Effects of School Choice on Students' Mobility: Evidence from Madrid*

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June 2017

Abstract

Endowing families with school choice might promote equality of opportunity, facilitating access to better schools to all students regardless the neighborhoods where they reside. Nevertheless, family mobility may be driven by their socioeconomic characteristics and by the features of the center. Thus, school choice could have a negative impact by exacerbating differences across students from distinct backgrounds and intensifying segregation. After the implementation of the inter-district school choice in the Community of Madrid, there has been a decrease in the segregation of the educational system. Families from the lowest socioeconomic status are those who respond the most when facing an increase in the level of school choice. The largest increase in within-school heterogeneity is experienced by the best schools. This evidence suggest that school choice does promote equality of opportunity.

I Introduction

The consequences of an increase in the level of school choice within the educational system might be enormously unpredictable according to the existing literature. Some researchers claim that a market-based school system increases the competition between schools resulting in a rise of school productivity. Hoxby (2000) [17] shows with an IV methodology that the higher is the level of choice the more productive schools are. Meanwhile, there is another strand in the literature arguing that a higher level of choice exacerbates educational inequality (Ladd, 2002) [22]. Hsieh and Urquiola (2006) [18] find in Chile that school choice has not increased average quality of education. However, it intensifies segregation based on socioeconomic status. Baum-Snow and Lutz (2011) [6] provide evidence that desegregation policies trigger the unwanted effect: a rise

I would like to thank the Consejería de Educación staff (Ismael Sanz and Luis Pires) and the Census Office staff (Antonio Bermejo) for the provision of data and their great kindness. I would also like to thank José Montalbán, Lucas Gortázar and all Cemfi faculty and mates, specially; my advisor, Caterina Calsamiglia and Manuel Arellano, Juan Manuel Castro and Luis Lafuerza for their essential help and support throughout this project.

in private school enrollment and migration to suburban districts. Hoxby (2000) [17], conversely, finds that students are equally segregated in different school systems regardless the level of school choice.

A set of questions that arises naturally when one claims that school choice may lead to an increase (or decrease) in the level of segregation is the following: Why should we care about segregation? Is a segregated educational system worse than other less segregated? Are there winners (or losers) in a less segregated system? I try to explain briefly along the following lines why should we care about segregation within the educational system. Parents choose the school for their offspring with the highest possible quality taking into account other school characteristics such as proximity and accessibility. The school performance depends on two main dimensions: teaching quality and student body composition. Even for the most educated families, raking centers in terms of the teaching quality that they provide to the students is a hard and imprecise work. For that reason some families tend to identify school composition as the measure of school quality (Rothstein, 2006) [23]. Having a segregated educational system will hinder low (and even middle) socioeconomic background students from benefiting higher socioeconomic peers spillovers. Nevertheless, recent literature has not found evidence of the positive effects on educational outcomes from studying in a class with peers from a higher socioeconomic background. For instance, Katz et al. (2001) [20] and Abdulkadiroglu et al. (2014) [3] evaluate the Moving to Opportunity (MTO) program in Boston consisting in relocating families from low socioeconomic environments to neighborhoods with a higher socioeconomic average. They find no gains in the educational outcomes from being with better peers and different racial composition. However, Chetty et al. (2016) [10] analyze the long-term impact of the MTO. They observe that younger participants moving to a lower-poverty neighborhood were more likely to attend college and earning a higher wage. Kremer and Levy (2008) [21] asses the impact of -determined by lottery- roommates behaviors on college outcomes. They find that students sharing the room with students who drank the previous year obtain lower grades. Additionally, Hastings and Weinstein (2008) [16] find that attending to a high-performing school improves the student achievement significantly, even if the student comes from a low-socioeconomic environment. One illustrative example is the result obtained by Cullen et al. (2006) [11]. They study the outcomes for students who get the seat in their most preferred school and those who do not. Seats were assigned by a lottery and they find that winning that lottery provides no academic benefit. Though, students experience improvements on nontraditional measures. Thus, school choice promotes equality of opportunity, allowing children from disadvantaged families attend schools with students from higher socioeconomic background.

During the last three decades, there has been a clear pattern in way that educational authorities have modified school choice policies. Many countries has increased vastly the degree of school choice in their educational systems. The Comunidad de Madrid Government introduced for the academic course 2013/2014 the inter-district school choice (Distrito Único) in the main municipalities of the autonomous community. Before this reform a student from a particular district had priority to obtain a seat in the schools located within the same district in which she resides. This priority made families almost unthinkable to get a seat in a school situated in an outer district provided that the school for which they were applying was sufficiently good. The reform eliminates this priority originating a sharp rise of the degree of school choice. Families, therefore, have access to an enlarged set of schools in comparison to the one during the intra-district school choice.

In this paper I take advantage of this recent policy change and a unique dataset to asses the impact of Tiebout choice on social segregation within the school system in the city of Madrid, shedding light on one of the most controversial issues in education economics: whether school choice leads to a higher degree of segregation or, conversely, it promotes equality of opportunity and allows students from low socioeconomic environments to access schools with a higher average peer quality. In order to address this question I analyze how families changes their choices and how they translate into school assignments after the implementation of the inter-district school choice. When families are constrained by the number of schools that can apply for, their choices do not correspond with their preferences. In this case, priority becomes a critical determinant of the choice list (Calsamiglia et al., 2010) [9]. Inter-district school choice reform implemented in Madrid changes profoundly the assignment criteria in the case schools are oversubscribed. In view of this, we might expect that the family choice list is altered by the new priority criteria. Therefore, this new law implementation offers an opportunity to evaluate the changes in parents school decisions and which are the implications for the social mobility within school system.

Following Hsieh and Urquiola (2006) [18], under a higher level of school choice school may tend to select students based on ability or background characteristics. For-profit schools -like the charter schools in the Madrid school system- have incentive to "cream skim" students since high-ability students demand less resources to be educated and they generate a better reputation for school making it more profitable. The Madrid school choice mechanism allows schools to establish the criterion that assigns one of the points which gives priority to get a seat in the school[1]. Therefore this point may be used by schools to select students based on some characteristics as ability or family status. Despite I try to get micro-data on the criteria met by each student I did not get them. Thus, in this paper I am not able to assess to what extend this phenomenon is relevant within the Madrid educational system.

I assemble a unique data set composed of the universe of families applications for preschool and primary schools -and assigned school- for two academic years (2010 and 2016) in the city of Madrid and census data on years of education and household income at censual section level. I assign to each family the average years of schooling and the average household income of the section where they reside. To classify schools according to their quality I employ administrative data from the external evaluations on "Indispensable Knowledge and Skills" (CDI in its Spanish acronym) to sixth grade students of primary education. An appropriate approach for this research would be to assess separately the effect of school choice on students mobility by the two main stages of education: elementary and secondary. In this paper I address the effects of school choice on elementary students given that this is the only group for which data are available. However, secondary students characteristics facilitate their responsiveness to a rise in the level of school choice.

I find that families respond to a higher degree of school choice by commuting further (around 15% more) and applying more for schools out of their districts (around 33% more). When I investigate this change by socioeconomic status, estimates show that the group of families that

[1]In Section III this priority criteria is explain in detail.

undergoes the largest increase in the distance and the probability of applying for an outer school is the one from the lowest socioeconomic status. These findings have important consequences for social mobility. Socioeconomic heterogeneity within-school increases by 12.5% after the inter-district school choice reform in terms of parent education. Meanwhile, results on heterogeneous effects show that low-performing schools bear a higher level of segregation concerning parent education. In addition, the increase in the degree of heterogeneity is positively correlated with the school quality. In other words, the biggest decrease in segregation is undergone by the best schools. On the other hand, schools located in low-income districts experience a decrease in the level of within-school heterogeneity. Along with the inter-district school choice reform there are other forces operating at the same time blurring the specific impact of the school-choice reform on segregation. Therefore, after the implementation of the inter-district school choice reform, the Madrid educational system experiences an overall decrease in the level of segregation driven mostly by high-performing schools. Simultaneously, there is an increase in the level of segregation within the schools located in low-income districts. The school choice reform plays an important role by promoting geographical mobility but I cannot attribute the whole change in the level of segregation to the inter-district school choice.

The rest of the paper is organized as follows. Section II deals with the literature related to school choice. Section III describes the Madrid educational system focusing mainly on the school choice features. Data are detailed in Section IV. The results and its analysis are shown in Section V. Section VII concludes.

II Literature

School choice benefits have been the center of a lively debate during the last decades since Milton Friedman publish his article on "The Role of Government in Education" (Friedman, 1955) [13]. Advocates for school choice claim that a market-based school system increases the competition between schools for students what, as a consequence, would imply a rise in the productivity of schools. Hoxby (2000) [17] shows with an IV methodology that the higher is the level of choice the more productive are schools. However, there are another strand in the literature arguing that a higher level of choice exacerbates educational inequality as Ladd (2002) [22]. Hsieh and Urquiola (2006) [18] find in Chile that school choice does not increase average quality of education, but it does increase segregation. Baum-Snow and Lutz (2011) [6] provide evidence that desegregation raises enrollment in private schools and migration to suburban districts (residential segregation).

Additionally, responses to school choice will depend on family socioeconomic background since preferences for different dimensions of education vary across types following Anderson et Al. (1992) [4] and Burgess et al. (2015) [8]. Hasting et Al. (2005) [14] argue that if high-income families care mainly about quality of education and poorer families choose school based on proximity, school choice will lead to a more stratified school system. The impact of school choice will be determined eventually by parent' preferences on education. They also find that low-performing schools serve local families, whereas high-performing schools provide their service to families who value predominantly academic aspects. Families who place more value to education are more responsive to changes in school quality. Nevertheless, Hastings et Al. (2012) [15] find that idiosyncratic preferences for test scores are negative correlated for those related with proximity which may create a disparate demand-side pressure to raise the school quality. Hastings and Weinstein (2008) [16] show with the help of a natural and field experiment that low-socioeconomic parents receiving information about the school performance increases the probability that those families choose a high-performing school.

This research will contribute to the literature shedding light on the effects of the inter-district school choice on segregation in the school system at elementary level. Though there are some research on the effects of school choice on segregation, there is still lack of unambiguous evidence. For instance, Urquiola (2005) [24] detects an increase in sorting when metropolitan areas in the United States experience a rise in the level of school choice. His research relies on differences in two distinct education markets, primary and secondary, which are characterized by different district areas. However, the results cannot be certainly extrapolated to other cities or regions. He cannot isolate the effect on school choice given that the change in segregation might be potentially driven by other causes. The ambiguity of the literature on this topic is demonstrated with the findings of Burgess and Briggs (2010) [7]. They investigate the effect of school choice on social mobility in secondary education in England. They find that children from poor families are less likely to get seats in good schools and this probability is unaffected by the degree of school choice. This suggests that there must be other additional features belonging (or related to) the educational system affecting students' mobility beyond the degree of school choice.

III The Madrid Educational System Reform

In accordance with the trend towards greater level of school choice over the last decades in many countries, the "Comunidad Autónoma de Madrid" implemented an inter-district school choice or a unique educational zone (in Spanish, "zona única educativa") for the academic course 2013/2014 [2]. The school choice reform was motivated by the constitutional right that parents possess to freely choose among the publicly funded centers where their children will be educated. A second pillar of the justification for the reform is the equality of opportunity. The Madrid Government argues that a unique educational zone promotes equality of opportunity, allowing more disadvantageous families to access a larger number of schools. A third principle of the reform is the informative transparency. Educational administration and centers must provide all needed information in order to help families in the decision-making process (Decreto 29/2013, de 11 de abril, del Consejo de Gobierno, de libertad de elección de centro escolar en la Comunidad de Madrid) [1].

This new school choice system targets all level of education from preschool to high school and all publicly funded centers. The largest enrollment episode in the educational system occurs at the first grade of the second level of preschool education, that is, when children are three years old. Once they enter a center, the majority of students usually remain in the same school

[2]Spain has transferred education policy to the autonomous communities (Ley Orgánica 9/1992, de 23 de diciembre, de transferencia de competencias a Comunidades Autónomas que accedieron a la autonomía por la vía del artículo 143 de la Constitución) [2].

for the rest of preschool and primary education. As a consequence -and also because of data availability-, I focus on this stage of education.

Families pretending to enroll their kids in some of schools belonging to the public educational system have to complete an application form where they list the most preferred schools, from one up to fourteen. As I have highlighted above, this application process takes place predominantly during the first year of the second stage of preschool (at the students' age of three), but it could also be before or after given that preschool is voluntary and there can be some -although few-students changing center during primary education. In the case a school is oversubscribed seats are assigned to the students with more points according to the criteria established by the law. The points distributed by the criteria of the pre-reform and post-reform laws are detailed in the appendix. However, I explain below the main differences between the two norms[3].

The inter-district school choice reform is characterized by the reduction in the number of points given to the students applying for a school located in the same district they reside. It is reduced from 4 points (33% of the maximum scoring[4]) to 0.5 points (3.3% of the maximum scoring[5]). The change is qualitatively dramatical as it can be observed by looking at the difference in the weight between the two periods. This change in the weight that the district of residence has on the scoring is not only due to its direct reduction, but also because there are several changes in other criteria that decreases its relative importance. These other modifications must be studied consciously since they might have crucial implications for the probability that students get the school they wish, albeit the lack of data about this issue does not allow to estimate its effect separately from the main change.

First, students with one sibling already enrolled in the school or a parent working in the center will obtain 6 points more (from 4 to 10) after the school choice reform. Moreover, when one of the parent is a former student of the center the child gets 1.5 points, something that did not happen with the intra-district school choice. On the other hand, priority based on chronic diseases completely disappears. One more family feature that loses weight after the reform is the low income priority. During the intra-district school choice period families with per capita household income under the IPREM[6] (7,236.60 euros) receive 2 points and 1 if the per capita household income was between 200% and 100% of the IPREM (7,236.60 - 14,473.20). Inter-district school choice grants 2 points to students from families recipient of the Minimum Insertion Subsidy (Renta Mínima de Inserción, in Spanish). The Minimum Insertion Subsidy recipients are much less numerous than the families with a per capita household income under the 100% of the IPREM. In addition, the relative weight of 2 points decreases from the pre-reform period to the post-reform. Thus, there is a sharp decrease in the priority to low income families along with the increase in the school choice level.

The school choice reform explicitly recognizes the importance that families are conveniently informed in order to make use of the higher level of school choice. As a consequence, schools

[3] I call intra-district school choice period to the school choice system before the unique educational zone was implemented, namely the 2010 regulatory framework. I call inter-district school choice reform to the regulation by which the unique educational zone is implemented (2013 onwards).

[4] Computation assuming no family member in the center.

[5] Adjusted omitting the scoring given by residing in the Community of Madrid and in the same municipality, it increases up to 5.6%.

[6] IPREM is the acronym in Spanish for Multiple Effects Income Public Index.

will be required to undergo evaluations every year at third (internal evaluation) and sixth grade (external evaluation) of primary education[7]. Test scores are anonymous and they are taken simultaneously with socioeconomic characteristics of the student so that scoring is balanced with the student background. The Government in the Community of Madrid must publish these test scores by school with the aim of facilitating parents know how well or bad every center is performing.

IV Data

I draw information from two data sources: Government of the Community of Madrid and the Census Office of Madrid. The former provides information on applications and assignments as well as school scoring in the CDI tests. Data on household income and parents education is supplied by the Census of Madrid. This section describes the main features of the data used in this empirical work.

A. Application Form Data and CDI

The Government of the Community of Madrid gave access to the universe of applications in the city of Madrid for the years 2010 and 2016 regarding preschool and primary education. For each applicant, the dataset contains information on the schools to which the family is applying for together with its ranking. The school to which the student is eventually assigned is also provided. Students residence is given by their geographic coordinates that, with the help of geolocation software, are linked to different geographic zones (districts, neighborhoods and sections). In the municipality of Madrid there are 27,607 applicants for the academic course 2010/2011 and 34,063 applicants for the course 2016/2017. We can only use the students residing in areas that do not change with respect to this areas' definition in the year 2014. For instance, if a geographical area is created in 2016 and there some students living there, these applications cannot be kept in the database. 264 applications in 2010 and 443 applications in 2016 are missed by this reason.

The Community of Madrid also facilitates a list with the schools and some of their features. Each school is localized by its coordinates which are used to be assigned to geographic units in the same way that is done for families. The CDI test scores are used as proxy for school quality or, more precisely, the 'perceived quality' by parents. The measures that the CDI tests provide are the following: the average total grade by school, the ranking of this particular school and the percentage of students that pass the exam [8]. I also have access to information about the school ownership, whether the center is public or charter as well as whether the center is bilingual or not[9]. CDI test scores and bilingualism are dynamic features so they can vary between periods. There are 5 centers that disappear between 2010 and 2016. I am not able to use the applications of these schools since I have no information on these schools beyond the center code. In this

[7]These tests are not the same than CDI. Then new law (LOMCE) regulates these evaluations.

[8]There are also grade by topic (math, sciences and literature).

[9]Some schools belong to the bilingual program which consists in teaching part of the subject in a foreign language. In Section VI there is more information on bilingualism.

process 229 applications are lost belonging to the year 2010. Each application is linked to the first choice school along with all characteristics of this school. The perceived quality of the school chosen by a family for a particular academic course is approximated by the CDI result of this school the previous year. Obviously, when family is making the decision about the school the most recent measure of quality is the one from the previous year. There are 16 schools in the applications database that do not appear in the CDI tests database. Thus, the application database shrinks in 1,065 students (23 from 2010 course and 1,042 from the 2016). One potential explanation could be that some schools do not take the external evaluation for any reason[10]. A second potential explanation it could be that, given that these schools are mainly from 2016, they are new schools so they still do not have a performance measure. This last explanation would be a concern if the new schools present systematic characteristics related with the outcomes that is analyzed, since they could bias the results of this paper. Therefore, there are 27,091 applications for the academic year 2010 and 32,578 applicants in 2016, which add up to 59,669 observations. All these students apply for 504 centers distributed all over the city. As we can see in table 1 the majority of applications received by the educational system of Madrid are for the first grade of the second stage of preschool education, third grade of preschool. At this level of education students are three years old[11].

One of the main features that parents take into account when they decide to which school apply for is school quality which is more important for more educated parents (Hasting et al., 2005) [14]. For the purpose of the research I use the average grade of schools in the external evaluations (CDI) in the previous year in which families are making their choices to divide schools into three groups. CDI tests evaluate all primary and secondary schools, although the results used here are those for primary. This evaluation tests students from sixth grade (12-13 years old). This measure is not net of student background, so the proxy for school quality is a combination of both value-added and peer effect. Since parents care about these two dimensions of school quality this proxy is a good proxy for what parents understand as education quality. Nevertheless, it may be the case that parents put a large weight on peer quality when they are working out their subjective school quality. Therefore, I also group schools into groups according to the average income in the school district. Average school quality in the district and the average income in the district are quite correlated (0,91). Schools are divided into low-, middle- and high-scoring as we can see in figure A.2a in the appendix. Low-scoring schools are those whose average grade in the external evaluation is below 6.5 -out of 10-. High-scoring schools have an average grade above 7.7. Additionally, schools categorization depending on the average income in their districts are also grouped into three types -see figure A.2b-: low-income (average income below 29,971 euros), middle-income (average income between 29,971 and 45,236 euros) and high-income (average income larger or equal to 45,236 euros).

[10]This requirement of the reform was the most controversial issues and there were many reluctant parents to let their children take the tests.

[11]For instance, applicants for third grade of preschool in 2010 are all children born during the year 2007.

Table 1: Distribution of applications across grades and years.

	2010		2016	
	Number	Proportion	Number	Proportion
Preschool 3^{rd}	16,979	62.67%	20,626	62.31%
Preschool 4^{th}	2,381	8.79%	2,673	8.20%
Preschool 5^{th}	1,842	6.80%	1,987	6.10%
Primary 1^{st}	3,948	14.57%	4,746	14.57%
Primary 2^{nd} to 5^{th}	1,410	5.20%	1,797	5.52%
Primary 6^{th}	531	1.96%	749	2.30%
	27,091	100%	32,578	100%

B. Census Data

Data from the Government of Madrid do not contain information on socioeconomic characteristics of the students' families. This information is drawn from the Census Office of Madrid and it comprises the proportion of population within the different groups of education and the average household income in the geographic unit. The average household income data are only available for the year of the education reform (2013/2014). As a consequence both census data (parents' education and household income) belong to this year. Census data are built in the following geographic units: district, neighborhood and censual section. The most disaggregated unit is the censual section which contains no more than 2,500 people each. This units are constructed with the purpose of elections. The appendix includes an example on the sectioning of the center of Madrid in figure A.1. An additional feature of the household data that is worth to highlight is the following. The Census Office does not facilitates information on the average household income in the section. Each section is characterized by the decile of the household income distribution in the city. This is an important limitation of this proxy for socioeconomic status because it presents really little variability as I will show once it is used for estimation.

For every section, the Census Office provides the proportion of interviewed people in each education category[12]. Defining the average number of years of schooling for each category we have the average years of schooling in each section. In addition, the Census Office constructed a database with the proportion of population within each education category by age group: one group from 25 to 49 and other 50 and older. I use the education by the 25-49 age group to obtain a more accurate proxy for the parent education, given that the level of education within this age interval is more relevant for families with children in preschool and primary age. Nevertheless, I do not use this measure as the leading one because the database correspond to 2017, so I utilize it for robustness check.

Parents education and household income for every student applying for school is needed to carry out the research. Provided that application database does not contain this information, I assign to each family the average number of years of schooling and the average household income

[12] In the appendix there is detailed information about this computation.

in the section where the family resides. This will introduce measurement error but these are the unique proxies available for socioeconomic status. Nevertheless, the geographical unit is small so it will be relatively homogeneous in those terms.

V Results and Analysis

In this section I analyze the changes in some dimensions of the students' mobility induced by the school choice reform. As I will discuss later, the identification strategy does not allow to infer to what extend the inter-district school choice is driving the results. There could be other forces operating simultaneously, in the same or in opposite direction. Thus, I will try to identify and evaluate any potential issue that could also influence the students' mobility across districts and schools within the city of Madrid. I will start by assessing the impact of the inter-district school choice on the geographical mobility of the students. Secondly, I will investigate the effects of the reform on the within-school segregation (or sorting) in the educational system of Madrid. Lastly, I will treat the possible concern that may be affecting these outcomes.

A. Geographical Mobility

In order to assess whether the implementation of the unique district law in Madrid has increased the mobility of children in terms of geographic distance or time, I use the following specification:

$$D_{i,j} = \iota + \kappa L_i + \beta X_i + \xi_{i,j} \tag{1}$$

$$D_{i,j} = \iota_2 + \kappa_2 L_i + \sum_{c=1}^{5} SES_{i,c}\pi_c + \sum_{c=1}^{5} SES_{i,c}L_i\pi_{2,c} + \beta_2 X_i + \xi_{i,j} \tag{2}$$

where D_i is the travel time[13] from the residence of the student i to the first choice school j in her application form. L_i is a dummy that takes the value 1 if the choice is made after the law change. $SES_{i,c}$ is a set of dummies accounting for the socioeconomic status of the student i that can be either information on family income and parents education. $X_{i,j}$ are some controls like the population density in the neighborhood where the student i resides. κ accounts for the average change experienced by the travel time between families and first choice school. $\pi_{2,c}$ represents the average change in travel time experienced by the families in the category c of the education or income distribution.

[13]Travel time and distance between families residence and their first choice school is computed using the Open Source Routing Machine (OSRM) command that returns the travel time and distance using latitude and longitude. I also run this regressions with the distance instead of travel time as the explained variable but I do not include these results in the paper for the shake of shortness. The times and distances are obtained using OpenStreetMap whose advantages consist in an unlimited request and that it works off-line, so results can be replicated (Huber and Rust, 2016) [19]. The database contains UTM coordinates in ED50 base. The command needs GPS coordinates and ETRS89 base so I use a geographical information system (GIS) to turn them into suitable coordinates.

An alternative way of assessing whether the reform has originated a rise in the geographical mobility is to investigate if the proportion of families applying for schools beyond the district where they reside has suffer any variation between the two years:

$$H_{i,j} = \rho + \tau L_i + \theta X_i + \zeta_{i,j} \tag{3}$$

$$H_{i,j} = \rho_2 + \sigma_2 L_i + \sum_{c=1}^{5} SES_{i,c}\varphi_c + \sum_{c=1}^{5} SES_{i,c}L_i\varphi_{2,c} + \theta_2 X_i + \zeta_{i,j} \tag{4}$$

$H_{i,j}$ is a dummy that takes value 1 if a student i applies for a school j located in a different district where she resides, and 0 otherwise. τ will account for the average increase (or decrease) in the proportion of 'foreign' applications[14] within the whole Madrid educational system. $\varphi_{2,c}$ will capture the heterogeneous effect of the policy change on the proportion of 'foreign' applications by parent education or family income.

The results of the previous regressions are shown in table 2. The first three columns contains the estimates of the specifications 1 (column 1) and 2 (columns 2 and 3), while the last three columns correspond to specifications 3 (column 4) and 4 (columns 5 and 6). In the first column we can notice that, after the reform, the time that families are willing to spend in commuting to school increases by 14.2%. Column 2 shows the estimates from specification 2 in which the measure of the socioeconomic status is parents' education. The estimates present values that we could expect from this analysis. Travel times has a positive correlation with parents' education. This is consistent with the idea that more educated parents place more value on education and they are willing to commute longer to the school. The exception are families from the top of the distribution. A plausible reason could be that their opportunity cost is so high that these families do not find profitable to invest too much time in commuting to school. As a result, its average time is smaller than the one for families in the forth and in the third quintile. Looking at the responses to the policy change by education group, remarkably, the least educated families are the ones who experience the largest increase in the commuting time that they are willing to spend to attend school (12.8%). However, the fourth quintile reduces 5.7% the time between the two periods. The top educated families also increases by 5.4% the time between their residence and the school they wish. Column 3 presents the results of model 2 in which the socioeconomic variable is the household income. Estimates exhibit the same pattern as in column 2, though significance decreases. Nevertheless, under this specification still the least educated families are responding more to school choice by commuting longer to their first choice school.

Columns 4 to 6 show the estimates of the specifications intended to evaluate the impact of the reform on the proportion of students applying for a school located in a different district where they reside. Between the years 2010 and 2016 the proportion of those students attending schools in other districts rises from 12% to 16%. This means an increase of 33% between these two academic courses or 4 percentage points as shown in column 4. In column 5 are shown the coefficients from the specification 4 where socioeconomic variable is parents' education. Again, we can see a clear pattern consistent with the previous results. The probability that a family

[14] Foreign applications are those applications made by families residing in a different district where the school which they are applying for is located.

Table 2: Geographic Mobility Coefficients.

	Dependent variable					
	Travel time (Log)			'Foreign' applications (Prop.)		
	(1)	(2)	(3)	(4)	(5)	(6)
Post-reform	.142*** (.0075)	-	-	0.040*** (0.003)	-	-
Parents' education:						
2^{nd} quintile	-	.125*** (.017)	-	-	.018*** (.007)	-
3^{rd} quintile	-	.256*** (.017)	-	-	.087*** (.007)	-
4^{th} quintile	-	.355*** (.018)	-	-	.114*** (.007)	-
5^{th} quintile	-	.227*** (.017)	-	-	.132*** (.007)	-
Post-reform*Parents' education:						
1^{st} quintile	-	.128*** (.017)	-	-	.032*** (.007)	-
2^{nd} quintile	-	.031 (.023)	-	-	.022*** (.009)	-
3^{rd} quintile	-	-.021 (.023)		-	.028*** (.009)	-
4^{th} quintile	-	-.057** (.024)	-	-	-.010 (.009)	-
5^{th} quintile	-	.054** (.023)	-	-	-.021** (.009)	-
Household Income:						
2^{nd} quintile	-	-	-.009 (.019)	-	-	.018** (.007)
3^{rd} quintile	-	-	.070*** (.019)	-	-	.068*** (.007)
4^{th} quintile	-	-	.142*** (.018)	-	-	.073*** (.007)
5^{th} quintile	-	-	.222*** (.018)	-	-	.101*** (.007)
Post-reform*Household Income:						
1^{st} quintile	-	-	.131*** (.019)	-	-	.030*** (.008)
2^{nd} quintile	-	-	.030 (.026)	-	-	.017* (.010)
3^{rd} quintile	-	-	-.024 (.025)	-	-	.009 (.010)
4^{th} quintile	-	-	.028 (.025)	-	-	.016* (.010)
5^{th} quintile	-	-	-.011 (.024)	-	-	-.003 (.010)

Notes:*, ** and *** indicate significance at 10-, 5- and 1-percent level, respectively. The controls are the population density in the student neighborhood. Standard errors are in brackets.

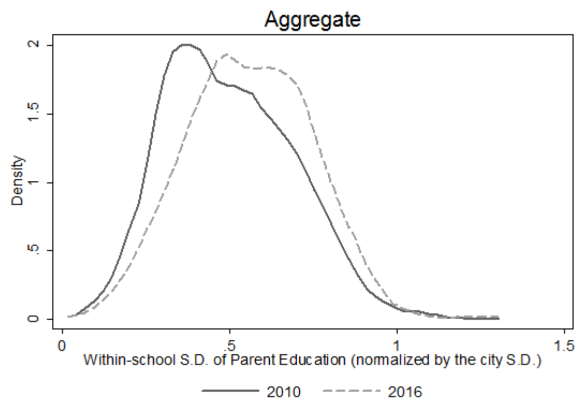
applies for a schools situated in a foreign district is increasing with the parents' years of education. However, the increase in the probability of applying for a foreign school after the rise of the degree of school choice seems to be negatively correlated with the level of parents' education. The families from a lower socioeconomic background are the ones who increase more the likelihood of applying for a foreign district school. Families from the top of the distribution decreases their likelihood of applying for a school beyond their districts. Columns 6 shows results from the model 4 where socioeconomic variable is household income. The pattern exhibited is along with the previous columns, although household income does not offer the same level of significant as parent education.

Overall, families with a higher socioeconomic status are characterized by longer distances between their first choice school and their residences as well as by larger probability of applying for a school located in an outer district. However, after the inter-district school choice implementation it can be observed that the families enlarging the most the time between their first choice school and home are those in the lowest quintiles of the distribution. In the same way, families belonging to the lowest socioeconomic status are undergoing the largest increase in the likelihood of applying for a school located in a different district. In principle, these results are consistent with Hastings and Weinstein (2008) [16]. They show that under information of school quality parents from low socioeconomic backgrounds respond to this information by applying for school with higher quality. Certainly, school choice reform introduces the duty to publish the external evaluation results making this information in effect easily accessible to all families.

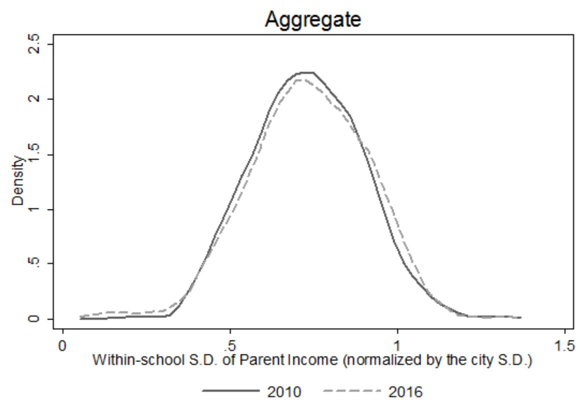
B. Segregation

The ultimate aim of this paper is to evaluate the impact that the school choice reform has on the level of segregation of the school system of Madrid. As it is shown in the previous section, after the implementation of the inter-district school choice there is an increase in the time that families want to spend in taking their kids to school or in the proportion of families that prefer to apply for a school in other district. In other words, after the policy reform families are willing to apply for schools further in order, most likely, to obtain a higher quality of education for their children. This circumstance would not have any impact on social mobility if there is no heterogeneous effect in the responses regarding to the former geographical outcomes by student socioeconomic background. However, results of table 2 show that families respond to school choice reform heterogeneously depending on the SES. Precisely, families from the lowest socioeconomic status are those who undergo the largest rise in the time between the school and their homes. In addition, they are those who increase the most their applications for schools situated in other districts. A priori, this geographical mobility may generate an increment in the heterogeneity within schools in terms of students socioeconomic background.

The first approach utilized in this paper to assess the effect of school choice on school segregation is a graphical analysis of densities. In figure 1 are represented the density for both 2010 and 2016 academic courses of the within-school standard deviation of the socioeconomic status of families. The left-hand side graph (figure 1a) shows the density of within-school standard deviation of parents' years of education. The dashed line represents the density for 2016, while the continuous line refers to 2010 density. The 2016 density is clearly shifted to the right, what



(a)

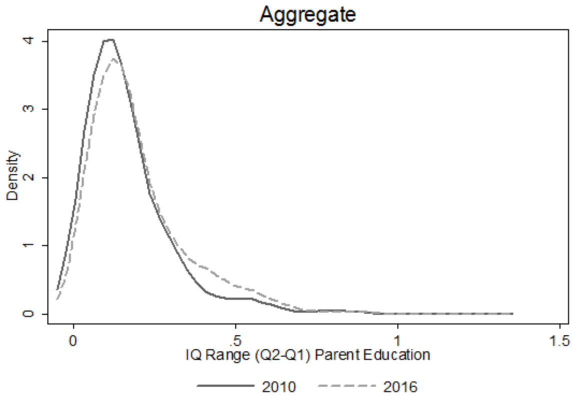


(b)

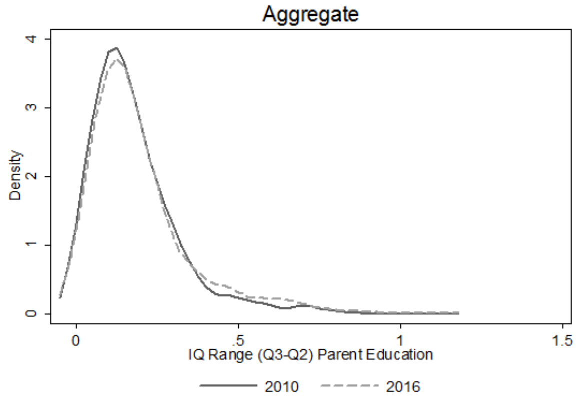
Figure 1: Densities of within-school SES standard deviation by year and standardized by the city average.

stands for an increase in within-school students' background heterogeneity. However, the right-hand side graph (figure 1b) does not exhibit any distinguishable change between the two periods. This plot shows the density of the within-school standard deviation of household income. As I argue above this may be due to the lack of variability of this measure of household income. Dividing these densities into low-, middle- and high-scoring schools we can notice that high- and middle-performing schools undergo the biggest increment of the within-school heterogeneity in terms of parents education (see the left-hand side of figure A.3 in the appendix). Splitting the within-school standard deviation of the parents' income into low-, middle- and high-scoring schools (see the right-hand side of figure A.3) we cannot appreciate any significant change between the 2010 and 2016 densities. The only one that seems to experience a variation is the density for middle-scoring schools. In figure A.3d the 2016 density seems to shift slightly to the right. That would mean an increase in the household income diversity between the two periods within middle-scoring schools.

To complete the graphical variance analysis I compute the inter-quantile ranges for parent education of students applying for each school. Precisely, I calculate the range between the second and the first quartile and the range between the third and the second quartile for each school. This inter-quantile ranges inform us about the way in which the diversity is changing after the inter-district school choice implementation. Plotting the densities of these two ranges (see figure 2) for both years, it can be notice a striking (though very small) feature of the densities. The IQ range between the second and the first quartile seems to undergo a larger shift to the right than the IQ range between the third and the second quartile. This phenomenon is driven by the high-scoring schools as we can see in figure A.4a and A.4b -in the appendix- more clearly. There has been an increase in the students from low socioeconomic background applying for the best schools along with a relative decrease in the proportion of high SES students applying for these top-performing schools. This evidence is pointing out somehow that between the two academic years there is an increase in the equality of opportunity, probably, induced by the inter-district school choice reform.



(a)



(b)

Figure 2: Densities of within-school SES standard deviation by year and standardized by the city average.

The second approach is to estimate numerically the change between years. In order to do that, I develop a econometric framework that will help to obtain point estimates as well as standard errors for the change in within-school heterogeneity of students backgrounds. This specification will also allow to estimate differences in the change experienced by the within-school heterogeneity over other potential dimensions that could be of interest in the research. First, the socioeconomic status is regressed on school dummies and controls such as the level of heterogeneity in the student neighborhood as equation 5 below shows:

$$SES_{i,j} = \theta_j + \beta X_{i,j} + \epsilon_{i,j} \tag{5}$$

$SES_{i,j}$ is the proxy for socioeconomic status of student i applying for a school j and $X_{i,j}$ is a proxy for SES heterogeneity in the school j neighborhood. Once the model is estimated, I get the residuals. Afterwards, the logarithm of the residuals' absolute value ($|\hat{\epsilon}_{i,j}|$) are regressed on post-reform indicator and interactions between post-reform indicator and other variables like school quality or average income in the school district:

$$log|\hat{\epsilon}_{i,j}| = \gamma_1 Z_{i,j} + \gamma_2 L_i + \gamma_3 (L_i \cdot Z_{i,j}) + \varepsilon_{i,j} \tag{6}$$

$Z_{i,j}$ are the school characteristics and L_i is the post-reform dummy. The first regression extracts the average SES in the school that individual i is applying for along with the part of this variation which is the result of the average level of heterogeneity in the neighborhood where the family lives to each observation. Thus, the average $|\hat{\epsilon}_{i,j}|$ within the school j will reflect the average level of heterogeneity not explained by the school fixed effects and the neighborhood heterogeneity. Regressing the logarithm of this measure of dispersion on a set of variables we obtain information about how this dispersion varies over the different variables. This method will allow us to evaluate the effect of school choice according to any dimension that may have an implication for school heterogeneity. The two dimensions that are considered in this paper are the school quality and the average income of the district where school is located as described above.

Table 3: Change in within-school SES heterogeneity.

	Parents' Years of Education			Household Income		
Dependent variable: $log\|\hat{\epsilon}_{i,j}\|$	(1)	(2)	(3)	(4)	(5)	(6)
Post-reform Indicator	.125***	-	-	-.010	-	-
	(.010)			(.008)		
Low Scoring School	-	-.117***	-	-	.121***	-
		(.022)			(.019)	
Middle Scoring School	-	.002	-	-	.083***	-
		(.020)			(.017)	
Low Scoring School*Post-reform	-	-.013	-	-	-.108***	-
		(.029)			(.024)	
Middle Scoring School*Post-reform	-	.052**	-	-	.032	-
		(.026)			(.022)	
High Scoring School*Post-reform	-	.100***	-	-	.009	-
		(.022)			(.019)	
Low Income District	-	-	-.048***	-	-	.185***
			(.017)			(.014)
Middle Income District	-	-	.058***	-	-	.152***
			(.020)			(.017)
Low Income District*Post-reform	-	-	-.042*	-	-	.009
			(.023)			(.019)
Middle Income District*Post-reform	-	-	.046*	-	-	.048**
			(.027)			(.023)
High Income District*Post-reform	-	-	.126***	-	-	-.023
			(.017)			(.014)

Notes:*, ** and *** indicate significance at 10-, 5- and 1-percent level, respectively. Standard errors are in brackets.

Table 3 presents the results for the estimations of model 6. From columns 1 to 3 the socioeconomic status measure is the level of student parents' education, while from column 4 to 6 the socioeconomic status measure is the student household income. Column 1 shows the result of the equation 6 where the unique regressor is the dummy that takes the value 1 if the choice is made after the reform, in 2016. The point estimate of the model gives a precise measure of what the figure 1a depicts: an increase in the within-school heterogeneity between the two years of 12.5%. In column 2 and 3 we can find the results for the full specification. Column 2 shows the estimates of equation 6 by school quality. It yields two important results. First, low-scoring schools are those with a smaller level of within-school heterogeneity (11.7% smaller than middle- and high-performing schools). Second, the increase in the school composition heterogeneity is positively related with the quality of school. The schools that experience the largest rise in SES diversity are the best schools. Heterogeneity increases by 10% in the high-scoring schools and by 5.2% in middle-scoring schools, while it remains constant in low-scoring centers. Column 3 shows a very similar pattern in the results as column 2. However, we can see that schools located in low-income districts undergo a decrease in diversity; consistent with a partial process of segregation within the schools located in the poorest districts.

Regarding the household income as the SES, I find the expected result in column 4 as the graphical analysis of the standard deviation density was pointing out. After the policy reform there is no significant change in the within-school diversity in terms of household income, at least, in the aggregate. Column 5 shows the results for the full specification 6 over the school quality dimension. Two important differences appear respect to column 2 despite the fact that the pattern in the change after the reform is notably similar. Firstly, according to household income, school quality is negatively correlated with the level of diversity. This constitutes evidence of elite segregation. The best schools are more homogeneous. Secondly, the interaction coefficients show that, like with the parents' years of education, the change in within-school heterogeneity is positively correlated with school quality. However, regarding household income we see a decrease in the heterogeneity level between 2010 and 2016. Column 6 contains the results by average income district of the school. They are essentially similar to those in column 5 though the point estimates are larger. Nevertheless, there is an important difference among the interaction coefficients. Whereas low scoring schools are the only schools experiencing a change in heterogeneity (a decrease), schools situated in middle income districts undergo the only positive change in heterogeneity.

With the aim of providing extra evidence from a different perspective to the change in segregation that the Madrid school system suffers between 2010 and 2016, I utilize three different indexes that appear in the social sciences literature regarding segregation. Firstly, I compute the *"desegregation index"* (Hoxby, 2000) [17] which gives the probability that a student finds in her school a student from a different SES over the same probability computed for the whole city (equation 7). Thus, this index will go from 0 to 1, being the desegregation index equal to 0 if the educational system is fully segregated and 1 if the system is completely desegregated.

$$D.I. = \frac{Pr(SES_i^j \neq SES_k^j)}{Pr(SES_i^{city} \neq SES_k^{city})} \tag{7}$$

Secondly, I use the *entropy index* that informs about how different is the composition within schools with respect to the overall city composition (White, 1986) [25]. In equation 8 is represented how is computed the entropy index (H). $\overline{H}$ is the average[15] of h_j, while $p_{j,l}$ is the proportion of students in school j belonging to the SES l. So, in principle h_j can take different values for each school. I divide the SES into 5 categories ($m = 5$).

$$H = \frac{\hat{H} - \overline{H}}{\hat{H}} \tag{8}$$

$$h_j = -\sum_{l=1}^{m} p_{j,l} \cdot ln(p_{j,l})$$

The maximum value for the entropy index is 1 -when the educational system is perfectly segregated- ($\overline{H} = 0$) and the minimum value for this index is 0 -when the each school has the same composition than the whole city- (($\overline{H} = \hat{H}$).

Lastly, I also compute the index used by the O.E.C.D. call *index of social inclusion*. It is calculated as follows:

[15]weighted by the number of applications in each school

Table 4: Change in school segregation after the reform.

	2010		2016		**Change**	
	YS	HI	YS	HI	**YS**	**HI**
Panel A						
Aggregate						
Desegregation Index	0.655	0.837	0.686	0.836	**4.87%**	**-0.14%**
Entropy Index	0.431	0.222	0.391	0.220	**-9.31%**	**-0.93%**
Index of Social Inclusion	76.19	89.87	79.07	90.34	**3.78%**	**0.52%**
Panel B						
High Scoring						
Desegregation Index	0.660	0.789	0.670	0.785	**1.50%**	**-0.49%**
Entropy Index	0.417	0.268	0.400	0.263	**-4.02%**	**-1.98%**
Index of Social Inclusion	75.21	90.18	78.76	89.47	**4.72%**	**-0.79%**
Middle Scoring						
Desegregation Index	0.658	0.838	0.716	0.855	**8.80%**	**-2.03%**
Entropy Index	0.425	0.214	0.360	0.201	**-15.27%**	**-6.39%**
Index of Social Inclusion	76.09	90.07	79.69	91.18	**4.73%**	**1.23%**
Low Scoring						
Desegregation Index	0.645	0.866	0.647	0.848	**0.38%**	**-2.02%**
Entropy Index	0.450	0.207	0.438	0.216	**-2.55%**	**4.37%**
Index of Social Inclusion	74.35	91.33	77.42	90.26	**4.13%**	**-1.17%**

Notes: YS accounts for parents' years of schooling, while HI accounts for household income.

$$I.S.I. = 100 \cdot (1 - \rho) \tag{9}$$

$$\rho = \frac{corr(SES_{i,j}, \overline{SES}_j)}{S^{SES}_{within} + S^{SES}_{between}}$$

ρ is ratio between the correlation coefficient of the socioeconomic status of each student i and the average socioeconomic status of her school j over the sum of the within-school standard deviation and the between-school standard deviation of SES in the Madrid educational system. As this index approximates to 100 the segregation within the educational system decreases.

Table 4 shows the values for all these indexes for both SES measures (parent education and household income) and before and after the inter-district school choice reform. The last two columns of the table presents the percentage change between the two academic years. Panel A in table 4 presents values for indexes in aggregate terms. The desegregation index for parents' years of schooling increases almost 5% after the reform. That means a decrease in the level of the segregation in the Madrid educational system. The entropy index falls almost 10% from 2010 to 2016. Furthermore, the index of social inclusion rises by around 4%. All these results represents a reduction in the degree of segregation experienced by the educational system as a whole. If we focus on household income as the SES measure we notice a change close to zero in all the three indexes along with the pattern observed in the figure 1b. Despite the lack of meaningful variation, the level of the desegregation index and the index of social inclusion (entropy index) for household income are larger (smaller) than for parent education. The reason is probably related with the reduced level of variability of this proxy for SES.

I divide the sample into three groups by school performance. The results are shown in panel B of table 4. At first sight we see that the group of schools that undergoes the largest rise in parents' education heterogeneity is the middle-scoring group of schools. Desegregation index and entropy index almost double the decreases in segregation suffered in aggregate terms. However, the index of social inclusion for years of schooling exhibits a extraordinary similarity across groups. Low-scoring schools present a completely different results depending of the SES measure used. Regarding parents' years of schooling, there is a small decrease in the level of segregation, whereas for household income this group of schools experiences an increase in the level of segregation with a remarkable consistency across the three indexes. This change is also noticeable in figures A.3e and A.3f. Results found in table 4 contradict those shown in table 3. Despite both estimates are intended to capture the change in the level of segregation within the educational system after the policy reform, we have to bear in mind that they are capturing distinct aspects since the methodological approach is completely different. While these indexes are raw measures of within-school heterogeneity that do not take into account how different the SES categories are (just whether they are different or not), the estimates from the model 6 are more sophisticated and sensitive measures of segregation, free of school fixed effects and with standard errors. For this reason, I consider model 6 more convenient to evaluate the policy change consequences throughout some further dimensions in the following sections.

C. Interpretation and Discussion

The inter-district school choice reform seems to facilitate families the access to schools that were not available under the intra-district school choice. The inter-district school choice does not simply originate a new demand for schools situated out of the district, it also generates mobility inside the district. 'Foreign' applications trigger a chain reaction. The increase in the proportion of families applying for schools in foreign districts (4% out of the whole applications) releases some seats in the schools located in those districts where they reside. All these students crossing the district borders create an emerging supply of seats and a subsequent internal demand for them. As a result, there are other seats released that might be attractive by other families and so on. Therefore, the inter-district school choice combines a twofold effect: a direct one -made by families applying for foreign district schools- and an indirect effect on the intra-district mobility triggered by the direct effect. In order to disentangle this two components of the mechanism through which mobility is generated I run the model 6 excluding those applications whose first choice is a school located in an outer district. The estimates in this model would account for the indirect effect generated by the increase in the level of school choice. The difference between the estimates of the restricted model and the estimates from the unrestricted model accounts for the part of the change in segregation explained by the direct effect of the school choice reform.

Table 5 shows the estimates for the model 6 on the restricted sample to intra-district applications. Overall indirect effect of school choice on the decrease of the segregation level accounts for three quarters of the total decrease (9.1% out of 12.5%) regarding to parent education. If

Table 5: Change in within-school SES heterogeneity (without 'foreign' applications).

	Parents' Years of Education		Household Income	
Dependent variable: $log\|\hat{\epsilon}_{i,j}\|$	(1)	(2)	(3)	(4)
Post-reform Indicator	.091***	-	-.026***	-
	(.011)		(.010)	
Low Scoring School	-	-.091***	-	.157***
		(.023)		(.021)
Middle Scoring School	-	.005	-	.090***
		(.022)		(.019)
Low Scoring School*Post-reform	-	.052*	-	-.107***
		(.031)		(.028)
Middle Scoring School*Post-reform	-	.116***	-	.079***
		(.029)		(.025)
High Scoring School*Post-reform	-	.113***	-	-.028
		(.018)		(.021)

Notes:*, ** and *** indicate significance at 10-, 5- and 1-percent level, respectively. Standard errors are in brackets.

we analyze the effect of school choice in terms of household income the importance of foreign applications becomes evident. Intra-district mobility increase the level of segregation within the educational system for household income as the measure of SES (2.6%). However, the direct effect of inter-district school choice (those who apply for a 'foreign' school) balances it out. Looking at the interaction terms (changes after the reform) we can notice that intra-district mobility mainly occurs within the middle-performing schools. Under the unrestricted sample we have that within-school heterogeneity increases in the middle-scoring schools by 5.2% regarding parent education (3.2% but not significantly different from 0 regarding household income), whereas it increases by 11.6% (and significantly by 7.9%) under the sample containing only intra-district applications.

On the other hand, it is worth mentioning that inter-district school choice would not unambiguously increase the distance between families and schools in any case. As it is discussed above, the chain reaction originated after a higher level of school choice might deliver an equilibrium in which the average distance was shorter than under the intra-district school choice. However, the case of Madrid which is analyzed in this paper presents a different outcome. On average, first choice schools under inter-district school choice are further away, despite some families could choose schools located even closer.

To conclude this section I would like to discuss the differences between applications, assignment and enrollment. So far, I have only focused on applications since the original intention of this paper was assessing the effect that school choice has on the responses of families. Though both assignment and enrollment are highly determined by the parents' choices, the purest measure of the parents' reaction is the application. In this applications form families express their choices according to their preferences and school assignment criteria. Facing a criteria modification, families will adapt their choices to maximize their expected utility from their list of schools that they submit within the application form. In the appendix are included all the results presented in the paper up to this point (apart from table 5) taking into account not the first choice school which parents are applying for, but the school eventually assigned. This would shed light on any possible concern regarding the gap between the potential effects of school choice on segregation (applications) and its actual effects on segregation (assignment)[16]. Table A.1 contains the results equivalent to those in table 2[17]. As we can see results are extraordinarily similar, although assignment mobility is slightly smaller. The average increase in travel time shrinks by 2.3 percentage points and the proportion of 'foreign' applications falls 0.7 percentage points. If we now look at heterogeneous effects the results are even more similar to those regarding to applications. The main change is that the increase in the travel time undergone by the most educated families disappear in the assignment data. This phenomenon is consistent with the evidence that families from the highest SES make more risky choices (Calsamiglia et al., 2010) [9]. Table A.2 presents the estimates of the model 6 with data on assignment. Results are once more exceptionally akin. The average increase in parent education heterogeneity is 1 percentage point smaller with assignment data than for data on application. The average change in heterogeneity regarding household income remains not significantly different from 0. Concerning the heterogeneous effects by school quality and average income in the school district results' pattern prevails in table A.2 although they become a little bit blurred. Table A.3 shows the variations for the indexes of social segregation. With respect to the aggregate we can notice how the percentage changes in those indexes are markedly similar. By school performance, the changes maintain the same sign and the schools belonging to the middle-scoring group experience the largest increase as the results in table 4.

VI Additional Results

In this section I evaluate issues related to the educational system that may have an impact on school segregation besides inter-district school choice reform. Given that the empirical approach used in this paper cannot rule out the fact that the variation in school heterogeneity might be driven by other causes, I try to identify additional and potential sources of transformation of the within-school socioeconomic composition. First, I study whether the districts that are growing disproportionately are playing any role in the change of school heterogeneity. After, I assess the impact of the bilingualism expansion on school segregation. I terminate the section with two robustness checks about the proxy for school quality and parents' educations, the main dimensions that I exploit in this paper.

A. High-Growth Districts

Between 2010 and 2016 the number of students applying for a publicly funded school rises from 27,091 to 32,578 (roughly 20%). This growth is not uniform across the districts of Madrid. While

[16]In this paper there is not availability of data on enrollment

[17]There are only 49,738 observations with assigned school in this database.

Table 6: Change in within-school SES heterogeneity (by district growth).

SES: Parents' Years of Education	High-growth districts: All		High-growth districts: Schools available both years		Rest of the districts	
Dependent variable: $log\|\hat{\epsilon}_{i,j}\|$	(1)	(2)	(3)	(4)	(5)	(6)
Post-reform Indicator	.119***		.071***	-	.064***	-
	(.018)		(.022)		(.012)	
Low Scoring School	-	-.230***	-	-.230***	-	.037
		(.041)		(.043)		(.026)
Middle Scoring School	-	.053	-	.053	-	.010
		(.055)		(.036)		(.024)
Low Scoring School*Post-reform	-	.178***	-	.088	-	-.048
		(.052)		(.070)		(.035)
Middle Scoring School*Post-reform	-	-.049	-	-.043	-	.069**
		(.044)		(.050)		(.032)
High Scoring School*Post-reform	-	.099***	-	.052	-	.046*
		(.035)		(.040)		(.027)

Notes:*, ** and *** indicate significance at 10-, 5- and 1-percent level, respectively. Standard errors are in brackets.

some of them remain quite stable, there are other districts experiencing a vigorous increase in the number of applicants for their schools. In the graph A.5 -in the appendix- is depicted the growth rate of the 21 districts of Madrid between both years. There are 4 districts (Vicálvaro, Villa de Vallecas, Fuencarral and Barajas) whose growth rate is larger than 100%. In those districts the number of students applying for their schools more than doubles. Moreover, there are 13 districts (the previous districts plus Hortaleza, San Blas, Moratalaz, Arganzuela, Usera, Villaverde, Tetuán, Salamanca and Retiro) that grow more than 10%. The share of applications of the last set of districts experiences a dramatical increase from 23% in 2010 to 35% in 2016. Most of those districts whose number of applicants increases so sharply are outlying districts and are growing also in terms of population quite rapidly. While some of them are predominantly middle-high socioeconomic status, there others clearly from a low socioeconomic position.

Table 6 shows the estimates of specification 6, namely the estimates of the changes after the reform (γ_2 and γ_3). Column 1 and 2 contain estimates with a restricted sample for those districts whose number of applications grows over 10% between 2010 and 2016, while columns 5 and 6 present the estimates for a restricted sample to those districts whose number of applications grows less than 10% between the two years. Estimates of the average growth in each group of districts reflect that high-growth districts undergo a much larger increase in the degree of heterogeneity than the low-growth districts (around 6 percentage points higher). A second aspect deserving to be highlighted is the fact that within high-growing districts, low-scoring schools are the centers that experience the biggest rise in heterogeneity (17.8%). This difference with respect to the aggregate estimate might be driven by the existence in this group of districts of low SES districts.

Table 7: Change in within-school SES heterogeneity (by bilingualism).

	Parents' Years of Education			Household Income		
Dependent variable: $log\|\hat{\epsilon}_{i,j}\|$	(1)	(2)	(3)	(4)	(5)	(6)
Post-reform Indicator	.125***	-	-	-.010	-	-
	(.010)			(.008)		
Non-Bilingual School*Post-reform	-	.074***	-	-	.022*	-
		(.014)			(.012)	
Bilingual School*Post-reform	-	.095***	-	-	-.052***	-
		(.020)			(.017)	
Charter&Bilingual School	-	-	-.020	-	-	-.080***
			(.018)			(.015)
Public&Bilingual School	-	-	-.050**	-	-	.027
			(.023)			(.019)
Public&Non-bilingual School	-	-	-.046**	-	-	-.002
			(.023)			(.019)
Charter&Bilingual*Post-reform	-	-	.095***	-	-	-.048**
			(.024)			(0.020)
Public&Bilingual*Post-reform	-	-	.101***	-	-	-.087***
			(.030)			(0.026)
Charter&Non-bilingual*Post-reform	-	-	.073***	-	-	.029**
			(.017)			(.014)
Public&Non-bilingual*Post-reform	-	-	.008	-	-	-.024
			(.032)			(.027)

Notes:*, ** and *** indicate significance at 10-, 5- and 1-percent level, respectively. Standard errors are in brackets.

In order to gain some insight in the mechanism operating on the high-growth district I run again the specification 6 only on the high-growth districts and for those schools that were teaching during both 2010 and 2016. The estimate of the average change in within-school heterogeneity falls from 11.9% to 7.1% (column 3). Therefore, the results suggest that a vast part of the increase in the heterogeneity generated by the high-growth districts appears through the new schools, those that were not functioning in 2010 and open afterwards. Moreover, we can conclude that the group of district growing fast is playing an important role in the reduction of the degree of segregation in the Madrid educational system between both years.

B. Bilingualism

Madrid education authorities implemented for the academic course 2004/2005 a new program where a substantial part of the subjects are taught in a foreign language -predominantly English, although not the only one- within the public school system. During the period of time passed between the two years evaluated in this paper this program suffers a huge expansion from approximately 26% of the whole applications in 2010 to more than 55% in 2016. Uniquely because of this tremendous increase it is worth to pay detailed attention in this research. Additionally, recent literature has identified an evident process of selection of students into the so-called bilingual program in Madrid (Anghel et al., 2016) [5].

The results from the estimation of the model 6 are presented in table 7. Columns 1 and 4 just show the average increase in the within-school heterogeneity after the reform (such as we have seen above) for both measures of SES: parents' years of schooling and household income. Columns 2 and 5 show the estimates when the model includes other dimensions apart from the post-reform dummy. In this case $Z_{i,j}$ is a dummy that takes value 1 if the school j is bilingual school when student i is making the choice[18]. Regarding parent education we can see that bilingual schools indeed undergo a higher decrease in the level of within-school segregation (9.5%) than non-bilingual schools (7.4%). However, with respect to household income the greatest increase affects to the non-bilingual schools.

Following Elacqua (2012) [12][19] I add another dimension in this analysis. The goal is to observe whether segregation is varying differently for charter and for public schools. Columns 3 and 6 in table 7 present the estimates including another interaction with a dummy for charter schools. While for bilingual schools there is not a significant difference in the change of heterogeneity after the reform with regard to if they are charter or public (the difference is .6 percentage points), for non-bilingual schools being a charter or a public becomes crucial. Public non-bilingual schools do not change their heterogeneity between 2010 and 2016, whereas charter non-bilingual raise their within-school heterogeneity by 7.3%. In other words, publics schools are suffering a dual response to the inter-district school choice by bilingualism. While the public bilingual schools are undergoing the largest increase in heterogeneity among all the groups treated in this section (10.1%), the non-bilingual schools do not experience any significant variation in segregation. Therefore, bilingualism is a main actor in the changes that the Madrid educational system is undergoing regarding to social mobility.

C. Robustness Checks

Throughout the paper I focus mainly on the school quality as a dimension that may help us to understand the mechanism that could be shaping the socioeconomic composition of the Madrid educational system. Given its importance it would be relevant to investigate the behavior of the results under a different proxy for school quality. The proxy used all over this paper for the quality of a particular school is the average grade that students in this school obtain in the external evaluation test. In this section I estimate the model 6 in which $Z_{i,j}$ is the school quality proxy by the proportion of students that pass the external evaluation test (CDI). Results are shown in table 8. Column 2 (4) presents the results regarding diversity in terms of parents'

[18]Recall that schools may change their bilingual status from one year to the other, from non-bilingual to bilingual.

[19]Elacqua shows that heterogeneity among schools plays an important role in segregation in Chile. While public schools serve mainly to more disadvantageous children, within the private voucher sector there is not a clear pattern. Non-profit schools exhibit less segregation, whereas segregation levels are higher in for-profit schools.

Table 8: Change in within-school SES heterogeneity.

	Parents' Years of Education		Household Income	
Dependent variable: $log\|\hat{\epsilon}_{i,j}\|$	(1)	(2)	(3)	(4)
Post-reform Indicator	.125***	-	-.010	-
	(.010)		(.008)	
Low Scoring School[a]	-	-.102***	-	.106***
		(.018)		(.015)
Middle Scoring School[a]	-	.007	-	.091***
		(.018)		(.016)
Low Scoring School[a]*Post-reform	-	-.016	-	-.107***
		(.025)		(.021)
Middle Scoring School[a]*Post-reform	-	.044*	-	-.026
		(.025)		(.021)
High Scoring School[a]*Post-reform	-	.113***	-	.036**
		(.018)		(.015)

Notes:*, ** and *** indicate significance at 10-, 5- and 1-percent level, respectively. Standard errors are in brackets. [a]Whether the school is classified in low-, middle- and high-scoring school will be given by the proportion of students who pass the external test.

education (household income). The pattern exhibited by the results is remarkably similar to those in column 2 (5) of table 3. Low-scoring schools present a lower (higher) level of heterogeneity than middle- and high-scoring schools. Moreover, the rise in the heterogeneity after the reform is positive correlated with the proxy for quality as in table 3. While heterogeneity regarding parent education is characterized by an increase within the high-scoring schools, household income heterogeneity shrinks in low-scoring schools.

A second check that I carry out is shifting the thresholds by which the schools are classified into low-, middle- and high-scoring. Schools are grouped into low-, middle- and high-performing schools regarding if their average grade in the external evaluation is below 6.5, between 6.5 and 7.7 and above 7.7, respectively. I modify these thresholds from 6.5 to 5.9 and from 7.7 to 8. Thus schools in the low-performing group will be worse on average and schools belonging to the high-performing group will be better on average. Results are shown in table A.4 in the appendix. As we could expect, point estimates concerning parent education -as the SES proxy- become larger in absolute terms. That is, low scoring schools under the new specification is much more segregated than in the standard one (its heterogeneity is 21% smaller than high-scoring) and middle-scoring schools exhibit an increase in the level of heterogeneity in comparison to the high-performing schools (5.3% higher). Though after the school choice reform the group that undergoes the larges increase in heterogeneity remains to be the high-scoring school, strikingly the middle-scoring group of schools appears to have experienced a decrease on 6.8% in the heterogeneity after the inter-district school choice reform. This fact may be due to the fact that middle-scoring group of schools is incorporating many different schools so that it becomes quite heterogeneous and the overall result is an increase in segregation within this group.

The Census Office of Madrid built a database with information on the average years of education by age group by section. The novelty of this database is that we can construct a more accurate proxy for parents' years of schooling since we are eliminating part of the noise in this measure by narrowing the age interval to that one in which inhabitants within a section are more likely to have children in preschool and primary. This information correspond to 2017 so I decide to use it for checking robustness. Table A.5 in the appendix shows the results by school quality, which are essentially the same as with the standard measure.

VII Conclusion

This paper constitutes a new piece of evidence about the effects of school choice on social segregation within the educational system. I take advantage of a natural experiment that takes place in the city of Madrid. In 2013 is implemented in Madrid an inter-district school choice by which the degree of school choice rises sharply. I use this increase in school choice level to evaluate the consequences that it has on social mobility and segregation in the Madrid educational system. I find that families increase the average distance that they are willing to cover to go to school and the likelihood of attending a school located in an outer district when they enjoy a higher degree of school choice. Students from a lower socioeconomic background are those experiencing the largest increase in the time (and distance) that they are willing to invest in commuting to school and the probability of attending school in different districts. This geographical mobility rise translates into social mobility. The best schools undergo the greatest rise in the within-school socioeconomic heterogeneity. However, those schools situated in the poorest districts suffer an increase in segregation. As a result, there is a decrease in the overall level of segregation together with an increase in the degree of segregation of schools located in low-income districts.

We should bear in mind that there are other forces in the Madrid educational system contributing simultaneously to the increase in the level of heterogeneity. The methodology used in this paper does not allow to precisely disentangle the impact of the school choice reform. It could also be the case that some of these forces are just the channel through which school choice is operating. In that case, a larger portion of the increase in within-school heterogeneity can be attributed to the inter-district school choice reform. Nonetheless, all these issues operating concurrently with school choice reform cannot completely explain the whole decrease in school segregation. The nature of this reform turns it into a source of insight for future research. It might have a potential impact on the educational outcomes and housing prices -in the middle-run- and on the labor market outcomes -in the long-run-, deserving all of them further investigation.

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VIII Appendix

A. Family Characteristics Giving Priority

Within the Comunidad de Madrid, once a school is oversubscribed, students are assigned to the center based on the following criteria for the academic course 2010/2011. Those with the maximum number of points get the seats:

- Presence of one sibling enrolled or parent working in the center .... 4 points
  - For each additional sibling or parent .... 3 points
- Family residence or work center of some of the parent is in the district of the school .... 4 points
- Family residence or work center of some of the parent is in the adjacent district to the school district .... 2 points
- If student's per capita family income is smaller or equal than the 2008 IPREM (7,236.60 euros) .... 2 points
  - If student's per capita family income is smaller or equal than twice 2008 IPREM (14,473.20 euros) and smaller than 2008 IPREM (7,236.60 euros) .... 1 points
- Disability of the student, some parent or brother .... 1.5 points
- Large family .... 1.5 points
  - Extra large family .... 2.5 points
- Some other circumstance relevant for the center .... 1 point

After the reform introduced by the government in 2013, the criteria are the following:

- Presence of siblings enrolled or parents working in the center .... 10 points
- Family residence or work center of some of the parent is in the municipality of Madrid .... 4 points
- Family residence or work center of some of the parent is in the district of the school .... 0.5 points
- If the student's father or mother is beneficiary of the Minimum Insertion Subsidy ("Renta Mínima de Inserción") .... 2 points
- Disability of the student, some parent or brother .... 1.5 points

- Student's parents or brothers are former pupils .... 1.5 points
- Large family .... 1.5 points
    - Extra large family .... 2.5 points
- Some other circumstance relevant for the center .... 1 point

B. Section Example

Figure A.1 shows an example of the layout of the sections in the Madrid districts of "Centro" and "Retiro". The larger the sections the less is the proportion of residential area there:

Figure A.1: Census sectioning in the city of Madrid (Instituto de Estadística de Madrid).

C. Years of Schooling

Census education categories are the followings:

1. Cannot read, cannot write
2. No studies
3. Incomplete Primary
4. Elementary high school, Primary or Compulsory Secondary Education (E.S.O. in Spanish)
5. Vocational Training (Elemental)
6. Vocational Training (Advanced)
7. High school
8. Other Intermediate Graduates

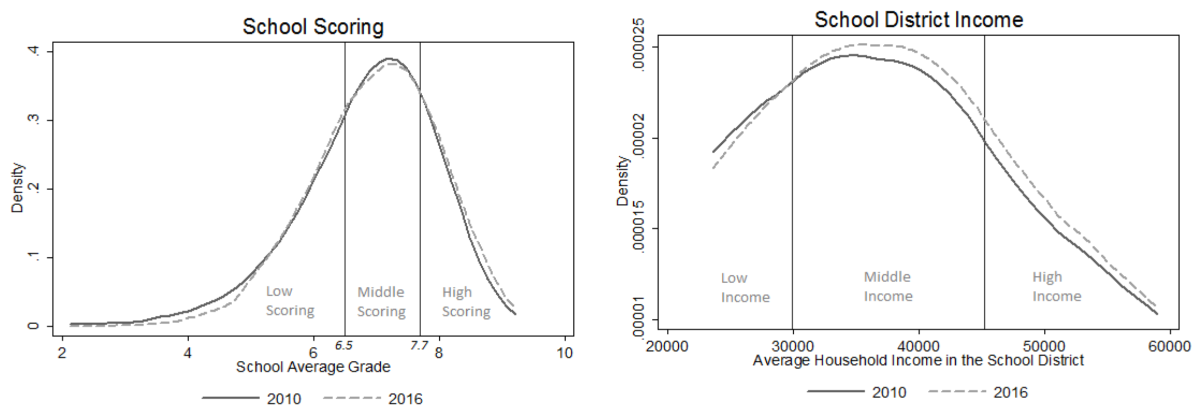
9. University School Graduates
10. Technical Engineer
11. College Graduated
12. No-university Graduated
13. PhD and other Post-graduates

I group all these 13 categories into 6 new categories. Categories 1 and 2 make the Non-studies. Category 3 remains as Primary Education. Categories 4 and 5 form the Low Secondary Education. Categories 6, 7 and 8 are put together in Upper Secondary Education. Categories 9 and 10 form the Low Tertiary Education. Groups 11, 12 and 13 are joined in category College.

Given that this categories account for the proportion of people in the section whose maximum education level completed is precisely this, to obtain a continuous measure of the average years of schooling in section s I assign to each proportion an average number of years of schooling to get this diploma:

$$\begin{aligned} YS_s =& Non-studies_s * 3 + Primary_s * 5 + LowSecondary_s * 13 + \\ & UpperSecondary_s * 15 + LowTertiary_s * 17 + College_s * 20 \end{aligned} \tag{A.1}$$

D. School Classification

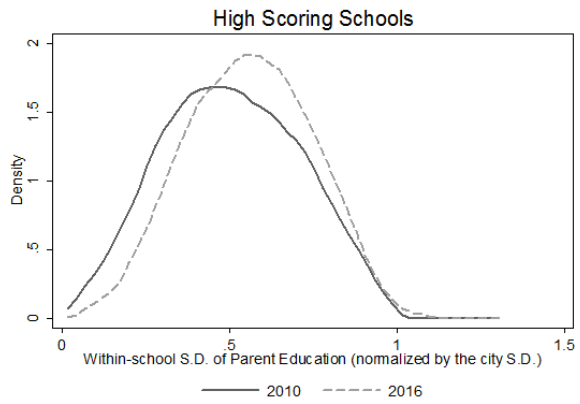


(a) Schools grouped according to performance.

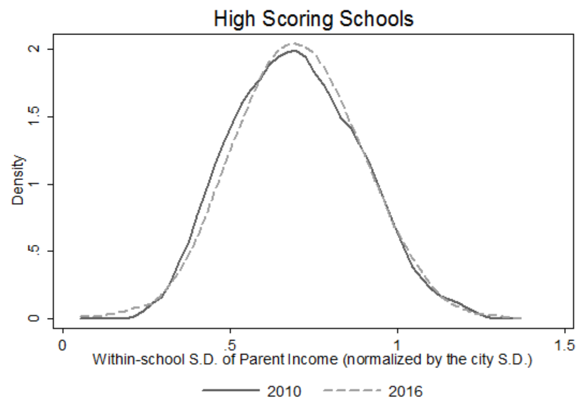
(b) Schools grouped according to average income of the district where they are located.

Figure A.2: Different schools classifications.

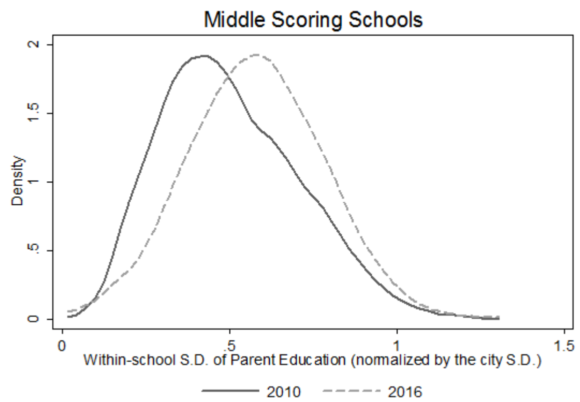
E. Miscellaneous



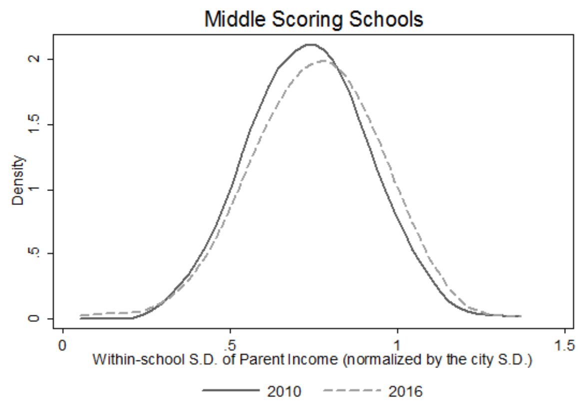
(a)



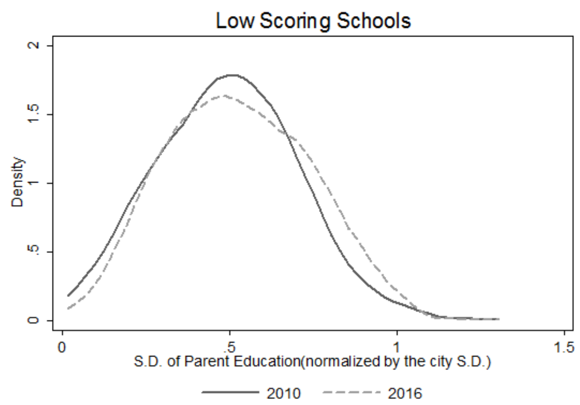
(b)



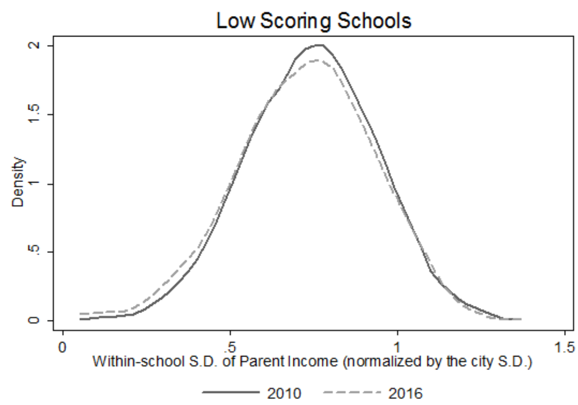
(c)



(d)



(e)



(f)

Figure A.3: Within-school S.D. of SES by school performance.

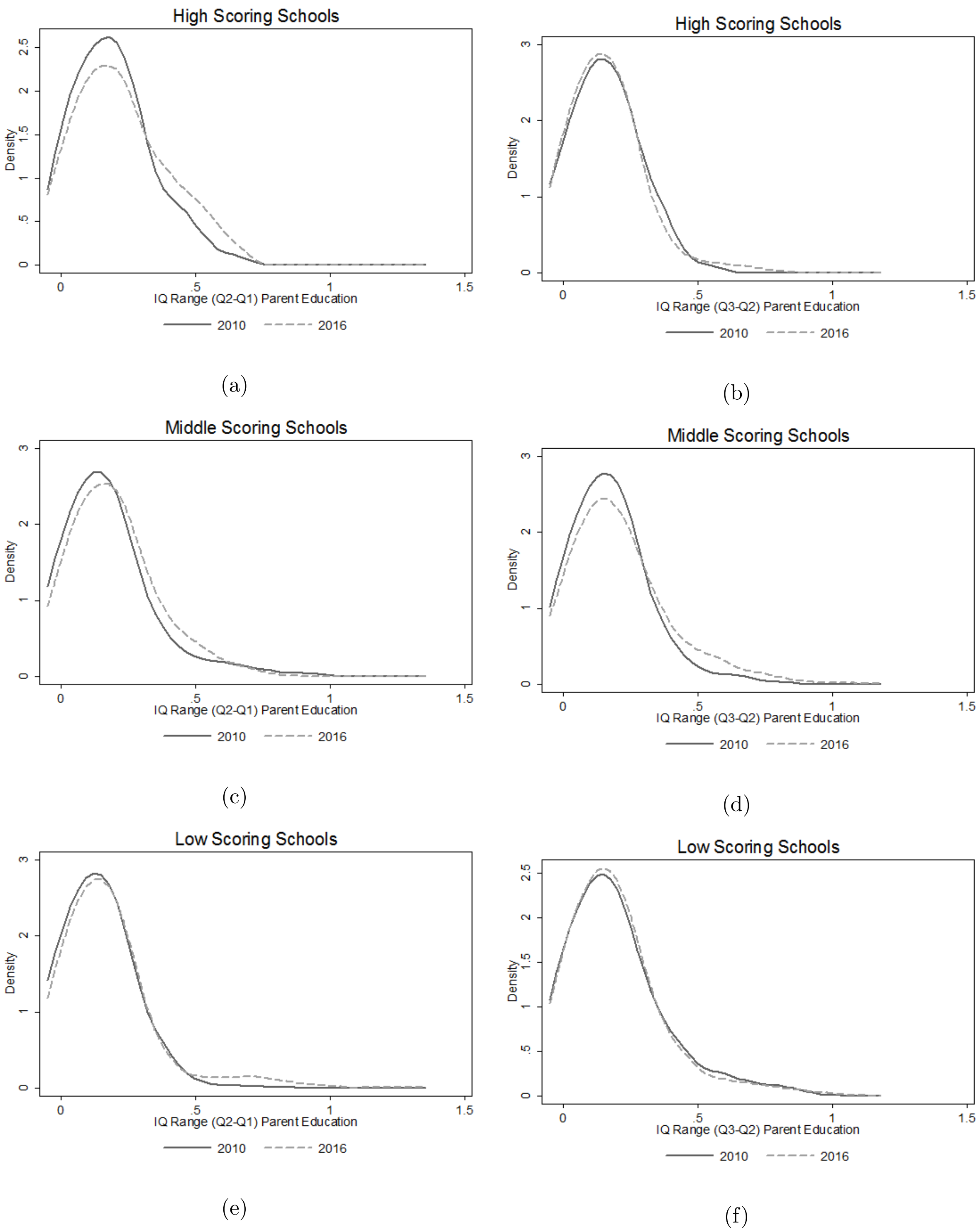


Figure A.4: Inter-quantile ranges of SES by school performance.

Table A.1: Geographic Mobility Coefficients (based on assignment).

	Dependent variable					
	Travel time (Log)			'Foreign' applications (Prop.)		
	(1)	(2)	(3)	(4)	(5)	(6)
Post-reform	.119***	-	-	0.033***	-	-
	(.007)			(0.003)		
Parents' education:						
2^{nd} quintile	-	.120***	-	-	.013*	-
		(.017)			(.007)	
3^{rd} quintile	-	.243***	-	-	.084***	-
		(.017)			(.008)	
4^{th} quintile	-	.327***	-	-	.119***	-
		(.017)			(.008)	
5^{th} quintile	-	.273***	-	-	.136***	-
		(.017)			(.008)	
Post-reform*Parents' education:						
1^{st} quintile	-	.111***	-	-	.029***	-
		(.017)			(.007)	
2^{nd} quintile	-	.023	-		.019*	-
		(.023)			(.010)	
3^{rd} quintile	-	-.009	-	-	.029***	-
		(.023)			(.010)	
4^{th} quintile	-	-.040*	-	-	-.018*	-
		(.023)			(.010)	
5^{th} quintile	-	.009	-	-	-.036***	-
		(.023)			(.010)	
Household Income:						
2^{nd} quintile	-	-	.003	-	-	.022***
			(.018)			(.008)
3^{rd} quintile	-	-	.064***	-	-	.073***
			(.018)			(.008)
4^{th} quintile	-	-	.148***	-	-	.081***
			(.018)			(.008)
5^{th} quintile	-	-	.259***	-	-	.111***
			(.017)			(.008)
Post-reform*Household Income:						
1^{st} quintile	-	-	.111***	-	-	.028***
			(.019)			(.008)
2^{nd} quintile	-	-	.011	-	-	.015
			(.025)			(.011)
3^{rd} quintile	-	-	.006	-	-	.010
			(.025)			(.011)
4^{th} quintile	-	-	.019	-	-	.010
			(.025)			(.011)
5^{th} quintile	-	-	-.026	-	-	-.015
			(.023)			(.010)

Notes:*, ** and *** indicate significance at 10-, 5- and 1-percent level, respectively. The controls are the population density in the student neighborhood. Standard errors are in brackets.

Table A.2: Change in within-school SES heterogeneity (based on assignment).

	Parents' Years of Education			Household Income		
Dependent variable: $log\|\hat{\epsilon}_{i,j}\|$	(1)	(2)	(3)	(4)	(5)	(6)
Post-reform Indicator	.116***	-	-	.004	-	-
	(.011)			(.010)		
Low Scoring School	-	-.100***	-	-	.105***	-
		(.024)			(.021)	
Middle Scoring School	-	.025	-	-	.040**	-
		(.022)			(.020)	
Low Scoring School*Post-reform	-	-.002	-	-	.005	-
		(.032)			(.029)	
Middle Scoring School*Post-reform	-	-.013	-	-	.092***	-
		(.029)			(.026)	
High Scoring School*Post-reform	-	.116***	-	-	-.037*	-
		(.024)			(.022)	
Low Income District	-	-	-.077***	-	-	.166***
			(.022)			(.016)
Middle Income District	-	-	.068***	-	-	.119***
			(.021)			(.019)
Low Income District*Post-reform	-	-	.030	-	-	.055**
			(.025)			(.023)
Middle Income District*Post-reform	-	-	.065**	-	-	.076***
			(.029)			(.026)
High Income District*Post-reform	-	-	.081***	-	-	-.034**
			(.018)			(.017)

Notes:*, ** and *** indicate significance at 10-, 5- and 1-percent level, respectively. Standard errors are in brackets.

Table A.3: Change in school segregation after the reform (based on assignment).

	2010		2016		**Change**	
	YS	HI	YS	HI	**YS**	**HI**
Panel A						
Aggregate						
Desegregation Index	0.668	0.851	0.697	0.845	**4.31%**	**-0.65%**
Entropy Index	0.428	0.220	0.390	0.218	**-9.00%**	**-0.91%**
Index of Social Inclusion	75.94	90.01	78.70	90.38	**3.63%**	**0.41%**
Panel B						
High Scoring						
Desegregation Index	0.672	0.795	0.692	0.799	**2.98%**	**0.50%**
Entropy Index	0.415	0.268	0.393	0.258	**-5.39%**	**-3.81%**
Index of Social Inclusion	75.03	90.08	78.44	89.05	**4.54%**	**-1.14%**
Middle Scoring						
Desegregation Index	0.677	0.854	0.712	0.851	**5.18%**	**-0.34%**
Entropy Index	0.430	0.224	0.379	0.221	**-11.87%**	**-1.44%**
Index of Social Inclusion	75.90	90.25	79.03	90.94	**4.12%**	**0.76%**
Low Scoring						
Desegregation Index	0.653	0.876	0.673	0.879	**3.07%**	**0.42%**
Entropy Index	0.451	0.208	0.425	0.192	**-5.92%**	**-7.16%**
Index of Social Inclusion	74.12	91.26	77.68	91.00	**4.80%**	**-0.28%**

Notes: YS accounts for parents' years of schooling, while HI accounts for household income.

Table A.4: Change in within-school SES heterogeneity.

	Parents' Years of Education		Household Income	
Dependent variable: $log\|\hat{\epsilon}_{i,j}\|$	(1)	(2)	(3)	(4)
Post-reform Indicator	.125***	-	-.010	-
	(.010)		(.008)	
Low Scoring School†	-	-.210***	-	.090***
		(.030)		(.025)
Middle Scoring School†	-	.053**	-	.110***
		(.024)		(.020)
Low Scoring School†*Post-reform	-	.059	-	-.085***
		(.039)		(.033)
Middle Scoring School†*Post-reform	-	-.068**	-	-.052**
		(.031)		(.026)
High Scoring School†*Post-reform	-	.165***	-	.043*
		(.028)		(.024)

Notes:*, ** and *** indicate significance at 10-, 5- and 1-percent level, respectively. Standard errors are in brackets. †Thresholds defining high-, middle- and low-scoring are modified here; 5.9 and 8.0 instead of 6.5 and 7.7.

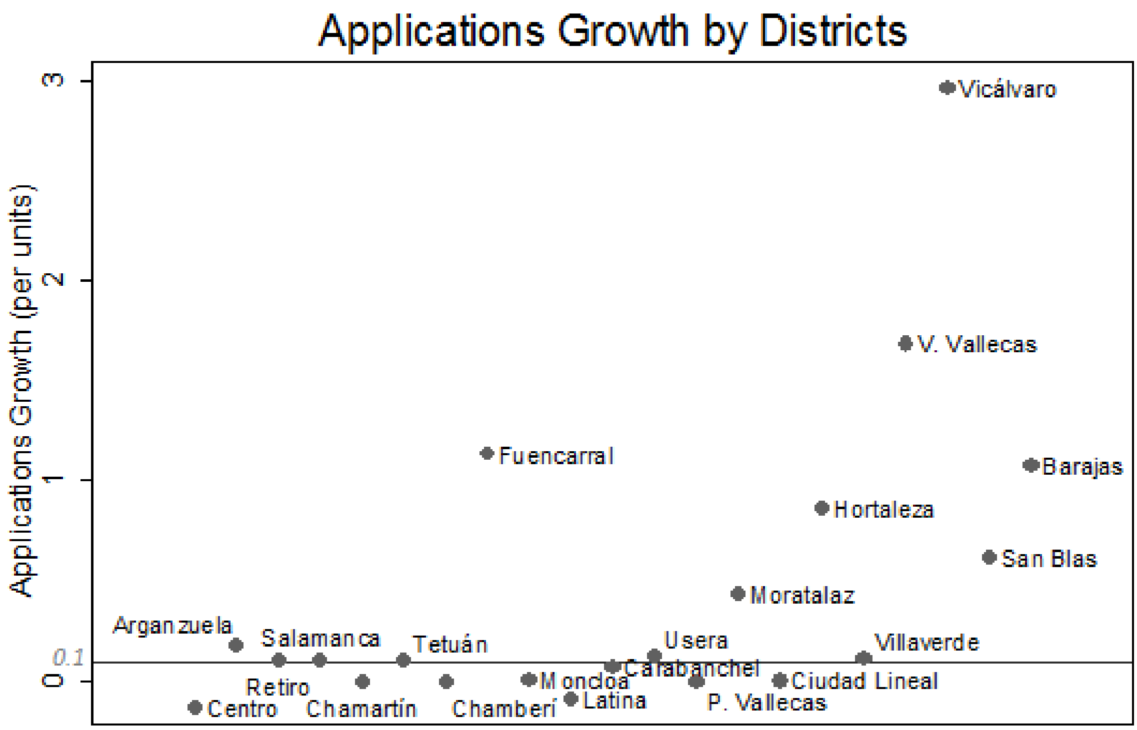


Figure A.5: District growth in the number of applications between 2010 and 2016.

Table A.5: Change in within-school SES heterogeneity.

	Parents' Years of Education*	
Dependent variable: $log\|\hat{\epsilon}_{i,j}\|$	(1)	(2)
Post-reform Indicator	.125***	-
	(.010)	
Low Scoring School	-	-.118***
		(.022)
Middle Scoring School	-	-.003**
		(.020)
Low Scoring School*Post-reform	-	-.011
		(.029)
Middle Scoring School*Post-reform	-	.054**
		(.026)
High Scoring School*Post-reform	-	.099***
		(.022)

Notes:*, ** and *** indicate significance at 10-, 5- and 1-percent level, respectively. Standard errors are in brackets. $\star$ Parents' years of education is calculated with a more accurate proxy consisting in the the average years of education in the section where the family resides restricted to residents in the section between 25 and 49 years old.