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Linkage among School Performance, Housing Prices, and Residential Mobility

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Abstract: Ensuring equal opportunity of quality basic education is critical for a sustainable society, but access to high-quality public education is limited by the place of residence and income level of the household, especially under rigid geographic school assignment. This paper identifies multilateral linkages among academic performance of elementary school, housing prices, and residential mobility in Seoul. A spatial simultaneous equation system is applied to address feedback simultaneity and spatial interactions between local housing market and residential mobility. The results show that school performance positively affects both housing prices and population in-migration, but the increase in housing prices discourages the residential move into affluent school districts. Based on the finding that discouraging effect of housing price premium on population in-migration outweighs the population inflow attracted by school performance, this paper suggests policies to reduce the inequality of educational achievements.

Keywords: primary education; housing prices; residential move; spatial simultaneous equations; sustainability

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1. Introduction

Education of young generation is pivotal to build a sustainable society, because human capital is a prime determinant of sustainable economic growth and social development [1,2]. Improving basic education is a central issue of sustainable education policy, as it benefits both individuals and society by ensuring higher lifetime earnings and standard of living, enhancing the status of women, increasing productivity and national income, reducing fertility and public expenditures for social services, and contributing to social cohesion [3]. In many countries (especially in urban areas), basic education coverage has been substantially expanding, but gaps in the quality of basic education and students' attainments across schools are still sizable. Considering that educational achievement in early childhood influences on the opportunity of higher education and future earning, poor access to a quality education during compulsory schooling would reduce social mobility in long-term perspective.

Unequal chances to receive a quality education for children of compulsory school age attribute to geographically uneven distribution of academic resources (e.g., qualified teachers, school funding, and other locality-specific educational systems and environment) and restricted school choices. At elementary and middle school level, geographic school assignment is commonly adopted due to the merits of commuting efficiency and safety [4]. However, a rigid geographic school assignment (e.g., absence of commuting option to distant schools) is disadvantageous for students from financially challenged household who have a relatively limited choice set of residence. Studies showed that housing price premium for school quality tended to be especially higher under geographic school assignment policy (This refers to a school systemin which students are assigned to a school based on the proximity to residence (e.g., school catchment area)) because residential constraints in school choice intensify competition between potential home buyers [5,6]. Marginalized students are often penalized by the loss of positive peer externalities (e.g., share of motivation, school discipline and learning from each other) as they face the leakage of rich peer students heading toward affluent school districts (e.g., "white flight" against school desegregation policies [7,8]). Accompanying with the loss of parental involvement in school administration and financial support (e.g., donations), the leakage of affluent students might further harm the school quality. Accordingly, the proportion of students with educationally advantaged family backgrounds would decline in lower-ranked school districts but keep increasing in affluent school districts. This implies that housing price premium for school quality leads to residential and school sorting by income level where students are assigned to a school based on their residential information. By depriving the opportunity of better education of disadvantaged children, this could widen the gap of academic achievement across schools, in turn threatening social sustainability. Therefore, it is important to understand the linkage between housing prices and residential mobility involved with school quality and performance, which can be developed to persistent gap in school quality and students' academic achievement.

The purpose of this paper is to identify multilateral linkages among academic performance of elementary school, housing prices, and residential mobility in Seoul, wherein a rigid geographical school assignment is applied. Seoul, the capital of South Korea is characterized by high parental investment in children's education to ensure them to enter top-tier universities [9,10]. In many eastern Asian countries, an education from a top-tier national university has been recognized as one of the primary ways to promote social status and to escape from a legacy of poverty. In particular, South Korea has been known of highly intense competition for a degree from prestigious universities, because the expansion of opportunity for primary and secondary school education and the increase in demand for white-collar occupations, accompanied with the rapid economic development and industrialization since 1960 have made young generations to strive to enter a top-ranked university which generally permits upward movements. Such an intense competition has caused high dependence on private tutoring of primary and secondary school students. According to 2016 data provided by Statistics Korea, 67.8% of primary and secondary school students receive private tutoring and they spend six hours per week for the tutoring on average. The high dependence of students on private tutoring services has been concerned because it could weaken the quality and the authority of public education. Further, this often works against for lower-income students and those living in less urbanized areas with limited access to extra-curricular activities. To lower the dependence on private tutoring services, free-lectures as a supplementary for primary and secondary school curriculum has been provided by a state-run broadcasting company since 1997. In addition, quota systems favorable for rural residents have been introduced for the admission from specialized high schools and universities. (Specialized high schools of South Korea are conceptually similar to magnet school of the U.S. in that they have autonomous admission policies and a thematic curriculum such as science and foreign language. Due to their high entrance rates into top-ranked universities, competition for specialized high school in Seoul has been intensified for the early teen-aged students)However, despite such governmental efforts, the gaps in school performance and the entrance rate to elite-universities across regions and income-classes has kept increasing. Hence, this study attempts to shed a light on the inter-relationship between school performance, housing prices and residential mobility, to uncover underlying mechanism of the persistence educational gap in South Korea.

The capitalization of school quality into housing prices has been studied in a body of literature (see Nguyen-Hoang and Yinger [11] for an overview). However, little attention has been paid to the feedback mechanism of residential in-migration and housing prices which intensifies the inequality of the access to high-quality public education. This paper contributes to the literature by providing an insight on persistent disparity in school performances caused by the interplay between housing prices and residential moves. We find that discouraging effect of housing price premium on population inflow is more than twice greater than the attracting effect of school performance on residential in-migration. This indicates that high-performing school districts suppress population in-migration at equilibrium;

and speculative investment in housing properties exist in good school districts, further raising barrier to residential relocations seeking for better learning environment.

We use town-level data for Seoul(A town refers to the lowest tier of administrative units in South Korea, of which the average population is close to 25,000 in Seoul), the capital of South Korea, together with elementary school data covering the school resources and performance level of attending students. In Seoul, housing prices tend to be highly elastic with respect to school performance, and residential moves to gain educational advantage are frequently observed. Despite the notion that housing prices are more responsive to school achievements of high school level [9,12], we limit the research target to elementary schools. In Seoul, a rigid geographical school assignment (i.e., no allowance of intra-district school choice) is applied for elementary school students, and students are generally assigned to a school located within 1.5 km distance from the residence(In 2010, Seoul has 547 public elementary schools and school attendance zone (no overlapping) and 11 school districts with their own local education authority). Accordingly, housing price premium for school quality is more apparent compared among elementary schools rather than high schools where the school assignments are partly based on students' own choice. (A school choice reform in 2010 allowed high schools in Seoul to fill 60% of freshmen based on preference list submitted by students, and the other 40% are filled by random assignment within school district as has done before the school choice reform. Chung [6] showed that the school choice reform reduced house price differential between high- and low-performing school districts using boundary fixed approach and panel fixed approach together. Note that commuting for out-of-district schooling options costs relatively low in Seoul due to highly developed public transport system, different from the case in which school choice turned out to be less favorable to disadvantaged students due to the burden of transportation cost (e.g., Teske et al. [13] andAlves et al. [14])). Growing popularity of specialized high schools [15] also explains high residential demand in neighborhood with high-performing schools. In addition, residential and school sorting based on income level will be especially detrimental at elementary school level, given the significance of peer externality on academic achievement of students in this age [16]. A spatial simultaneous equation model is applied. The use of this method is appropriate to relieve endogeneity problems caused by feedback simultaneity and spatial dependence of housing prices and the pattern of residential relocation. The structure of this paper is as follows. Section 2 reviews related literature. Section 3 analyzes the linkage among academic performance, housing prices and residential mobility in Seoul and discusses the implications of the results. Section 4 summarizes main findings and argues for the agenda of further research.

2. Literature Reviews

Over the past few decades, there have been great academic interests to the influence of students' educational outcome on perceived neighborhood quality. Based on Hedonic framework, initiated by Rosen [17], revealed preference to the proximity to high-performing schools in the form of the increase in property value has been studied in a large body of literature (e.g., [11,18–21]). School performance signals both the quality of school inputs (e.g., teacher quality, classroom setting, and per pupil expenditure) and potential peer effects. (Hoxby [22] argued that peer's ability per se comprised the vast majority of peer effects compared to their family background, race and ethnicity based on a natural experiment of student reassignment in North Carolina. In contrast, Brasington and Haurin [23] found that parental characteristics of a school have significantly greater effect on property value than peer group attributes do. They provided an interpretation on this: positive parental characteristics (e.g., education and income level), are valued in housing market of the neighborhood because these are linked to parental involvement in school administrations). Considering that local communities are selected by "consumer-voters" to satisfy their preference for the services and goods provided there [24], it would be sensible to think that high-performing schools are attractive to potential home buyers, especially those with school-age children [25]. Due to relatively fixed housing supply in the short term, their housing demand often cannot besufficiently met, generating a premium over properties in a neighborhood with good school environment.

The house price premium associated with school quality works against lower-income students. Admittedly, the choice set of school quality for children education is constrained by the financial capacity of households. Rothewell [26] showed that on average, low-income students were attending a school ranked in the 42nd percentile on the state exams, while the middle- and high-income students were attending a school ranked in the 61st percentile using the U.S. national data. Bayer et al. [27] found that all others being equal, the marginal willingness to pay (MWTP) for school quality (measured by school test score) was significantly lower among racial minorities and families in lower socio economic status in San Francisco Bay Area. (They stated the heterogeneity of MWTP reflects not only the difference in the preference to or affordability for higher school quality but the 'preference to self-segregation' on the basis of race and education as well: people tended to prefer to live in a neighborhood that has similar education level and higher proportion of residents in their own-race). Only affluent families were allowed to relocate to the neighborhood with a high performing school due to their high MWTP for school quality and affordability of housing price premium. In addition, high housing prices often force families with financial difficulties to out-migrate toward neighborhoods characterized by lower-value housing, in turn raising the probability of their children to attend lower performing schools [28,29]. Lavy et al. [30] showed that the proportion of low-performing peers could adversely influence on school achievement due to disruption in inter-students and student-teacher interactions.

A forced residential relocation caused by unaffordable housing cost [31] is another channel of adverse effects of housing price premiums for school quality on marginalized students. There has been a consensus on the negative influences of either residential or school change on school outcomes (e.g., test score,drop-out rate) [32–34]. These are explained by the loss of social relations [35], stress from disconnection with a familiar environment and intimate peer group [36], and the discontinuity of educational settings [37,38]. Some authors pointed that poor school outcome of mobile students would attribute to their intrinsic properties (e.g., financial instability, family dissolution), rather than residential mobility per se [38,39]. However, other studies adopting advanced methods such as propensity score matching to control individual characteristics (e.g., Gasper et al. [40], Haelermans and De Whitte [41]) found negative association between the mobility and school outcome. Furthermore, even non-mobile students could be negatively affected due to the mobility of peer students disrupting curriculum development [42].

Nonetheless, the literature showed that residential mobility and school outcome can often be positively related. Inter-school-district moves tended to be related with improvement in school quality [29,42]. Using the data of Current Population Survey in the U.S., Schachter [43] found that residential mobility was higher among racial minorities and low-income households especially those were renters, but highly educated movers tended to move longer distance. In line with this, Schafft [44] showed that push factors such as poverty and unemployment were highly associated with frequent and short-distance moves. He suggested that the relationship between mobility and poverty was more evident in frequent intra-regional or short-distance relocations than inter-regional or long-distance relocations. The former can be defined as being "involuntarily pushed out" to nearby areas due to lack of ability to pay for housing costs, whereas the latter implies "selective relocations" to meet specific purposes, such as job opportunities or education programs.

The existing literature provides the base of understanding the multi-directional interactions among school performance, housing prices, and residential mobility. Housing price premiums are observed in high-performing school districts, because school outcome accounts for better-quality educational services and positive peer externalities. Students' performance would be negatively influenced by low-performing peers and high mobility (especially that characterized by short-distance moves) of the own and peer students. Differentiated from previous literature focusing on bilateral link between school performances and housing prices, we pay attention to the feedback between housing price premium and population in-migration involved with school performance to account for constrained mobility by households' financial condition. In this regard, the study attempts to provide an insight on residential sorting behavior and associated inequity in public education, which are reinforcing each other. In addition, this study attempts to better understand the socio-economic mechanism associated with school performance, housing prices, and residential mobility by specifying the spatial dependence of the variables. The use of spatial econometric model will be proper to specify continuous nature of external environments affecting academic performance and the decision on residential relocation as well as housing market across local administrative boundary.

3. Analysis

3.1. Conceptual Framework

On the basis of the arguments in the previous section, we establish a schematic model structure in which school performance influences local housing prices and residential in-migration via direct and indirect channels. As shown in Figure 1, direct channels are composed of the linkage between school performance and housing prices and that between school performance and population in-migration when other factors are controlled. Indirect channels are composed of the linkage of school performance–housing prices–population in-migration and that of school performance–population in-migration–housing prices. Feedback linkage from housing prices to school performance is also taken into account in the model because the literature has suggested school performance at elementary school level is highly associated with family background of peer groups, indirectly captured by housing prices of the town. The intensities of linkages at equilibrium are estimated using a simultaneous equation model to adjust for the feedback between population inflows and housing prices.

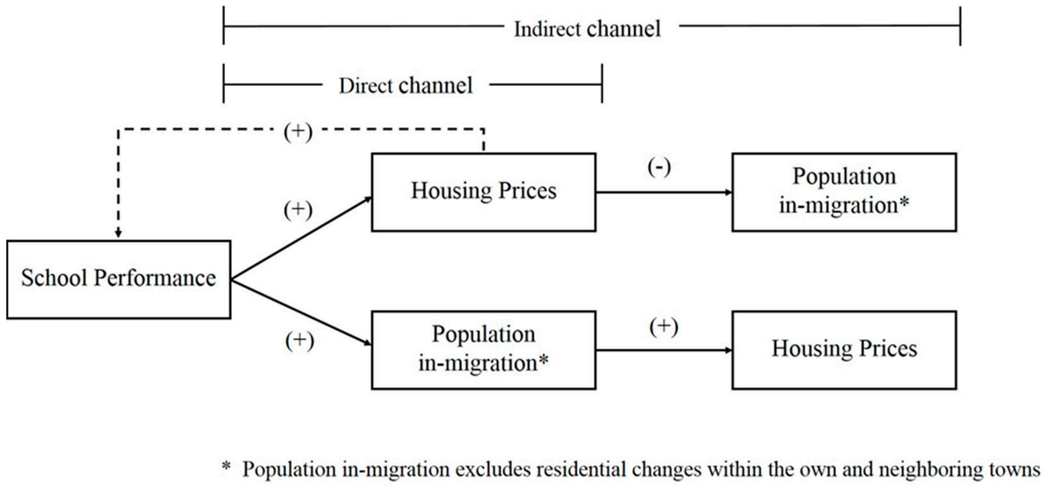


Figure 1. Linkages among Academic Achievement, Housing Prices, and Residential Relocation.

We posit that school performance is affected by the frequency of short-distance residential relocations within the neighborhood, based on previous findings on the influence of students' mobility (especially those involved with short-distance moves driven by push-factors) on their school outcome. We define the residential changes within the own and neighboring towns as short-distance moves, given the avoidance of major change in daily life and housing search cost of non-promotional movers. Contrastingly, residential changes to gain educational advantage tends to be longer-distance moves, mostly involved with the change of school district. [29] (The gap in quality of education is larger across school districts, because each school district has their own local education authority, which is responsible for budgetary control, supervision and guidance for schools of their authority. Accordingly, inter-school district moves are more common than intra-school district moves among families with interest to children's education). In Seoul, spatial coverage of an elementary school catchment zone is limited to the own and adjacent towns. In this sense, the population inflow excluding those from the own and neighboring town is adopted as a proxy of local in-migrations associated with school quality.

3.2. Model Specification

To investigate multilateral linkages among school performance, housing prices, and population in-migration, we apply a spatial simultaneous equations model composed of three equations described as:

$$\begin{aligned} Y_1 &= X_1\beta_1 + \rho_1 WY_1 + \lambda_1 W\mu_1 + \varepsilon_1 \\ Y_2 &= X_2\beta_2 + \rho_2 WY_2 + \lambda_2 W\mu_2 + \varepsilon_2 \\ Y_3 &= X_3\beta_3 + \rho_3 WY_3 + \lambda_3 W\mu_3 + \varepsilon_3 \end{aligned} \quad (1)$$

$$\varepsilon_i \sim N\left(0, \sigma_i^2\right) \ \forall\, i = (1,\ 2,\ 3),$$

where W is a spatial weights matrix of known constants, and the vectors Y_1, Y_2, and Y_3 represent school performance, housing prices, and population in-migration, respectively. X_i denotes an $N \times K$ matrix of exogenous explanatory variables, and β_i is an associated $K \times 1$ vector with unknown parameters to be estimated. The disturbance vector μ_i exhibits spatial dependence, and the vector ε_i is an independent and identically distributed (i.i.d.) error term with zero mean and finite variance (σ_i^2). The scalar ρ_1 is the spatial autoregressive coefficient, and the scalar λ_1 is the spatial autocorrelation coefficient. To address both feedback simultaneity between Y_2 and Y_3 and spatial dependence specified in the model, the generalized spatial three-stage least squares procedure (GS3SLS) suggested by Kelejian and Prucha [45] is applied. The two-stage least squares procedure method (GS2SLS) is also available to estimate our model, but GS3SLS estimator is more efficient than GS2SLS estimator by utilizing full system information concerning potential correlation across equations. For details in estimation method, refer to Kelejian and Prucha [45] and Jeanty et al. [46], in which the simultaneous interaction and spatial interdependence between housing prices and population migration was analyzed using two-stage least squares procedure method.

The elements of the spatial weights matrix are defined as below (LeSage and Pace [47] showed the estimates and inferences were not sensitive to the specification of spatial weights matrix, and flexible spatial spillover specification could save the efforts to build an accurate matrix. In this study, a contiguity based spatial weights matrix is chosen over those in other types (e.g., a distance decay type) to illustrate local attributes shared across the administrative boundary).

$$w_{ij} = \left[\begin{array}{c} 1,\ \text{if } i \text{ and } j \text{ share edge } (\text{s})\text{nor corner } (\text{s}) \\ 0,\ \text{if } i \text{ and } j \text{ do not share edge } (\text{s})\text{nor corner } (\text{s}) \end{array} \right. \quad (2)$$

The matrix is row-standardized to provide information on the scale of spatial interactions across observation. Among 369 observations, there are 5.36 neighbors per row (column) on average. The number of neighbors per row (column) ranges from one to eleven, and the medium is five.

In a spatial econometric model, spillover effects should be considered to evaluate the impact of the change in the explanatory variables on dependent variables. Regarding this issue, Lesage and Pace [48] proposed the partial derivative effects estimates composed of direct and indirect effects. In detail, the indirect effect is defined as the sum of the marginal change in dependent variable of a particular observation due to the change in explanatory variable of all other observations, whereas the direct effect is caused by the change in its own observation. The accumulation of spatial spillover effects due to the feedback between observations is described as a form of a multiplier matrix as in Equation (3).

$$\begin{aligned} &(I_n - \rho W_n)^{-1} = I_n + \rho W_n + \rho^2 {W_n}^2 + \rho^3 {W_n}^3 + \ldots \\ &I_n : Identiti\ matrix\ (n \times n) \\ &W_n : Spatial\ weight\ matrix\ (n \times n) \\ &\rho : Estimate\ of\ the\ spatial\ lag\ of\ dependent\ variable \end{aligned} \quad (3)$$

The direct effect of kth independent variable of ith observation is represented by its coefficient β_k multiplied by the value of ith diagonal element of the multiplier matrix. The corresponding indirect effect due to the change in all other observations (except for the ith) is the coefficient β_k multiplied by the sum of off-diagonal elements of ith row of the matrix. In the same time, the indirect effect, representing the change in the rest owing to the change in ith observation, is calculated by multiplying β_k by the sum of off-diagonal elements of ith column, instead of ith row. Due to the symmetry of the multiplier matrix, the indirect effect can be measured by either row sums or the column sums of off-diagonal elements of the matrix [48]. Total effect, the sum of direct and indirect effects, is used to examine the impact of the change in an explanatory variable on the dependent variable. In order to test the spatial spillover, standard errors of the effects are calculated using simulated parameter sets based on 1000 random draws with a normal distribution assumption and variance-covariance matrixes provided by Elhorst [49].

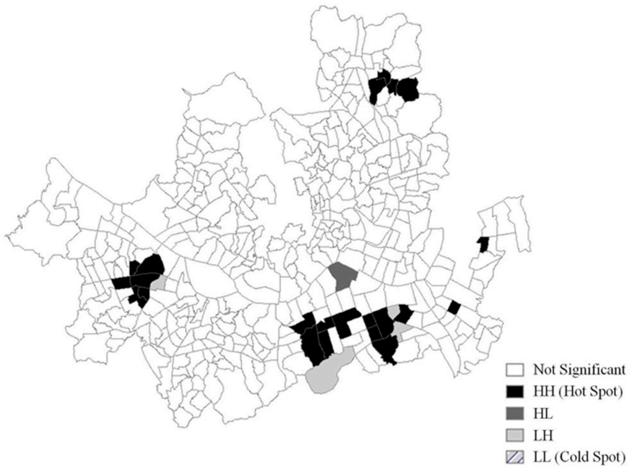
3.3. Estimation

This study uses a cross-sectional data set of 369 town-level units of Seoul in 2010.We use same-year-data for all variable because the relationship between school performance, housing prices, and residential mobility we explore in this paper is association, rather than causation. Further, using different-year data seems odd due to the feedback linkage between the three key variables because the three key variables serve as both dependent and independent variables.The matching of schools to these spatial units is done using the information on school catchment areas announced by the Seoul Metropolitan Office of Education. Since 2008, Korean Ministry of Education has made public announcement of individual school information including the outcome of national assessment of academic achievement conducted for 6th grade elementary school students. The information on the academic achievement of a school is provided in the form of the percentages of students who were rated above-average level, average level, and below-average level. The odds-ratio of students in a school who achieved above-average levels in all three subjects of Korean, Mathematics, and English to those who achieved average and below-average level (SCORE) is used as a proxy for school performance. As a proxy of local level housing prices, the annual average of median sale prices per square meter (PRICE), provided by a realty bank is used (In order to relieve aggregation bias, price information is collected from plats with common physical attributes (e.g., size, age, type, and the scale of apartment complex)). The residential in-migration (IN_MIG) is measured by the population inflow excluding those from neighboring towns and residential relocation within the same town.

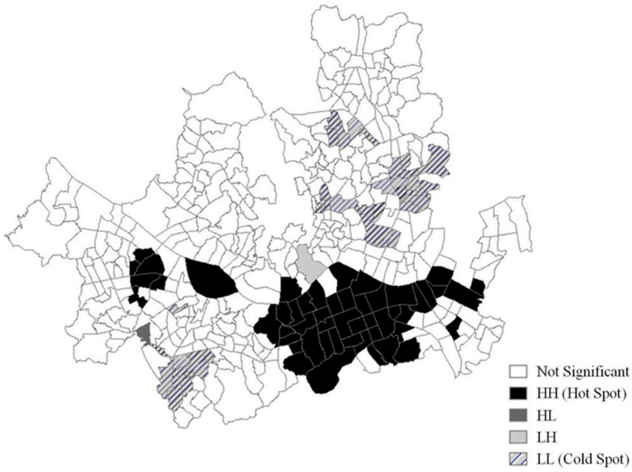
Explanatory variables for school performance are composed of the frequency of short-distance residential moves (SHORT), the access of private tutoring services (PRIVATE), and the level of family wealth (WEALTH), which is a predictor of social economic status of the family. Note that in Seoul, elementary school quality is not much dependent on teacher quality due to highly qualified teacher requirement and teachers' rotation across schools. In addition, school funding for academic curriculum is relatively equivalent across schools as well because a large portion of the finance is covered by the budget of the Seoul, rather than that of local authority of education. The SHORT variable is measured by the annual record of the residential changes within the own and neighboring towns in Seoul. Though the literature discussing the difference in relationship between move and academic achievement by the distance of move is not very rare, there is a lack of consensus in identifying "short-distance" in terms of quantitative measure. In accordance with Schafft [44], we consider residential mobility driven by housing instability or any other type of financial hardships is represented by short-distance migration in our model. In South Korea, the majority of housing lease in South Korea is characterized by key-money system: instead of paying monthly rent, tenants make a lump sum payment as a deposit for the occupancy. After a termination of two-year lease contract, many renters change home due to the burden of renewed increase in key deposit money. They tend to relocate into no further than neighboring towns, in order to avoid major change in daily life and reduce search cost of new housing. Therefore, we consider the residential changes within the own and neighboring towns as short-distance moves. The PRIVATE variable and the WEALTH variable are measured using the number of employees in private education industries (confined to those related to tutoring services for primary and secondary school age kids) and local property tax revenue, respectively.

Housing prices are estimated using the distance to central areas (DIST), access to public transport (TRANS), endowment of public sports facilities (SPORTS) (Some of local governmental agencies operate sport facilities in which fitness programs or lessons of specific sports are provided to residents for a reasonable fee) and parks (PARK), both representing local amenities. In addition, the effect from the scale of out-migration (OUT_MIG) is controlled along with the IN_MIG, becausethey collectively affect housing prices through the change in housing demand. Access to employment locations, along with the quality of local public goods is the most significant determinants of population in-migration [50,51]. The proximity to workplace is measured by average commuting time of residents (CTIME), provided by Seoul Metropolitan Household Travel Survey. Not only the proximity to workplaces, the opportunity of being employed as well explains residential choice [52–55]. The effect of job opportunity (Confined to consumer-oriented service sectors, it can be viewed as access to the specific functions) on residential choice might be different across industrial sectors, due to both supply- (e.g., spatial allocation of urban functions) and demand-side reasons (e.g., preference to or avoidance of externalities of the industry). Accordingly, the scale of local industries, measured by the size of employment of the own and neighboring towns, is controlled for both manufacturing (MANU) and service (SERV) sectors. In addition, the size of local housing market (HOUSING), represented by housing stock level is controlled (The size of local housing market on population in-migration might be better represented by the quantity of potentially available housings (e.g., the size of local housing lease market) rather than the housing stock per se, but the latter is advantageous in terms of data availability). To address potential endogeneity issue due to feedback linkage between dependent variables, three excluded instrument variables (IVs) are selected: the ratio of female teachers in a school, log of average of officially assessed land price in 2005, and the residential in-migration in 2005. The use of the ratio of female teachers in a school as an IV for the school performance variable is based on the empirical finding that female teachers were associated with higher test scores in the U.S. [56,57]. While some authors suggested that female teachers would be more favorable to female students (e.g., Ehrenberg [58]), the hypothesis that a same-sex teacher improves students' performance was not empirically supported in Holmlund [59]. To check the validity of the IVs, F-tests concerning the joint significance of IVs are performed (The statistics are reported on Table A1 in Appendix A). Null hypotheses that the IVs are weak are rejected at the 1% of significance level in both models.

Table 1 gives the summary statistics and a description of the variables used in this study. The left skewed distribution of school performance and its explanatory variables (e.g., the access to private tutoring services) imply that the benefit from accessibility to high quality of educational environment is limited to a few neighborhoods. To illustrate, a local indicator of spatial association (LISA) developed by Anselin [60] is analyzed with respect to the access to private tutoring services and school performance (see Figure 2a,b). In both figures, hot spots, defined as local spatial clusters, are observed in the south-eastern part and mid-western part. These neighborhoods were initially developed in the 1970s and the 1980s as urban sub-centers of Seoul. Massive investment in transportation infrastructure (e.g., subway networks) and transfers of urban facilities including prestigious high schools from central zone attracted a population. In addition, concentration of top-ranked schools and upper-middle income households led to the growth of private education industries. Combined with speculative housing demand, the fame as a Mecca of education created housing price premium in these area (see Figure 2c). Figure 2d shows that spatial pattern of the ratio of short-distance in-migration is different from the former ones. The hot spots of access to private tutoring services, school performance and housing prices tend to be cold spots in terms of the ratio of short-distance in-migration. Relatively longer-distance in-migration indicates that relocations to these neighborhoods are more likely to be inter-school district moves motivated by the quality of educational settings or involved with speculative housing investment, rather than related with unstable housing conditions.



(**a**)



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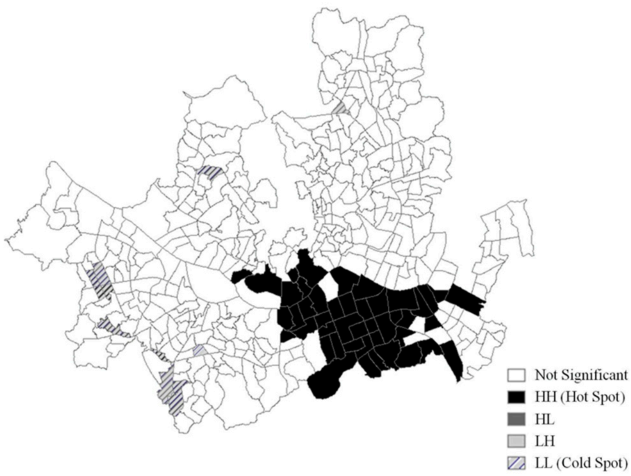
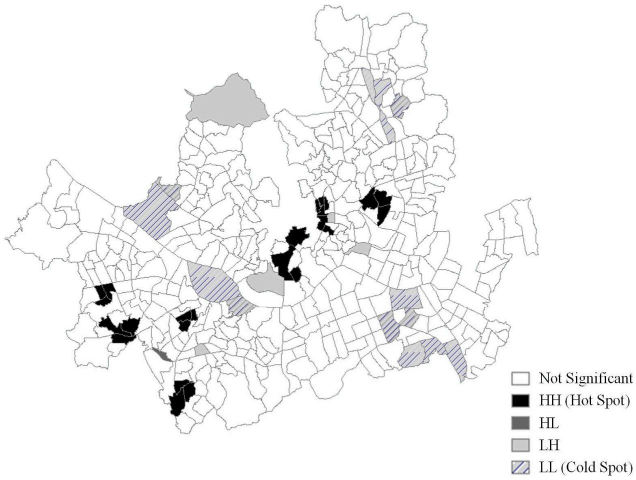


(**c**)

Figure 2. *Cont*.



(**d**)

Figure 2. LISA Analysis with respect to (**a**) Access to Private Tutoring Services; (**b**) School Performance; (**c**) Housing Prices; and (**d**) Ratio of Short-distance In-migration.

Table 1. Descriptive Statistics of Variables.

Variable	**Description**	**Mean**	**Median**	**Std.dev.**
Academic performance (SCORE)	The odds-ratio of students in a school who achieved above average levels in Korean, Mathematics, and English to those who achieved average and below average level	0.621	0.580	0.214
Housing prices (PRICE)	One-year average of medium housing prices per square meter (unit: 1000 USD)	3.849	3.444	1.442
Population in-migration (IN-MIG) [1]	Population inflow excluding those from neighboring towns and intra-town residential change (unit: 1000 people)	1.135	0.949	1.054
Short-distance residential relocation (SHORT) [1]	The frequency of residential move within its own and bordering towns (unit: 1000 people)	1.929	1.877	0.834
Access to private tutoring services (TUTOR) [2]	The number of workers from private tutoring industries (unit: 1000 people)	0.088	0.058	0.106
Family wealth (WEALTH)	Average property tax per household (unit: 1000 USD)	0.450	0.308	0.320
Distance from sub-centers (DIST)	Minimum of Euclidean distances from five sub-centers of Seoul to the town (unit: 1 km)	5.175	4.853	2.718
Access to public transport (TRANS)	Ratio of area located within 500 m from a subway station to the total area of the town	0.478	0.361	0.469
Endowment of public sports facilities (SPORTS)	The number of public sports facilities available within 1000 m from the town	6.870	6.000	4.516
Endowment of parks (PARK)	The number of parks available within 1000 m from the town	2.371	2.000	2.654
Population out-migration (OUT-MIG) [1]	Population outflow from the town (unit: 1000 people)	2.095	2.032	0.884
Workplace proximity (CTIME)	Average commuting time of current residents (unit: 1 min)	37.415	37.593	4.570
Scale of local manufacturing sectors (MANU) [2]	Manufacturing sector employment in its own and bordering spatial units (unit: 1000 people)	1.228	0.754	2.197
Scale of local service sectors (SERV) [2]	Service sector employment in its own and bordering spatial units (unit: 1000 people)	18.838	13.055	17.264
Scale of local housing market (HOUSING)	The number of housing units (unit: 1000 EA)	6.242	5.969	2.594

[1] The data on population moves in the IN-MIG, OUT-MIG and SHORT variables are provided by the 2010 population census; [2] The number of employees in a certain industrial sector (the TUTOR, MANU, and SERV variables) are provided by the business census.

Table 2 shows the estimation results using the GS3SLS method (in Appendix B, we present estimation results using the OLS and the 3SLS methods, and test results for endogeneity and spatial autocorrelation, by which the use of the GS3SLS method is justified). The results are by and large consistent with our expectation and findings from the literature. Focusing on the key variables involved with our hypotheses, the academic performance of schools in catchment areas (SCORE) is positively associated with both housing prices (PRICE) and population in-migration (IN-MIG); housing prices (PRICE) is negatively linked to population in-migration (IN_MIG), but population in-migration (IN_MIG) is positively linked to housing prices (PRICE). Overall, the results satisfy the hypotheses in terms of sign and statistical significance, except that the estimate of IN_MIG of the housing price equation is not significant at 10% level. While short-distance residential move (SHORT) has a negative association with school performance, the access to private tutoring services (TUTOR) and wealth level (WEALTH) shows a positive linkage to it. This supports the importance of educational environment including financial stability of the own and peer students, and the provision of private tutoring services on school outcome. The positive and significant estimates of spatial lags (ρ) evidence the existence of the spatial spillovers and dependencies.

Table 2. Estimation Results.

	Dependent Variable								
	School Performance: SCORE			**Housing Prices: ln(PRICE)**			**Population In-Migration: ln(IN_MIG)**		
Intercept	0.357	**	(0.183)	4.549	***	(0.441)	−0.225	*	(0.874)
SHORT [1]	−0.063	***	(0.020)						
ln(TUTOR)	0.035	***	(0.009)						
ln(WEALTH)	0.088	***	(0.016)						
SCORE				1.261	***	(0.069)			
ln(IN_MIG) [3]				0.014		(0.032)			
DIST				−0.018	***	(0.005)			
TRANS				0.047	*	(0.028)			
SPORTS				0.004		(0.003)			
PARK				0.007		(0.011)			
ln(OUT_MIG)				−0.089	**	(0.043)			
ln(PRICE) [2]							−1.079	***	(0.114)
SCORE							1.022	***	(0.180)
CTIME							−0.006		(0.007)
ln(MANU)							−0.038		(0.044)
ln(SERV)							0.262	***	(0.061)
ln(HOUSING)							1.120	***	(0.068)
Spatial lag (ρ)	0.827	***	(0.070)	0.320	***	(0.065)	0.154	**	(0.066)
Λ	−0.417	***	(0.028)	−0.093	***	(0.049)	0.036		(0.187)
Quasi-R^2		0.294			0.539			0.565	

[1] SCORE = $\beta_0 + \beta_1 \times$ ln(SHORT) + $\beta_2 \times$ ln(TUTOR)+ $\beta_3 \times$ ln(WEALTH) + ρW $\times$ SCORE + λW $\times$ μ + ε; [2] ln(PRICE) = $\beta_0 + \beta_1 \times$ SCORE + $\beta_2 \times$ ln(IN_MIG) + $\beta_3 \times$ DIST + $\beta_4 \times$ TRANS + $\beta_5 \times$ SPORTS + $\beta_6 \times$ PARK + $\beta_7 \times$ ln(OUT_MIG) + ρW $\times$ ln(PRICE) + λW $\times$ μ + ε; [3] ln(IN_MIG) = $\beta_0 + \beta_1 \times$ ln(PRICE) + $\beta_2 \times$ SCORE + $\beta_3 \times$ ln(MANU) + $\beta_4 \times$ ln(SERV) + $\beta_5 \times$ ln(HOUSING) + ρW $\times$ ln(IN_MIG) + λW $\times$ μ + ε; Standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; The goodness of fit in each equation is evaluated by the squared correlation between observed and predicted value of the dependent variables (Quasi-R^2), as applied in Jeanty et al. [46].

The estimation results provide a schematic sketch of linkages among school performance, housing prices, and residential moves. However, as mentioned above, the impact of a change in independent variables on the dependent variable can be more precisely measured based on partial derivative effects estimates composed of direct and indirect effects. Table 3 presents the average direct, indirect, and total effects of the GS3SLS results. The direct and indirect effects are statistically significant in key variables of our model, supporting the hypothesis of linkage among school performance, housing prices, and residential in-migration. Beginning with the school performance equation, a 1% increase in the frequency of residential change within its own and neighboring towns relates to 0.081unit decrease in the school performance of the town on average. As for indirect effect, a 1% increase in the frequency of short-distance residential moves of the town is related to 0.232 unit decrease in the school performance of all other towns on average, being greater than the direct effect. From a different point of view, a 1% increase in the frequencies of short-distance residential move of all other towns relates to 0.232 unit decrease in the academic performance of a particular town on average. The total effect arising from a percent increase in the frequency of short-distance residential move of a town is 0.313 unit decrease, which is significant at 1% level. The change of school performance in a town also relates to the change in the access to private education service and financial status of family in its own and the other towns. Comparing the size of direct and indirect effects, the school performance is more elastic to changes in the educational environments of other towns than the particular town. (Constant ratio between the direct and indirect effects for every explanatory variable is a limitation of SAC type model (without spatial lags of explanatory variables) [49]). This finding suggests that local educational setting generates a significant spatial externality in either positive or negative way, so inter-school level cooperation to improve educational environment is needed.

Table 3. Estimates of Average Direct, Indirect and Total Effects.

Equation	Variables	Direct Effects			Indirect Effects			Total Effects		
School performance: ln(SCORE)	ln(SHORT)	−0.081	***	(0.024)	−0.232	**	(0.087)	−0.313	***	(0.106)
	ln(TUTOR)	0.045	***	(0.011)	0.128	**	(0.043)	0.173	***	(0.050)
	ln(WEALTH)	0.113	***	(0.019)	0.324	***	(0.091)	0.437	***	(0.101)
Housing prices: ln(PRICE)	ln(SCORE)	1.281	***	(0.175)	0.031	*	(0.017)	1.311	***	(0.250)
	ln(IN_MIG)	0.015		(0.140)	0.006		(0.039)	0.021		(0.024)
	DIST	−0.017		(0.022)	−0.001		(0.004)	−0.025		(0.124)
	TRANS	0.046		(0.117)	0.024		(0.039)	0.077		(0.126)
	SPORTS	0.005		(0.012)	0.000		(0.000)	0.005		(0.012)
	PARK	0.006		(0.048)	0.000		(0.000)	0.004		(0.043)
	ln(OUT_MIG)	−0.098		(0.193)	0.000		(0.000)	−0.125		(0.220)
Population in-migration: ln(IN_MIG)	ln(PRICE)	−1.086	***	(0.102)	−0.192	***	(0.018)	−1.278	***	(0.120)
	ln(SCORE)	1.033	***	(0.182)	0.182	***	(0.030)	1.216	***	(0.197)
	ln(MANU)	−0.038		(0.040)	−0.007		(0.007)	−0.044		(0.047)
	ln(SERV)	0.263	***	(0.054)	0.046	***	(0.010)	0.310	***	(0.064)
	ln(HOUSING)	1.123	***	(0.057)	0.198	***	(0.010)	1.321	***	(0.067)

Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Housing prices are highly elastic to school performance of the catchment area: they would go up by 1.281% in response to a unit increase in academic performance on average. Taking into consideration of both direct and indirect effects, a unit increase in academic performance relates to 1.311% increase in housing prices on average. The size of the population inflow into a town is negatively associated with the increase in housing prices of its own and neighboring towns: the sizes of direct effect and indirect effect are 1.086% and 0.192%, respectively. A unit increase in school performance of a town relates to the increase in population inflow by 1.086% in the town and 0.192% in neighboring towns. The indirect effect as well as the indirect effect is statistically significant, suggesting that the impact of the increase in housing prices spread to neighboring towns, due to inter-connectivity across local housing markets. A 1% increase in school performance of a town leads to the increase in population inflow by 1.033% in the town and 0.182% in neighboring towns. Though significant at 1% level, the effect of school performance on population in-migration is smaller than that of housing prices.

Table 4 shows the change in housing prices and population in-migration with respect to a unit change in school performance, calculated based on the size of total effect in GS3SLS specification. A unit increase in school performance of a town leads to 1.355% of increase in housing prices, and the majority of the effect is generated through a direct channel (1.311%). In contrast, a unit increase in school performance of a town leads to the decrease in population in-migration by 0.46%, because the negative effect through the indirect channel (−1.675%) outweighs the positive effect through the direct channel (1.216%).

Table 4. Change in Housing Prices and Population In-migration with respect to a Unit Change in School performance.

	Direct Channel (A)	Indirect Channel (B)	Change in Total (A + B)
Housing prices	1.311%	0.044% (1.216% × 0.036%)	1.355%
Residentialin-migration	1.216%	−1.675% (1.311% × −1.278%)	−0.460%

Note that the change in housing prices and population in-migration with respect to the change in school performance is close to the association, rather than causation; Calculation is based on the size of total effect in GS3SLS model specification.

3.4. Discussion

According to the figures above, housing prices are more than twice elastic than population in-migration with respect to school performance, and a potential explanation is speculative investments in housing in good school districts, which impose further financial restriction on the residential choices of lower-income households. This suggest that inter-relationship between school performance, housing prices, and residential mobility under rigid geographic school assignment contributes to persistent school segregation. By identifying the multilateral linkage between these variables, we elucidate the underlying cause of substantial segregation of schools and residences with limited school choice, observed in the literature (e.g., [61]). Interestingly, while Clapp and Ross [62] found that racial (and income)-oriented segregation have only slight effects on middle- and high-income residences, the school quality (and housing price)-oriented segregation would affect both high- and low-income residences due to their difference in the drivers of residential moves(i.e., pull factors versus push factors).

Given the high dependence of school performance on peer composition in elementary school level [16], limited access to good school districts may further worsen the inequality of school performance. Furthermore, considerable sizes of indirect effects in three equations imply a spatially clustered pattern of the cumulative process of inequality. Therefore, spatially comprehensive approaches to enhance the general achievement level of weak school districts and dampen the speculative demand for housing in affluent school districts would be needed. In addition, governmental initiated land use plan to improve social mix (e.g., provision of public rental housings in affluent school districts) could increase positive peer effects that students from economically disadvantaged households can enjoy.

In order to reduce the inequality of educational achievement, more financial support is required for school districts with low fiscal self-reliance. The housing prices of these areas tend to be relatively low, which affects not only the amount of property taxes (a primary source of local government revenue) but also also school development funds and donations by parents and graduates. The budget support from the national government could be an effective solution to the problem of educational inequality. In addition, the national and local governments need to take an active role in the operation of after-school programs in an integrated way. An after-school program could provide children from lower income families with experiences similar to those enjoyed by children from middle-class families, who have access to a rich array of lessons, coached sports, and private tutoring. Such a program is one way to reduce the gap in access to qualified educational services [63]. The after-school program in South Korea has been operated to reduce the disparity of access to better educational services across school districts and income level groups since 2006, but the gap in the program's quality between rich and poor districts remains due to income disparities. Finally, public education of children under school age could ease spatial inequality of educational environment. The public education system for children under school age has been critical in students' academic performance. A long term research work showed strong correlation between kindergarten test score and adult outcomes such as college enrollment, mean income, and home ownership, implying the government support to enhance the quality of early childhood education in underprivileged areas would be valuable in light of the equality of education [64].

4. Summary and Further Research Agenda

This paper identifies multilateral linkages among academic performance of elementary school, housing prices, and residential mobility in Seoul where a rigid geographic school assignment is applied. A spatial simultaneous equation system is applied to address spatial interactions between local housing market and residential mobility. The results show that school performance positively affects both housing prices and population in-migration, but the increase in housing prices discourages the residential move into affluent school districts. Housing prices are more than twice elastic than residential moves with respect to school performance, implying that the residential demand to gain educational advantages is restricted by the housing price premium attached for school performance.

Our primary contribution is to explore the feedback between housing prices and residential movesinvolved with the performance and quality of local public school, which can be developed persistent education gap among different income-classes. Based on the finding that discouraging effect of housing price premium on population in-migration outweighs the population inflow attracted by school performance, this paper suggests policy alternatives to reduce the inequality of educational achievements.

As a further research subject, the effect of school performance on housing prices and residential moves at equilibrium can be observed for different income-classes, because individual households' responses to school quality might be non-linear. In addition, the change in peer-composition in terms of their ability or family backgrounds in consequence of residential separation by income classes could be considered as a determinant of school outcomes. This would provide a deeper insight on the cumulative process of inequality in school achievement. Moreover, structural changes among the three key variables can be tested using extended data set. For example, a Chow test can be used to identify whether affirmative action policies for low-income students affect the link between academic performance and housing markets. Finally, a disequilibrium model of housing markets and residential relocation is one of the alternatives to tracing the time-lag effects among the linkages between migration, housing prices, and school performance.

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Appendix A

To check the validity of the IVs, *F*-tests concerning the joint significance of IVs are performed. Table A1 presents the results of the validity check. Null hypotheses that the IVs are weak are rejected at the 1% of significance level in all three models.

Table A1. Validity Checks for Instrument Variables and Endogeneity Test.

	Equation		
	School Performance: SCORE	**Housing Prices: ln(PRICE)**	**Population In-Migration: ln(IN_MIG)**
Validity of IVs (H_0: IVs are weak)	191.169 ***	52.826 ***	38.156 ***

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Appendix B

Prior to the use of the GS3SLS methods, the OLS and the 3SLS methods were applied, but the GS3SLS method turned out to be more valid based on the results of tests for endogeneity and spatial autocorrelation Tables A2 and A3 presents the OLS and the 3SLS estimation results, and tests for endogeneity and spatial autocorrelation, respectively.

Table A2. Estimation Results from the OLS and the 3SLS methods.

Model		Dependent Variable								
		School Performance: SCORE			Housing Prices: ln(PRICE)			Population In-Migration: ln(IN_MIG)		
(1) OLS	Intercept	0.874	***	(0.212)	5.825	***	(0.195)	−5.629	***	(0.747)
	ln(SHORT)	−0.077	***	(0.023)						
	ln(TUTOR)	0.067	***	(0.012)						
	ln(WEALTH)	0.143	***	(0.017)						
	SCORE				0.797	***	(0.064)			
	ln(IN_MIG)				0.079		(0.051)			
	DIST				−0.028	***	(0.005)			
	TRANS				0.065	**	(0.027)			
	SPORTS				0.006	**	(0.003)			
	PARK				0.019	***	(0.005)			
	ln(OUT_MIG)				−0.105	***	(0.038)			
	ln(PRICE)							0.082		(0.098)
	SCORE							−0.274	*	(0.155)
	ln(MANU)							−0.022		(0.037)
	ln(SERV)							0.165	***	(0.051)
	ln(HOUSING)							1.233	***	(0.055)
	WH (*F*-test) **					10.834 ***			3.095 ***	
	DWH (χ-test) **					10.781 ***			3.128 ***	
	Adjusted R^2		0.222			0.542			0.635	
(2) 3SLS	Intercept	0.984	***	(0.201)	5.791	***	(0.236)	0.623		(2.07)
	ln(SHORT)	−0.085	***	(0.022)						
	ln(TUTOR)	0.059	***	(0.012)						
	ln(WEALTH)	0.123	***	(0.017)						
	SCORE				1.511	***	(0.118)			
	ln(IN_MIG)				0.034		(0.061)			
	DIST				−0.019	***	(0.005)			
	TRANS				0.046		(0.028)			
	SPORTS				0.005	**	(0.003)			
	PARK				0.006		(0.006)			
	ln(OUT_MIG)				−0.120	*	(0.07)			
	ln(PRICE)							−1.040	***	(0.344)
	ln(SCORE)							0.829		(0.571)
	ln(MANU)							−0.030		(0.042)
	ln(SERV)							0.261	***	(0.057)
	ln(HOUSING)							1.114	***	(0.073)
	Adjusted R^2		0.221			0.501			0.513	

Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A3. Test for Spatial Autocorrelation in the Residuals of the OLS and IV regression.

Model	Variable	Moran's I	LM Error	LM Lag	LM Error IV
OLS	SCORE	0.176 ***	28.349 ***	142.097 ***	-
	ln(PRICE)	0.159 ***	23.313 ***	692.812 ***	-
	ln(IN_MIG)	0.178 ***	28.955 ***	63.535 ***	-
IV regression	SCORE	0.153 ***	-	-	21.594 ***
	ln(PRICE)	0.102 ***	-	-	9.531 ***
	ln(I)	0.048 ***	-	-	2.613 ***

These tests are described in Anselin and Kelejian [65]; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

References

1. Zhang, X.; Kanbur, R. Spatial inequality in education and health care in China. *China Econ. Rev.* **2005**, *16*, 189–204. [CrossRef]
2. Šlaus, I.; Jacobs, G. Human capital and sustainability. *Sustainability* **2011**, *3*, 97–154. [CrossRef]

3. Tilbury, D. *Education and Sustainability: Responding to the Global Challenge*; IUCN: Gland, Switzerland; Cambridge, UK, 2002.
4. Musset, P. *School Choice and Equity: Current Policies in OECD Countries and a Literature Review*; OECD Publishing: Paris, France, 2012.
5. Machin, S.J.; Salvanes, K.G. Valuing school quality via a School Choice Reform. *Scand. J. Econ.* **2016**, *118*, 3–24. [CrossRef]
6. Chung, I.H. School choice, housing prices, and residential sorting: Empirical evidence from inter-and intra-district choice. *Reg. Sci. Urban Econ.* **2015**, *52*, 39–49. [CrossRef]
7. Rossell, C.H. School desegregation and white flight. *Political Sci. Q.* **1975**, *90*, 675–695. [CrossRef]
8. Fairlie, R.W.; Resch, A.M. Is there "white flight" into private schools? Evidence from the National Educational Longitudinal Survey. *Rev. Econ. Stat.* **2002**, *84*, 21–33. [CrossRef]
9. Seth, M.J. *Education Fever: Society, Politics, and the Pursuit of Schooling in South Korea*; University of Hawaii Press: Honolulu, HI, USA, 2002.
10. Anderson, T.; Kohler, H.-P. Education fever and the East Asian fertility puzzle: A case study of low fertility in South Korea. *Asian Popul. Stud.* **2013**, *9*, 196–215. [CrossRef] [PubMed]
11. Nguyen-Hoang, P.; Yinger, J. The capitalization of school quality into house values: A review. *J. Hous. Econ.* **2011**, *20*, 30–48. [CrossRef]
12. Caetano, G.S. *Identification and Estimation of Parental Valuation of School Quality in the US*; University of California: Berkeley, CA, USA, 2009.
13. Teske, P.E.; Fitzpatrick, J.L.; O'Brien, T. *Drivers of Choice: Parents, Transportation, and School Choice*; Center on Reinventing Public Education, University of Washington Bothell: Bothell, WA, USA, 2009.
14. Alves, F.; Elacqua, G.; Koslinki, M.; Martinez, M.; Santos, H.; Urbina, D. Winners and losers of school choice: Evidence from Rio de Janeiro, Brazil and Santiago, Chile. *Int. J. Educ. Dev.* **2015**, *41*, 25–34. [CrossRef]
15. Kim, K.; Lee, E.; Park, D. Influence of elementary and secondary schools demand on apartments. *Korea Spat. Plan. Rev.* **2010**, *65*, 99–113. (In Korean).
16. Burke, M.A.; Sass, T.R. Classroom peer effects and student achievement. *J. Labor Econ.* **2013**, *31*, 51–82. [CrossRef]
17. Rosen, S. Hedonic prices and implicit markets: Product differentiation in pure competition. *J. Political Econ.* **1974**, *82*, 34–55. [CrossRef]
18. Black, S.E. Do better schools matter? Parental valuation of elementary education. *Q. J. Econ.* **1999**, *114*, 577–599. [CrossRef]
19. Gibbons, S.; Machin, S. Valuing English primary schools. *J. Urban Econ.* **2003**, *53*, 197–219. [CrossRef]
20. Dhar, P.; Ross, S.L. School district quality and property values: Examining differences along school district boundaries. *J. Urban Econ.* **2012**, *71*, 18–25. [CrossRef]
21. Feng, H.; Lu, M. School quality and housing prices: Empirical evidence from a natural experiment in Shanghai, China. *J. Hous. Econ.* **2013**, *22*, 291–307. [CrossRef]
22. Hoxby, C.M.; Weingarth, G. *Taking Race out of the Equation: School Reassignment and the Structure of Peer Effects*; Working Paper; Department of Economics–Harvard University: Cambridge, MA, USA, 2005.
23. Brasington, D.M.; Haurin, D.R. Parents, peers, or school inputs: Which components of school outcomes are capitalized into house value? *Reg. Sci. Urban Econ.* **2009**, *39*, 523–529. [CrossRef]
24. Tiebout, C.M. A pure theory of local expenditures. *J. Political Econ.* **1956**, *64*, 416–424. [CrossRef]
25. Barrow, L. School choice through relocation: Evidence from the Washington, DC area. *J. Public Econ.* **2002**, *86*, 155–189. [CrossRef]
26. Rothwell, J. *Housing Costs, Zoning, and Access to High-Scoring Schools*; Brookings Institution: Washington, DC, USA, 2012.
27. Bayer, P.; Ferreira, F.; McMillan, R. A unified framework for measuring preferences for schools and neighborhoods. *J. Political Econ.* **2007**, *115*, 588–638. [CrossRef]
28. Coulton, C.; Theodos, B.; Turner, M.A. Residential mobility and neighborhood change: Real neighborhoods under the microscope. *Cityscape* **2012**, *14*, 55–89.
29. Theodos, B.; Coulton, C.; Budde, A. Getting to better performing schools: The role of residential mobility in school attainment in low-income neighborhoods. *Cityscape* **2014**, *16*, 61.
30. Lavy, V.; Paserman, M.D.; Schlosser, A. Inside the black box of ability peer effects: Evidence from variation in the proportion of low achievers in the classroom. *Econ. J.* **2012**, *122*, 208–237. [CrossRef]

31. Clark, S.L. Housing Instability: Toward a Better Understanding of Frequent Residential Mobility among America's Urban Poor. Available online: http://www.nhc.org/media/files/LawsonClark_analysis_for_child_mobility.pdf (accessed on 19 June 2017).
32. Wood, D.; Halfon, N.; Scarlata, D.; Newacheck, P.; Nessim, S. Impact of family relocation on children's growth, development, school function, and behavior. *JAMA* **1993**, *270*, 1334–1338. [CrossRef] [PubMed]
33. Simpson, G.A.; Fowler, M.G. Geographic mobility and children's emotional/behavioral adjustment and school functioning. *Pediatrics* **1994**, *93*, 303–309. [PubMed]
34. Mehana, M.; Reynolds, A.J. School mobility and achievement: A meta-analysis. *Child. Youth Serv. Rev.* **2004**, *26*, 93–119. [CrossRef]
35. Coleman, J.S. Social capital in the creation of human capital. *Am. J. Sociol.* **1988**, *94*, S95–S120. [CrossRef]
36. Hendershott, A.B. Residential mobility, social support and adolescent self-concept. *Adolescence* **1989**, *24*, 217. [PubMed]
37. Jason, L.; Danner, K.E.; Kurasaki, K.S. *Prevention and School Transitions*; The Haworth Press, Inc.: Binghamton, NY, USA, 1993.
38. Pribesh, S.; Downey, D.B. Why are residential and school moves associated with poor school performance? *Demography* **1999**, *36*, 521–534. [CrossRef] [PubMed]
39. Astone, N.M.; McLanahan, S.S. Family structure, residential mobility, and school dropout: A research note. *Demography* **1994**, *31*, 575–584. [CrossRef] [PubMed]
40. Gasper, J.; DeLuca, S.; Estacion, A. Switching schools revisiting the relationship between school mobility and high school dropout. *Am. Educ. Res. J.* **2012**, *49*, 487–519. [CrossRef] [PubMed]
41. Haelermans, C.; de Witte, K. Does residential mobility improve educational outcomes? Evidence from the Netherlands. *Soc. Sci. Res.* **2015**, *52*, 351–369. [CrossRef] [PubMed]
42. Hanushek, E.A.; Kain, J.F.; Rivkin, S.G. Disruption versus Tiebout improvement: The costs and benefits of switching schools. *J. Public Econ.* **2004**, *88*, 1721–1746. [CrossRef]
43. Schachter, J. *Geographical Mobility, 2002–2003*; US Department of Commerce, Economics and Statistics Administration, Bureau of the Census: Washington, DC, USA, 2004.
44. Schafft, K.A. Poverty, residential mobility, and student transiency within a rural New York school district. *Rural Sociol.* **2006**, *71*, 212–231. [CrossRef]
45. Kelejian, H.H.; Prucha, I.R. Estimation of simultaneous systems of spatially interrelated cross sectional equations. *J. Econ.* **2004**, *118*, 27–50. [CrossRef]
46. Jeanty, P.W.; Partridge, M.; Irwin, E. Estimation of a spatial simultaneous equation model of population migration and housing price dynamics. *Reg. Sci. Urban Econ.* **2010**, *40*, 343–352. [CrossRef]
47. LeSage, J.P.; Pace, R.K. The biggest myth in spatial econometrics. *Econometrics* **2014**, *2*, 217–249. [CrossRef]
48. LeSage, J.P.; Pace, R.K. *Introduction to Spatial Econometrics*; CRC Press: Boca Raton, FL, USA, 2009.
49. Elhorst, J.P. Linear Spatial Dependence Models for Cross-Section Data. In *Spatial Econometrics*; Springer: Berlin, Germany, 2014; pp. 5–36.
50. Hanushek, E.; Yilmaz, K. The complementarity of Tiebout and Alonso. *J. Hous. Econ.* **2007**, *16*, 243–261. [CrossRef]
51. Hanushek, E.; Yilmaz, K. Household location and schools in metropolitan areas with heterogeneous sububs: Tiebout, Alonso, and government policy. *J. Public Econ. Theory* **2013**, *15*, 829–855.
52. Jackman, R.; Savouri, S. Regional migration in Britain: An analysis of gross flows using NHS central register data. *Econ. J.* **1992**, *102*, 1433–1450. [CrossRef]
53. Jackman, R.; Savouri, S. Regional migration versus regional commuting: The identification of housing and employment flows. *Scott. J. Political Econ.* **1992**, *39*, 272–287. [CrossRef]
54. Gabriel, S.A.; Shack-Marquez, J.; Wascher, W.L. Regional house-price dispersion and interregional migration. *J. Hous. Econ.* **1992**, *2*, 235–256. [CrossRef]
55. Cameron, G.; Muellbauer, J. The housing market and regional commuting and migration choices. *Scott. J. Political Econ.* **1998**, *45*, 420–446. [CrossRef]
56. Goldhaber, D.D.; Brewer, D.J. Why don't schools and teachers seem to matter? Assessing the impact of unobservables on educational productivity. *J. Hum. Res.* **1997**, *32*, 505–523. [CrossRef]
57. Aaronson, D.; Barrow, L.; Sander, W. Teachers and student achievement in the Chicago public high schools. *J. Labor Econ.* **2007**, *25*, 95–135. [CrossRef]

58. Ehrenberg, R.G.; Goldhaber, D.D.; Brewer, D.J. Do teachers' race, gender, and ethnicity matter? Evidence from the National Educational Longitudinal Study of 1988. *ILR Rev.* **1995**, *25*, 547–561. [CrossRef]
59. Holmlund, H.; Sund, K. Is the gender gap in school performance affected by the sex of the teacher? *Labour Econ.* **2008**, *15*, 37–53. [CrossRef]
60. Anselin, L. Local indicators of spatial association—LISA. *Geogr. Anal.* **1995**, *27*, 93–115. [CrossRef]
61. Nechyba, T. School finance, spatial income segregation, and the nature of communities. *J. Urban Econ.* **2003**, *54*, 61–88. [CrossRef]
62. Clapp, J.M.; Ross, S.L. Schools and housing markets: An examination of school segregation and performance in connecticut. *Econ. J.* **2004**, *114*, F425–F440. [CrossRef]
63. Posner, J.K.; Vandell, D.L. After-school activities and the development of low-income urban children: A longitudinal study. *Dev. Psychol.* **1999**, *35*, 868. [CrossRef] [PubMed]
64. Chetty, R.; Friedman, J.N.; Hilger, N.; Saez, E.; Schanzenbach, D.W.; Yagan, D. How does your kindergarten classroom affect your earnings? Evidence from Project STAR. *Q. J. Econ.* **2011**, *126*, 1593–1660. [CrossRef] [PubMed]
65. Anselin, L.; Kelejian, H.H. Testing for spatial error autocorrelation in the presence of endogenous regressors. *Int. Reg. Sci. Rev.* **1997**, *20*, 153–182. [CrossRef]