of social care services. An exemplary case is the regional balance-based initiative conducted by SNU since 2005. Those admitted under this program had relatively higher GPAs with gradually improving records over several semesters, confirming that the selection program based on the candidates' potential was effective in fostering talented human resources. With clear recognition of the growing gap in education between the capital area and rural areas and among the different districts in large cities, universities need to prioritize identifying talented young people, particularly in those areas with a poor college admissions rate, which are identified in section 2.

Third, the admissions officer system should work toward expanding equal opportunities as far as the admission program continues. Prestigious private universities in the U.S., which had adopted the system quite early on, put a high emphasis on the potential and talent of candidates based on various standards such as their passion and commitment to social development, the uniqueness of their individual backgrounds, and outstanding achievements against the odds. By applying these considerations, admissions officers have created diversity within their student compositions, contributed to enhanced social mobility and eventually maximized the educational value of their universities. On the other hand, the Korean government should take strict enforcement actions against illegal or unethical practices that could significantly undermine the fairness and credibility of the admission officers system, including rampant private tutoring and so-called "admissions consultations" (which involve writing application documents for the candidates).

Lastly, based on a clear understanding of the damaging effects of the widening gap in college admissions between regions and classes, the government needs to set specific and forward-looking targets to close the gap. It should look into launching a government agency that takes charge of reaching these objectives, thereby enabling the system to enact fair admissions guidelines, offering colleges and universities certain incentives for their contributions to improving equal opportunity, securing a fund for national scholarships and managing the fund effectively, as well as strictly monitoring admissions procedures for corruption and irregularities.[17] These efforts by the government will make a significant contribution to improving educational opportunities in Korea and developing an effective system for fostering talented human resources.

In conclusion, the widening gap among classes, regions or districts in university admissions will hamper social and economic mobility in the Korean society. This reduces social vitality and may hurt social integration in the country. Also, in the long-term, if children from the more vulnerable classes remain in this social bracket when they grow up, this will increase social welfare costs throughout society. At the same time, if talented students fail to enter prestigious universities because of factors related to family background, this could lessen the efficiency of the country's system for fostering young talent. Such consequences could ultimately threaten the national economy's competitiveness. Therefore, universities need to be more active in finding and admitting talented students from educationally disadvantaged areas and vulnerable classes. In addition to universities, the government has an important role to play. The government needs to actively push forward with diverse policy efforts to enhance the academic capacity of students from disadvantaged or low-income areas, and to increase incentives for universities working toward equal opportunity education in their admissions processes.

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[17] For instance, the Office for Fair Access (OFFA) in the U.K., TRIO program in the U.S. and Higher Education Participation and Partnerships Program (HEPPP) in Australia have been introduced to assist low income families and socially vulnerable groups in gaining admission to leading universities and completing university education courses.

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