PAPER

Title: The role of catchment areas on secondary schools segregation

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Abstract:
    Using census data, we analyse the socioeconomic segregation of students at regional level, by using an specific segregation index. This index allows to decompose the segregation of students across schools in the different catchment areas. From our results it may be inferred that the most relevant source of segregation is the school itself, over and above the catchment areas**.** We find also significant correlations between the level of segregation within the catchment areas and factors such as size of the catchment area, parental level of education of the students attending schools and size of the area.

Keywords: *Segregation, socioeconomic level, students*, *catchment areas*

JEL codes: I24, R23.

1. Introduction

An equitable education system promotes equal opportunities to students in the educational process in terms of inputs, outputs and learning process. Nevertheless, many factors perpetuate inequality in education (gender, ethnicity, socioeconomic status, etc.) and their interaction ultimately explains the disparities.

In this research we address the level of segregation in Andalusian school at the regional level. Specifically, to the extent that students' socioeconomic status (SES) has a strong impact on their academic performance (Cordero et al., 2013), it may also be a potential source of segregation. This socioeconomic segregation has usually negative consequences for those disadvantaged in terms of income. School diversity serves as a means to compensate the effect of socioeconomic characteristics on academic performance. Results from PISA 2015 show that, in countries with a high level of school segregation, the impact of the socioeconomic status on reading performance is greater.

This study provides empirical evidence on this issue. Previous studies have found that exposure to a socially disadvantaged environment reduces students' likelihood of high school graduation (Brooks-Gunn et al. 1993; Harding 2003; Wodtke et al., 2011). Specifically, this paper makes use of a census dataset which contains information about students attending secondary education in the largest region of Spain (Andalusia).

Taking advantage of catchment areas' information, besides analysing school segregation we also address the uneven distribution of students across school catchment areas. The composition of catchment areas merely reflects the socioeconomic structure of neighbourhoods. Thus, when analysing the segregation across catchment areas, we tackle the geographical segregation.

This study pursues to analyse the socioeconomic segregation of students at different levels, simultaneously. The wider social units which groups students are the catchment areas. The next source of segregation are differences between schools within

a catchment area, which arise from the presence of public and semiprivate schools, as well as differences within each kind of school.

The paper is structured as follows. First, we present a review of the relevant literature with particular attention to the Spanish context; second, the institutional background of the school admission process in Andalusia is introduced. We then describe the main features of the dataset and the methodology used. Lastly we report the results and draw the main conclusions, including the educational policy implications.

2. Literature review

The socioeconomic segregation across schools in Spain is not very high in the secondary stage as compared to others OECD countries (Gutierrez et al., 2017, Murillo and Garrido, 2018). Social groups are differently influenced, being well-off students more segregated than those with a low SES (Murillo et al., 2018; Prieto-Latorre et al., 2019). Segregation also varies across regions (Mancebón and Pérez, 2010). Previous literature notes the existence of a heterogeneous distribution of the students among schools according to their funding levels, and leading to social segregation across schools and school types. In other words, there is a selection bias such that students' socio-economic and cultural status determines which school they attend (Fernández, 2008; Mancebón and Pérez, 2009; Murillo et al., 2018, Prieto-Latorre et al., 2019). Particularly, they found that high income students are concentrated in private and semiprivate schools. Private schools are out of debate because they do not receive public funding and they are managed in the market mechanism. However, public and semiprivate schools both receive public funding but they have a significant different distribution of students.

Previous studies in Spain have found differences in the level of segregation between public and private secondary education schools. Using the dataset of PISA 2015 for Spain, Murillo et al. (2018) found that differences between both types of schools suppose 22% of the level of segregation for poor students and 32% of the segregation for rich students[1]. Additionally, the segregation within each type of school

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[1] In their sample they group semiprivate and private schools.

has been analysed, being greater the segregation in semiprivate schools than in public schools (Mancebón and Pérez, 2009). This analysis used the level of parental education as a proxy for SES, which constitutes a less precise measure of the socioeconomic profile of the students than those used in our analysis, in which parental occupation and home possession are also considered – Index of Economic, Social and Cultural Status-.

3. School admission

In Spain, national legislation establishes the basics of students access to the educational system, but the organization and regulation is run by Autonomous Communities (regions). In light of the educational legislation, families can choose their children's school. However most of schools experiences over-demand.

Specifically, in Andalusia, a point-based system handles students' assignment to school (*Decreto 53/2007, de 20 de febrero*[2]). Home or parental working place near the school stand as the most important criteria to get access to school; concretely, 10 points if it is located in the catchment area and 6 points in a border area. Students also get priority of enrolment when they have siblings attending that school, a low family income, a "large family" status or single parent family, and existence of a disability of the student, parents or siblings.

This bonus system does not discern between place of residence and parental working location, giving an equal importance to both aspects. Nevertheless, subsequent modifications underline the use of the place of residence, giving greater weight in the selection process of students than parental working place[3].

Admission process concerns schools which receive public funding, that is, public schools and semiprivate schools. Public schools are fully funded whereas semiprivate schools received around 70%[4] of their funds from State resources. The

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[2] Our dataset contains information related to students attending 2nd course of secondary education in the academic year 2011/12. Those students get access to high school in the academic year 2010/11. The applicable Law in 2011/10 is Decreto 53/2007, de 20 de febrero.

[3] For example, *Decreto 40/2011, de 22 de febrero*, firstly applied to those students who get access to secondary education in the academic year 2011/12, grants 4 extra point to proximity of home than proximity to working place.

[4] The Survey of Financing and Expenditures of Private Teaching (*Encuesta de Financiación y Gastos de la Enseñanza Privada*) is conducted every 5 years. In 2009-10, semiprivate schools were funded in 75%, while in 2014-15 in 69.2%.

possibility of choice between a public or semiprivate school is not covered by law, thus the admission to both kind of schools is conditioned by the above mentioned – geographical- criteria.

The limited autonomy that Spanish schools have in this regard, due to the centralised nature of education in regions, would seem to imply that school choice *per se* is less likely to be a major source of segregation in the Spanish case (Pont et al., 2014), at least in comparison to other countries such as England. Therefore, the main factor that explains school segregation in Spain is the location of the student's home. The emphasis placed in the proximity to school shows that school composition is highly associated to neighbourhood composition. As neighbourhoods become segregated with families of the same socioeconomic background clustered together, the schools that serve that neighbourhood will become socially segregated.

4. Data

In Spain, students took two external standardised test during compulsory education, one of them in 4th course of primary education and the other in the 2nd course of secondary education. These exams did not determine students' progression; educational authorities used this information at an aggregate level for educational policy purposes.

Concretely, our census data contain information about students attending the second grade of secondary education in the academic year 2011-12 in Andalusia. In this dataset parents' questionnaires are used to create the index of Economic, Social and Cultural Status (ESCS), which is the variable used as a measure of students' segregation.

Additional information suitable for quantifying students' segregation are school catchment areas, due to the importance that admission process assigns to them. In our data, we can identify those schools which belong to the same catchment area and thus we can analyse the characteristics of nearby schools. For the first time, this information is ready for use for the Region of Andalusia as well as in the context in Spain.

This study is focused on catchment areas with more than 1 school (198 catchment areas are dropped). Although catchment areas with only 1 school suppose

40% of the catchment areas of our sample, they only group 14 % of the students (10,065 students).

The final sample we use to measure the segregation of students comprises 61,557 students, who attend 1,297 schools gathered in 279 catchment areas. Table A1 (Appendix) presents descriptive statistics for the catchment areas included in our analysis. Catchment areas included in our analysis have on average 4.6 schools, although the range of variation is very high (from 2 schools up to 23 schools within a catchment area). On average, catchment areas have 80% of public schools and 20% of semiprivate schools (146 catchment areas have only public schools, 1 catchment area have only semiprivate schools and the remaining 132 catchment areas have both types of schools).

Differences between the socioeconomic composition of public and semiprivate schools are apparent (Table A2). The higher socioeconomic status of the semiprivate schools is perceived not only in the Index of ESCS but also independently in each one of the variables composing the ESCS. For example, in public schools around 10% of parents have studied a Degree or a PhD, but this figure rises to 26% in semiprivate schools.

5. Methodology

We use the Mutual Information Index. This index was firstly proposed by Theil and Finizza (1971). Besides satisfying basic desirable properties, decomposability properties clearly differentiate the Mutual Information Index from other measures of segregation, as we will see.

The Mutual Information Index is a multigroup index, it analyses the distribution of the population who is classified in two or more groups along social units. In this research, the ESCS index is used to allocate students in four groups (quartiles of the ESCS distribution). The index compares that entropy of the groups of students with the conditional distribution of groups of students within the school. The school where the student attends reduces the uncertainty of the distribution of the groups of students and it is called mutual information (Cover and Thomas, 1991). The term $[E(P_q) - E(P_{q|s})]$

is the reduction in uncertainty of the distribution of students by quartiles due to the school.

The lower bound of the index is 0, which means that there is a lack of segregation if the proportion of students from each quartile is the same within each school, thus the distribution of students by quartiles in schools and their distribution conditioned on the schools are the same. The upper bound of the index is not fixed, it is obtained as the lower value of the logarithm of the number of groups (students are grouped by quartiles of the ESCS distribution) or schools (1,297 schools); in this case the maximum value of the index is 1.39 (=log4).

The property that the M index satisfies of decomposing the level of segregation across units is especially relevant in our research because we want to identify the different sources of students' segregation across schools at three levels simultaneously. The Region of Andalusia is divided in school catchment areas, so the first level of segregation are school catchment areas. If we consider all public schools within the catchment area as a social unit and the set of semiprivate schools is the other social unit, the differential distribution of students across both types of schools would be the second level of segregation. Lastly, we identify segregation between public schools within a catchment area and semiprivate schools within a catchment area.

The property which enables us to obtain the contribution to segregation of all the levels simultaneously is Strong Decomposability across units. According to this property, the M index can be decomposed in two terms: a first component measures the differential distribution of students across catchment areas (between) and a second term measures how much segregation arises from the distribution of students within schools of a catchment area (within).

Apart from Decomposability properties, the M index satisfies basic properties which are desirable for a measure of segregation (see Frankel and Volij, 2011 for an axiomatic characterisation of the properties of the M Index). The M index is scale invariant, which implies size invariance and organizational equivalence properties. In our setting, when the number of students increases proportionally across groups within each school, the index does not vary. School Division Property states that a school can be divided into sub-schools and the level of segregation will never be lower. In the case

that the school is divided into sub-schools with the same share of students across groups, the level of segregation is not altered (insensitivity to proportional division); in other case, the index will change. The Transfer principle describes the movement of a student from any group (any quartile of the ESCS distribution) to another school. The value of the index will change, but in the multigroup approach we cannot assure if segregation increases or decreases after this shift. Symmetry in groups and symmetry in units indicate that labels of the quartile of the ESCS and the name of school do not affect the index value. Lastly, segregation is unchanged if a school without students is added or removed (zero member property).

6. Results

The socioeconomic segregation of students across schools can be decomposed into segregation between catchment areas and segregation between schools within catchment areas. Differences within a catchment area arise because of two facts. Firstly, differences between public and semiprivate schools within a catchment area. For measuring this first source of segregation, we consider public schools within a catchment area as a social unit and semiprivate schools are the other social units. It means that if a catchment area has only one type of school, for example there are only public schools, there is no segregation in this level. In the case that a catchment area contains both types of schools, in this level we would be measuring different distributions between these two units.

The second source of segregation would be the distribution of students between the same type of schools within a catchment area; on the one hand, segregation between public schools within a catchment area and, on the other hand, segregation between semiprivate schools within a catchment area.

Table 2 reports the socioeconomic segregation of students at the different levels. The first column of the table decomposes the segregation of students from the whole distribution of the ESCS while the rest of the table considers a binary distribution of students in order to identify possible differential contributions from students of different socioeconomic groups. The value for socioeconomic segregation is 0.17 (it is a low value since the maximum level of the index is 1.38). If we look at the decomposition by percentages in Table 3, we see that around 50% of segregation is due to the distribution

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of students across catchment areas and 50% arise from the distribution within a catchment area. Within catchment areas, the social composition of public schools and semiprivate surprisingly schools supposes 26% of the segregation[5] and most of the segregation within a catchment area (74%) stands as differences between the same types of schools. Differences between public schools take 60% of the segregation within the same kind of schools in a catchment area while the remaining 40% are differences between semiprivate schools[6]. In fact, the distribution of students across public schools within a catchment area explains 24% of the total level of segregation.

The decomposition of segregation across levels is somewhat differentiated by quartile (Table 3). Especially, we found differences in the pattern of segregation between the richest students and the segregation of the rest of students. Catchment areas segregation is the most important factor explaining segregation of the richest students (52% of segregation), while for the rest of socioeconomic thresholds differences between schools within catchment areas are a more important element (over 50%). The main sources of segregation of these later groups (1st 2nd and 3rd quartile) are differences between public schools of the catchment area. In the case of the segregation of students from the 4th quartile, the distribution of students between public schools and semiprivate schools within the catchment area have more or less equal weight (54% and 45%). A possible reason is the concentration of students from the top quartile in catchment areas with a high proportion of semiprivate schools.

Notable here is the fact that main differences are identified between students over the median of the ESCS distribution, that is, students from the 3rd quartile and 4th quartile.

Table 2. Segregation of students by quartiles. Absolute values

	Total	1st quartile vs No 1st quartile	2nd quartile vs No 2nd quartile	3rd quartile vs No 3rd quartile	4th quartile vs No 4th quartile

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[5] Main reason is that most of districts (147 districts out of 279) have only one kind of school. With the subsample of districts which gathers public and semiprivate schools, we show that this figure is greater)
[6] It is important to take into account that they are expressed in relative terms (only a 28% of students attends semiprivate schools). In absolute terms differences between semiprivate schools within a district are greater than differences between public schools.

Total: Between schools	0.174	0.077	0.033	0.022	0.105
Between catchment areas	0.082	0.035	0.014	0.007	0.055
Between schools within catchment areas	0.092	0.042	0.019	0.015	0.050
• Between public and semiprivate schools within catchment areas	0.024	0.012	0.004	0.002	0.015
• Between the same type of schools within a catchment area	0.068	0.030	0.015	0.013	0.035
○ Public schools	0.041	0.020	0.008	0.008	0.019
○ Semiprivate schools	0.027	0.010	0.007	0.005	0.016

Notes:
The segregation of public and semiprivate schools within a catchment area is weighted by the proportion of students attending public and semiprivate schools. The percentage of students attending public is 71.86 % and the percentage of students attending semiprivate schools is 28.14%.

Table 3. Segregation of students by quartiles. Percentage decomposition by column

	Total	1st quartile vs No 1st quartile	2nd quartile vs No 2nd quartile	3rd quartile vs No 3rd quartile	4th quartile vs No 4th quartile
Total: Between schools	100.00%	100.00%	100.00%	100.00%	100.00%
Between catchment areas	47.13%	45.45%	42.42%	31.82%	52.38%
Between schools within catchment areas	52.87%	54.55%	57.58%	68.18%	47.62%
• Between public and semiprivate schools within catchment areas	13.79% [A]26.09%	15.58% [A]28.57%	12.12% [A]21.05%	9.09% [A]13.33%	14.29% [A]30.00%
• Between the same type of schools within a catchment area	39.08% [A]73.91%	38.96% [A]71.43%	45.45% [A]78.95%	59.09% [A]86.67%	33.33% [A]70.00%
○ Public schools	23.56% [B]60.29%	25.97% [B]66.67%	24.24% [B]53.33%	36.36% [B]61.54%	18.10% [B]54.29%
○ Semiprivate schools	15.52% [B]39.71%	12.99% [B]33.33%	21.21% [B]46.67%	22.73% [B]38.46%	15.24% [B]45.71%

Note:
In general, the reference level is total segregation between schools for students by quartile (calculated using the first row of Table 2). Exceptions:
[A] Reference level is segregation between schools within catchment areas for each column (third row of Table 2)

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7. Conclusions

The socioeconomic segregation of students affects the equity of an education system since it reinforces the relative advantage or disadvantage of students which already exists by socioeconomic background. In this paper we explore the segregation of students across schools using administrative data for the largest region of Spain (Andalusia). We have found that school segregation is higher than urban segregation. The distribution of students across catchment areas supposes 50% of the level of school segregation while the remaining 50% arises from differences within catchment areas, which in turn depends on the existence of public and semiprivate schools and differences within

Schools with a high concentration of low income students face an additional problem based on attracting high qualified and experienced teachers (Informe mezclate conmigo save the children). This is another fact which increases the inequity in education. Besides that, these schools have a high mobility of teachers. As the working environment of teachers is more challenging for teachers' incentives in these schools, not only in economic terms, but also in the reduction of lessons, both could help to deal with this problem of segregated schools and to create a stable teacher staff. Thus, more economic resources should be directed to schools and neighbourhoods with a high proportion of low income of students, which are those who suffer the negative consequences of segregation.

To sum up, policy measures which can be useful to address the segregation across schools are not only an issue of educational authorities, but also planning authorities while in the decision for allocating more resources in education is involved the entire parliamentary group. These proposals contribute to reduce the segregation at different levels (city, neighbourhood, schools) and their implementation can help to create socioeconomic diversity within schools.

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Appendix.

Table A1. Descriptive statistics by district

		By district	
		Mean	**Std. Dev**
Index of socioeconomic and cultural level		-0.160	0.410
Number of schools within the district		4.649	3.322
Number of schools within the district	**Public**	3.233	1.679
	Semiprivate	1.416	2.346
Proportion of schools within the district	**Public**	0.798	0.246
	Semiprivate	0.202	0.246
Proportion of parents with the level of education in the district	**Incomplete primary education or did not attend school**	0.105	0.061
	EGB or Compulsory Secondary Education	0.374	0.118
	Medium grade formation course	0.224	0.053
	High grade formation course	0.114	0.044
	University degree, PhD	0.183	0.118
Districts which are located in a municipality with	**Fewer than 5,000 inhabitants**	0.240	0.428
	From 5,000 to 10,000 inhabitants	0.118	0.324
	From 10,000 to 50,000 inhabitants	0.358	0.480
	From 50,000 to 100,000 inhabitants	0.075	0.264
	More than 100,000 inhabitants	0.208	0.407
Number of districts (observations)		279	

Table A2. Descriptive statistics by kind of school (at school level)

		By school			
		Public schools		**Semiprivate schools**	
		Mean	**Std. Dev**	**Mean**	**Std. Dev**
Index of socioeconomic and cultural level		-0.300	0.498	0.361	0.635
Number of students		49.039	33.995	43.858	24.904
Proportion of students from the quartile of ESCS distribution	**1st quartile**	0.339	0.189	0.153	0.165
	2nd quartile	0.282	0.113	0.207	0.116
	3rd quartile	0.224	0.109	0.272	0.107
	4th quartile	0.154	0.133	0.368	0.226
Proportion of fathers with the level of education in the school	**Incomplete primary education or did not attend school**	0.212	0.158	0.097	0.124
	EGB or Compulsory Secondary Education	0.415	0.156	0.278	0.149
	Medium grade formation course	0.186	0.107	0.238	0.094
	High grade formation course	0.087	0.070	0.126	0.077
	University degree, PhD	0.100	0.109	0.260	0.204
Proportion of mothers with the level of education in the school	**Incomplete primary education or did not attend school**	0.172	0.134	0.084	0.111
	EGB or Compulsory Secondary Education	0.460	0.162	0.289	0.158
	Medium grade formation course	0.183	0.101	0.249	0.100
	High grade formation course	0.077	0.064	0.118	0.067
	University degree, PhD	0.108	0.105	0.259	0.190

Schools which are located in a municipality with	Fewer than 5,000 inhabitants	0.223	0.416	0.008	0.087
	From 5,000 to 10,000 inhabitants	0.079	0.269	0.030	0.172
	From 10,000 to 50,000 inhabitants	0.334	0.472	0.220	0.415
	From 50,000 to 100,000 inhabitants	0.110	0.313	0.124	0.330
	More than 100,000 inhabitants	0.255	0.436	0.618	0.487
Number of schools (observations)		902		395	

Note:

In the sample are included catchment areas with more than 1 school.