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Regional disparity in educational impact of COVID-19 in Korea

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A B S T R A C T

This study empirically examines the inflation of education inequality during the COVID-19 pandemic in South Korea using land price and spatial modeling techniques. To estimate the difference in educational inequality by land price during the pandemic, we divided the short-term effect (2020) and the long-term effect (2021) as of 2019 based on the average scores of high school math and English. In addition, this study utilized the Spatial DID (Difference In Difference) method to reflect the spatial correlation between high land prices and low land prices. As a result of the analysis, math and English scores decreased in areas with low land prices during the pandemic. On the other hand, areas with higher land prices showed higher scores. In summary, the average score of online classes due to COVID-19 fell in regions with low land prices, while the average scores increased in regions with high land prices. Notably, the academic performance of all students did not decrease in the face-to-face teaching environment difficult due to COVID-19. Also, considering the spatial characteristics, the higher the land price and the higher the average score, the higher the spatial density. In other words, even in areas with high land prices, clustering occurred between areas with good school districts.

Key words: COVID-19; Academic achievement, Education inequality, Spatial DID, Spatial autocorrelation

1. Introduction

Currently, there has been a wealth of research looking into the connection between housing/land prices and education. A key perspective of this analyzes the ways in which the quality of education is so sought after that individuals are willing to pay significantly above the worth of the housing in order to attain the educational outcomes the area offers (Lan et al., 2018); (Han et al., 2021). This can be notably seen Han's 'Winning at the Starting Line: The Primary School Premium and Housing Prices in Beijing", which determines the exact premium being paid in "good quality school attendance zones (SAZs)"—a practice that has become the "main form of parents' investment in their children's education" (Han et al., 2021). These advantages are often understood to include better educational infrastructure, such as libraries and private learning space, fewer students per teacher, and better access to any necessary materials—among additional exclusive resources.

Utilizing these studies, one can infer a direct correlation between local land prices and the quality of education, which simultaneously establishes the definite diminishment in such quality of education for housing in lower land priced areas. Inequity of this degree is so readily recognizable that "families do their best to buy houses in high-quality primary SAZs, to enable their children to attend" high quality schools (Han et al., 2021). In turn, it can be deduced that students from lower local land price areas are receiving a lower quality of education than their peers for higher local land price areas.

Although this inequity has been previously and universally recognized, few papers have studied the inflation of these education gaps in the face of the COVID-19 global pandemic.

COVID-19 has posed many challenges for students, with many citing self-regulation concerns, system-oriented adjustment issues, and internet availability as general obstacles faced by a large majority of students—regardless of socioeconomic background (Aini et al., 2020). When compounded with established inequity concerns, such as those seen within the Republic of Korea, it is possible that many students experienced severe and undue disadvantages within recent years. These imbalances can be seen during the COVID-19 pandemic through many avenues, including elite students' superior access to internet for their online courses, as well as an ability to utilize private facilities in light of the closure of public amenities due to the public health crisis. If statistically affirmed, these unjust lapses

must be mitigated. It is imperative to study the impact of COVID-19 on academic achievement in relation to local land prices, as any significant incongruency in outcome can verify environmental factors' contribution to undue advantages/disadvantages in student's education outcomes. As high school performance in the Republic of Korea closely influences an individual's admission to deeply meritocratic universities—which ultimately informs the career/future available to that individual—it is important to guarantee as fair of an education system as possible (Cho, 2016).

Research regarding the impact of education facilities investment has unanimously found that the enhancement of infrastructure is heavily correlated to an increase in student academic achievement. Ramli considers this by adopting multiple perspectives, and observing that "E-Learning of systems management, teaching aids, and library of learning environment, hostels, sports facilities, and parking and transportation of infrastructure" notably impacted students' academic success—contributing to a total 51.5% increase in achievement among students (Ramli et al., 2018). It was found that structural aspects of the education system, including wellbeing at school and scholastic activities and support, were more outstanding indicators of academic achievement than even an individual's family background (Engin-Demir, 2009)). In fact, even student's perception of the organizational image of school, including perceptions of "quality image, sports image, general outlook and physical infrastructure image, and entertainment image", maintained meaningful correlation to student's academic achievement (Polat, 2011).

However, of the studies investigating this association of infrastructure and achievement, only one paper integrates both a short-term and a long-term outlook. This is significant as the study that did analyze this time-oriented aspect found no consequential evidence of a short-term affect (which juxtaposes all other studies) but did find a crucial long-term effect of improved infrastructure to include a 2-6% increase in accomplishment (Hong & Zimmer, 2016). Similarly, despite the relationship of investment and achievement being well-documented, the vast majority of these studies do not engage a comparative lens of regional and/or socioeconomic class. Particularly, in relation to housing prices and students' local zoning for public school, there is a gap of study. Although there is a clear relationship between housing prices and academic achievement, as well as a distinct correlation between educational infrastructure and academic achievement, there are few studies that have explored this distinct intersection.

Correspondingly, many of these papers do not analyze how parental income contribute to these findings. This is particularly in spite of clear evidence that the "socioeconomic status of parents" has a "strong association with the academic performance of students"—all while children in income-poor households with a negative net worth were "up to 0.24 standard deviations lower in academic ability" (Eshetu, 2015); (Dräger & Pforr, 2022). The relationship between infrastructure and achievement is further solidified when it was found that when students—particularly low-income children—were provided with correct and ample resources, they achieved "good academic results" (Henríquez et al., 2012). Unfortunately, whether due to the "substantial injections of private financing into public school for their parents" or their affluent parents "using class resources to provide youth with academic, social, and career support and access to exclusive university infrastructure", right now children whose parents are of a higher socioeconomic status are significantly more likely to be academically successful. These studies all provide key insight into the interrelation of inequity within infrastructure and academic achievement, a concern that has likely only swelled throughout the COVID-19 pandemic. As a symptom of the lack of regional and/or socioeconomic study within the academic infrastructure studies, spatial modeling methods have only recently been introduced in investigating similar subject matter. Even less commonly utilized is a Difference-in-Difference methodology in the contribution of factors correlated with academic accomplishment. Least common of all is an integrated analysis of the escalated circumstances following the COVID-19 pandemic, for which nearly no research exist.

2. Materials and Methods

The purpose of this study is to estimate whether the impact of COVID-19 on academic achievement varies depending on the local land price. Therefore, the effect of COVID-19 is divided short-term (2019, before COVID-19) and long-term effects (2020 and 2021, following the pandemic). Specifically, short-term effects measure changes in math and English grades from early 2020, as compared to those of 2019. Similarly, long-term effects measure grade changes from early 2021, again, as compared to those of 2019.

This study focuses on the changes in the score of Korean high school sophomores in mathematics and English. We study the second year of high school, particularly, for many reasons—including the fact that third years presents a limitation of comparison due to curriculum differentiation to prepare students for the SAT exam. Additionally, there are fewer missing values of the data for the second year of high school used for the study compared to the first year.

At the same time, we are also interested in the ways a student's grades may be affected by the educational facilities available to the student. It is noteworthy that educational facilities may be spatially heterogeneous according to the quality and accessibility of schools (Wen et al., 2018). Students from major cities can use abundant educational facilities, whereas, in suburban students may use relatively few educational facilities. This inequity causes a difference in the land price of the region (Lee, 2015). Consequently, students from high land prices areas are more likely to achieve stable academic achievement in spite of pandemic obstacles, by using relatively more diverse educational facilities. This study intends to estimate whether the impact of COVID-19 on academic achievement varies depending on the local land price by reflecting on spatial characteristics.

3. Results

During the pandemic period, the average math grades were 22.9, with a minimum score of 22.9 and a high score of 86. The minimum average English score was 32.9, and the highest score was 95. The pandemic also restricted students' outdoor activites—which may have, in turn, affected the students' health. As a result, the average BMI, the student's obesity index, was 22.691, the minimum value was 20, and the maximum value was 31.3. There were also significant regional differences in the dropout rate from school—with the average dropout rate being 1.908%. In fact, the maximum dropout rate is 50%,--also representing huge disparaties based on region. Similarly, the degree of financial independence that each local government can respond to the aftermath of the pandemic was found to be the lowest at 4%, but at the highest at 68.9%.

First, we classified schools based on their overall math scores from 2019. If the score was higher than the median, it was indicated in red, and if it was lower than the median, it was noted in yellow. Also, the geographic density of high-scoring schools was indicated by implementing the kernel density. In 2019, it spread widely in Seoul and surrounding areas and satellite cities. Then in 2020 and 2021, we analyzed the score change during the pandemic in relation to the 2019 distribution. Therefore, based on 2019, if the score has risen, it is displayed in red, and if it has decreased, it is shown in yellow. According to the distribution, schools with increased grades, despite the pandemics that began in 2020, have become increasingly denser and narrower, centered in the downtown area (like Seoul). Therefore, schools with above-average math scores appeared mainly in Seoul. In 2021, the density around Seoul was higher. In addition, it was found that the scores of cities with relatively high land prices increased. Consequently, it can be inferred that certain areas, such as cities, scored higher during the pandemic.

The distribution of top English schools shows a pattern similar to mathematics. In 2019, schools with an average English score were widely dispersed around Seoul and surrounding cities. According to the distribution, the density narrowed over Seoul after the 2020 pandemic. In 2021, the density centered on Seoul also increased, and in some cities such as Busan and Daegu, there were relatively higher schools with an average English score. Therefore, English scores were somewhat higher in certain regions during the pandemic. In this study, it is assumed that the difference in land price causes these characteristics. Therefore, we intend to use the DID method to statistically estimate the change in scores due to land price differences during a pandemic. As shown in the distribution map for math and English scores, the change in scores is expected to have a specific spatial relationship. Therefore, we venture to estimate the short-term and long-term effects of the pandemic by using Spatial DID, which combines spatial characteristics.

According to English scores, the average English mean score in 2020 decreased compared to 2019. However, there was no significant difference in 2021. In addition, the average English score was lower in regions with high land prices than regions with low land prices. This is a result of superficially low measurements due to the characteristics of schools in areas with high land prices, similar to math scores. This can be confirmed through Spatial DID results on the effects of the pandemic. Despite the short-term effects of the pandemic, English proficiency in areas with high land prices increased compared to areas with low land prices. Also, in the long-term effect of the pandemic, areas with high land prices improved their English scores compared to the time before COVID-19 (2019).

In regions with low land prices, the average English score decreased by 1.16 points in 2020 compared to 2019 due to the impact of the pandemic. It was also 1.11 points lower in 2021. However, despite the impact of the pandemic, the average English score in areas with high land prices increased by 1.79 points in 2020 and by 1.52 points in 2021. This is because the higher the land price, the better the educational infrastructure, such as libraries and private learning spaces, and the difference in the academic environment available to students.

Meanwhile, in terms of regional characteristics, only the Internet use rate affected English scores in 2020. The average English score increased in regions with higher internet usage rates. In 2021, social distancing policies and internet usage rates affected English scores. As social distancing continued for a long time, students' learning space was

limited. Therefore, as the highest level of social distancing continued, the average score in English decreased. In addition, in the case of the Internet use rate, the range of the grade increase due to the Internet use rate increased in 2021 compared to 2020. As online classes were conducted and various academic materials were provided on the Internet, the number of learning materials that students could use increased significantly during the pandemic.

In the school characteristics, the average English score in 2020 and 2021 was higher in girls' high schools than in coeducational schools. In addition, the average score of English in private schools was higher than in public schools. As the BMI index, which reflects students' health, increased, the average score of English decreased. On the other hand, the academic atmosphere of the school and the level of management of the students affected the average score of English. For example, similar to the math score, the average score in English decreased as the number of students per teacher increased. Also, the higher the dropout rate, the lower the average score. Finally, the rho value, which represents the spatial characteristics of English scores, was statistically significant in both 2020 and 2021. In particular, the value increased in 2021 compared to 2020. This means that schools with higher scores in 2020 than 2019 are clustered together. And the score gap according to space increased further in 2021.

4. Conclusions

This study analyzed the impact of COVID-19 on high school education based on land price by dividing it into short-term and long-term effects. In particular, the Spatial Difference in Difference analysis method considering spatial correlation was utilized in this study. As a result of the analysis, the average score for online classes due to Corona 19 fell in areas with low land prices, while the average scores for math and English in areas with high land prices rose. It is important to note that the academic achievement of all students has not reduced in a situation where face-to-face education is challenging due to COVID-19. According to the land price, the average score of the area with a low land price decreased, while the average score of the area with a high land price increased. After COVID-19, the median academic achievement has decreased, and an hourglass-type academic structure has been formed in which only high-scoring students and low-scoring students remain, which means that educational polarization has deepened. In addition, it was confirmed that the higher the land price, the higher the spatial density of schools with higher average score when spatial characteristics were considered. In other words, even in areas with high land prices, there is a clustering phenomenon between regions with good school districts.

The cause of the polarization caused by COVID-19 is that the gap in the educational environment between regions has changed significantly as face-to-face classes suddenly switched to online. Before COVID-19, the students of the middle and lower scores could study in a class atmosphere or with teacher encouragement. Still, as classes suddenly switched online, there were limitations on the tangible and intangible educational infrastructure that students could utilize. In particular, students in areas with low land prices would be less have had enough opportunities to study because they lacked relatively available materials or environments. But, on the other hand, students in areas with high land prices could continue learning even in non-face-to-face situations because there were many available learning spaces, and they were in an environment where tutoring was possible.

It is the disparity in academic achievement between regions with high land prices and regions with low land prices that are widening even in the educational conditions of schools and communities and the educational support environment of families. However, the education gap due to land prices during the pandemic is not just a gap in one field. This can be understood as a polarization beyond the simple meaning of a gap in that it is a total gap in related factors. In other words, the input and output of education show different characteristics depending on the land price, and these characteristics distinguish educational activities in weak areas. The parents are strongly motivated to move to an area with high land prices despite financial difficulties. As a result, the concentration of land prices in regions with relatively well-equipped educational environments occurs, and the polarization becomes more severe. In the end, the polarized educational environment according to land prices limits the opportunities for students in areas with low land prices to receive an appropriate education. Students in areas with low land prices have less opportunity to receive the education they want due to the vulnerability of the school's online education system, individual home environment, and the local community's educational support system. Therefore, to prevent educational inequality due to the conversion of online classes, policies should be implemented considering differences in educational conditions by region.

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