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Measuring School Segregation: Evidence from Lisbon

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Abstract

The paper estimates and analyses public primary school segregation in Lisbon between 2006 and 2016, along three dimensions: subsidized lunch, immigrant status, and parents education. Also, using 2011 census data, measures of residential segregation by education, unemployed status, and immigrant inhabitant status were obtained for the capital. Throughout this paper, I use the index of dissimilarity, the most popular unevenness index in the literature to compute measures of school segregation that I compare with residential segregation. The area analysed is the entire council of Lisbon, composed of 24 parishes containing a total of 24 public primary schools. The main findings include that segregation across schools has been decreasing over time for the dimensions of subsidized lunch and parents education and that it has increased for immigrant status. Furthermore, for the year of 2011, school segregation is higher than residential segregation.

Keywords: Stratification, Segregation, Education, Dissimilarity Index.

1 Introduction

The subject of school segregation - which can be defined as the uneven distribution among schools of pupils with different social and economic features (Valenzuela et al., 2014) - became one of the most debated issues of educational policy in 1954 with the declaration by the U.S. Supreme Court that segregation of schools was unconstitutional (Brown v. Board of Education, 1954).

Educational policy has been concerned with school segregation because there is evidence that segregation can lead to unequal educational opportunities and outcomes and can undermine social cohesion. By generating inequalities on students' access to school, and harming their achievement, it may be powerfully conditioning students' future life opportunities.

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This research studies school segregation of the primary public schools in Lisbon, which is a valuable tool to analyse the relationship between school stratification and possible measures to not compromise students' outcomes and improve schools' performance.

Traditional research in this field primarily focused on the study of racial and economic segregation between schools and within school districts in the United States and on the negative impacts of segregation on minority students (Park, 1926; Abramson et al., 1995).

Although segregation was previously defined by Park (1926) as the relation between the physical and social distance of certain groups or individuals, there is still no agreement regarding the theoretical definition of segregation (James and Taeuber, 1985; Massey and Denton, 1988; Allen and Vignoles, 2007) and about the most suitable approach to measure school segregation.

The main purpose of this research is to give a better comprehension of student segregation in Lisbon, by estimating its level and analysing its trends over the years. In this study, segregation is analysed as unevenness, which is one of the five measures of segregation² proposed by Massey and Denton (1988). Unevenness corresponds to the difference in the distribution of population groups in geographical and/or organizational units, and is measured in a relative sense as a group that is considered segregated if it is distributed differently (compared to another group) in particular units. Therefore, segregation between Lisbon public primary schools is estimated along three dimensions - subsidized lunch, immigrant status and parents' education - using the widely accepted index for purposes of evenness measures: the dissimilarity index.

The purpose of the present study is: i) Estimate and analyze the present level and recent evolution of stratification across Lisbon primary public schools. ii) Compare residential stratification with stratification in primary public schools in order to verify whether the schooling system is contributing to increase or decrease the residential stratification existent in the city.

The remainder of the paper is organized as follows: Section 2 presents the literature review about the different methods of measuring stratification and the main consequences of stratification on students. In Section 3 is presented a brief overview of the Portuguese schooling system. Section

²The five suggested measures are evenness, exposure, concentration, centralization and clustering.

4 provides an analysis of the index used to measure stratification and its characteristics. Section 5 presents the methodology, data and descriptive statistics. Section 6 presents and discusses the results of stratification. Section 7 concludes by suggesting some policy implications arising from the findings.

2 Literature Review

Literature on how to measure educational stratification never reached overall consensus. Over the last decades, scholars have been analysing how to measure segregation between schools, understanding the reasons for variations in school stratification, and its main implications on student achievement.

2.1 How to measure segregation?

The debate on how best to measure segregation has been ongoing for decades. In 1955, the publication of the Duncan and Duncan article (Duncan and Duncan, 1955), argued that there was inadequate information in other indices that was not already contained in the dissimilarity index, which indicated that some order has been brought to the segregation field. Later in 1965, Tauber (1965) reached the same conclusion and for more than 20 years, the dissimilarity index became the standard segregation measure of residential segregation among social groups.

The wave of agreement ended when Cortese et al. (1976), criticized the effectiveness of the segregation index. This led to further ambiguity in the segregation field once again. Since then, no consensus regarding one specific way of measuring segregation has been reached. Several different approaches to measure stratification have been proposed and reintroduced in the literature and diverse researchers have based their investigation on different segregation definitions and measures (Cortese et al., 1976; James and Taeuber, 1985). An important contribution to this discussion came with James and Taeuber (1985). They developed a set of criteria that define the concept of segregation by specifying desirable operational features of an index: 1. *Organisational equivalence*, 2.

*Size invariance, 3. The principle of transfers and 4. Composition invariance.*³

Massey and Denton (1988) tried to bring some clarity to the segregation field by providing an overview of twenty segregation measures previously mentioned in the literature. The authors proposed five dimensions of segregation and analysed which index should be applied according to each dimension. They categorized these dimensions as evenness⁴, exposure, concentration, centralization, and clustering. They concluded that the most appropriate measures for each dimension are respectively: the index of dissimilarity, the index of exposure, relative concentration, absolute centralisation and spatial proximity.

According to Massey and Denton (1988), *Evenness* corresponds to the differential distribution of two social groups in a city. *Exposure* refers to the degree of potential contact between minority and majority group members within geographic areas of a city. *Concentration* refers to the proportion of physical space occupied by a minority group in the urban environment. Residentially concentrated groups are the ones that occupy a small share of the total area in a city. *Centralization* is the level to which a group is spatially located near the center of an urban area. *Clustering* corresponds the extent to which areal units inhabited by minority members adjoin one another in space. The remaining indices that were studied by the authors were: Gini, entropy and Atkinson indices for evenness; ration of correlation for exposure; delta and absolute concentration for concentration; city centre proportion and relative centralisation for centralisation; and absolute clustering, relative clustering, interaction and isolation with distance adjustment for clustering.

Despite the efforts along the years, scholars still disagree about the most suitable method to measure segregation between schools and even about the definition itself.

"Arguments about how best to measure segregation combine normative disagreements about what segregation actually is with technical arguments about the desirable properties of a segregation index."(Allen and Vignoles, 2007)

More recent methods of measuring segregation have been introduced and discussed, and the battle for the adequate index to measure segregation continue. Allen and Vignoles (2007) analysed

³this criteria is explained in detail in section 4.1 Measuring Segregation - Index of dissimilarity.

⁴see footnote 2.

previous methods of measuring segregation used in the literature such as the Dissimilarity Index, Gorard's index and the Squared Root index, and proposed an alternative approach for measuring educational segregation: the segregation curve.

Recent studies have been mainly focused on estimating and evaluating the patterns of school segregation after policies changes at the school level. Söderström and Uusitalo (2010) measured segregation in Stockholm upper secondary schools and in the city of Stockholm after a policy change which allowed the students the possibility of choosing any school in Stockholm instead of the nearest school of their residence. To measure segregation, the authors used the dissimilarity (Duncan) index and R squared index and found that school choice contributed to increasing segregation. Also, several researchers analysed the impact of the introduction of vouchers on stratification patterns (Hsieh and Urquiola, 2006; Mizala and Torche, 2012).

2.2 Consequences of school segregation

Discussion regarding the unfavourable effects of segregation on individual's life started decades ago with the work of Myrdal et al. (1944) and Clark (1965) and continued throughout the 1990's with the contribution of Massey and Denton (1993) and Orfield and Eaton (1996). The subject continues to capture researchers' attention (Reardon and Owens, 2014).

There is evidence that both school and residential segregation may have an impact on student achievement. However, there is no agreement about which of these factors have a greater influence on student outcomes. It is well established in the literature that residential segregation has damaging effects on educational opportunities, on labor, health and political levels (Cutler and Glaeser, 1997; Kling et al., 2007). The literature agrees that neighborhood conditions may have an impact on students cognitive development and educational outcomes (Burdick-Will et al., 2011; Chetty et al., 2016; Sampson et al., 2008) which may translate into inequality educational opportunities if it causes children of different social backgrounds and races to live in advantaged and disadvantaged neighborhoods. School and residential segregation are related because a) children attend schools near their residence; b) usually the quality of the school depends on the characteristics of the neigh-

bourhood (Reardon and Owens, 2014).

In fact, there is evidence from previous research that disadvantaged students attending segregated schools are expected to experience inferior levels of academic success and higher dropout rates. Moreover, scholars also find that school segregation can have a negative impact on students' risk attitudes and psychological aspects related to school achievement among disadvantaged students (Orfield and Lee, 2005; Hanushek et al., 2009).

Investigation about the negative aspects of school segregation on students' success has been powerfully influenced by the debate on school compositional effects and on peer effects. According to the theory, "who you go to school with" matters. Peers' socioeconomic status and intellectual abilities have a fundamental role as forecasters of students' performance. Besides, the resources of the school (learning materials, teachers, learning environment) also have an important contribution to students' achievement, and usually, segregated schools are deprived of the best resources for child development (Coleman et al., 1966). Recent studies show the importance of school composition in student achievement (Angrist and Lang, 2004; Hoxby and Weingarth, 2005).

Additionally, segregation experienced during childhood may have a strong impact on students' college attendance and performance. Students growing up in minority-dominant schools and neighbourhoods can be expected to arrive at college unprepared academically, socially and psychologically for the challenges of a competitive academic environment (Massey and Fischer, 2006).

3 Brief overview of the portuguese school system

In Portugal, the allocation of pupils to public primary schools is a government task. Usually, portuguese students are exposed to a common curriculum until age fifteen. Policy makers place pupils based on their location of residency within the city. All children of six years of age are obligated to be enrolled in school by September fifteenth. Parents have the option of choosing between public and private institutions, however the focus of this paper will mainly be on the public sector.

4 Measuring Segregation - Index of dissimilarity

There are two important decisions that should be made when the purpose is to measure segregation. The first is the choice of the adequate indice and the second is the choice of the variables to analyse.

Following the method previously adopted by Söderström and Uusitalo (2010) and Valenzuela et al., (2014), we measure school segregation using the dissimilarity index (illustrated bellow) along three dimensions: subsidized lunch, immigrant status and parents' education.

$$D = \frac{1}{2} \sum_{s=1}^J \left| \frac{X_s}{X} - \frac{Y_s}{Y} \right|,$$

Where J stands for the number of categories (e.g., schools, parishes), X refers to the number of individuals belonging to group X (e.g., subsidized lunch pupils), and Y is the number of individuals belonging to group Y (e.g., non subsidized lunch pupils) X_s and Y_s are the respective numbers of individuals belonging to these groups in category s .

The dissimilarity index, developed by Duncan and Duncan (1955) is the most widely used index of evenness segregation. Evenness is one of the five dimensions of segregation proposed by Massey and Denton (1988) and it corresponds to the differential distribution of two social groups across areal units of an urban area i.e., it measures the difference between the distribution of subsidized lunch pupils across schools from the distribution of nonsubsidized lunch pupils across schools. The index value varies between 0 and 1, representing the minimum and maximum level of segregation respectively. This value illustrates the proportion of minority members that would need to move to from one school to another to guarantee an even distribution of the population. If the value of the index reaches one, it means that each area contains only one group, meaning that no minority and majority members share a common school. Dissimilarity values above 0.6 are considered situations of super segregation (Glaeser and Vidgor, 2000).

There is no perfect index, each has its own strengths and weaknesses. James and Taeuber (1985) established a set of four desirable axioms that a good segregation index should verify, that

is presented below. The definitions of each criterion are given by Iceland et al. (2002). The dissimilarity index meets the following properties reasonably well with exception of the third one:

1. Organizational Equivalence

This principle holds that an index should be unaffected by aggregating units with the same minority composition.

The principle of organization equivalence states that the measured level of segregation should remain the same if two schools that have identical proportion of majority/minority students and numbers of students are merged into a unique school.

2. Size Invariance

This axiom refers that the measure should not be affected if the number of people in each group is multiplied by a constant.

3. Principle of transfers

This criterion states that a measure should be sensitive to the redistribution or transfer of minorities among areal units with minority proportions above or below the metropolitan areas minority proportion (and not just transfers from areas above to areas below that proportion).

The Duncan index is violating this principle (James and Taeuber, 1985; Winship, 1978). Only transfers of minority members from areas where they are overrepresented (above the city's minority proportion) to areas where they are under-represented (below the minority proportion) affect the value of the index.

4. Composition Invariance

This principle states that the relative size of minority population should not affect the index.

The value of the index should remain constant when there is a proportional increase in the number of pupils receiving or not receiving subsidized lunch if each school's share of the sub-group (e.g. subsidized lunch) does not change and the distribution of the other sub-group (e.g. non-

subsidized lunch) remains the same. Thus, if new subsidized lunch pupils enter a geographical area from outside, causing the number of subsidized lunch pupils to double across the geographical area as a whole but the share in each school remains the same, the value of the index remains the same.

There are other indices that met all the previous axioms, such as the Square Root index, proposed by Hutchens (2004). Despite its imperfections, the dissimilarity index is preferred to the Square Root index not only because it is familiar to researchers, easy to compute and interpret but because the Square Root index displays low values even when the level of segregation is quite moderate, which is common to happen in schools (Allen and Vignoles, 2007). Besides, it is the most widely recognized and used segregation indice in the specialized literature. It was recently used in studies measuring segregation between schools in OECD countries (Jenkins et al., 2008; Allen and Vignoles, 2007).

5 Data and Methodology

5.1 Data

The dataset used to conduct this study results from two databases: MISIPUB and CENSUS 2011. MISIPUB is an administrative database containing an extensive set of information about the student population in the Portuguese Educational System for public institutions, making available data regarding student's features, and socioeconomic context, from 2006 to 2016.

5.2 Methodology

The methodology was defined to tackle two main objectives: measure school segregation and measure residential segregation. Therefore, this empirical study proceeds in 3 stages:

In a first stage, a descriptive analysis of the proportion of students by school, number of schools and parishes and other student characteristics are presented and analysed in order to achieve a characterization of the city of Lisbon and a better comprehension of students features across schools.

In a second step, I estimate the level and evolution over time of segregation between Lisbon public primary schools along three dimensions: subsidized lunch (SL), immigrant status (Im) and parents' education (PE) using the dissimilarity index (D) (illustrated below). The indicator subsidized lunch represents the students in Lisbon whose meals are partly financed by the government. Immigrant status means that the citizenship of the students is not portuguese. Parents' Education indicates that the student has at least one parent with a university degree.

For comparison purposes, I have also estimated segregation between schools with the segregation curve approach (a method which is explained in more detail in the results section) and with the R squared index (R^2), which corresponds to the ratio of the between school variance to the total variance. It estimates the fraction of the total variance that is due to variation across schools. When R^2 reaches the value of 1, all units within groups are equal, and therefore total variance equals across group variance. When it is zero, there is no variation across groups i.e. the means of each group are equal (Söderström and Uusitalo, 2010).

$$D_{School-Lx} = \frac{1}{2} \sum_{i=1}^S \left| \frac{SL_{school}}{SL_{lx}} - \frac{nonSL_{school}}{nonSL_{Lx}} \right|$$

$$D_{School-Lx} = \frac{1}{2} \sum_{i=1}^S \left| \frac{Im_{school}}{Im_{lx}} - \frac{nonIm_{school}}{nonIm_{Lx}} \right|$$

$$D_{School-Lx} = \frac{1}{2} \sum_{i=1}^S \left| \frac{PE_{school}}{PE_{lx}} - \frac{nonPE_{school}}{nonPE_{Lx}} \right|$$

$$R^2 = \frac{\sum_{s=1}^J \frac{ns}{N} (\{\bar{Y}_s - \bar{Y}\})^2}{\sum_{i=1}^N (\{Y_i - \bar{Y}\})^2 / N}$$

Next, an estimation of segregation within schools of the parish is done along the same three dimen-

⁵ \bar{Y}_s corresponds to the percentage of minority students at school s. \bar{Y} refers to the percentage of minority students in Lisbon. ns is the number of students at school s. N represents the total number of students in all schools. Y_i refers to individual students outcomes.

sions:

$$D_{School-Parish} = \frac{1}{2} \sum_{i=1}^{S_{parish}} \left| \frac{SL_{school}}{SL_{parish}} - \frac{nonSL_{school}}{nonSL_{parish}} \right|$$

$$D_{School-Parish} = \frac{1}{2} \sum_{i=1}^{S_{parish}} \left| \frac{Im_{school}}{Im_{parish}} - \frac{nonIm_{school}}{nonIm_{parish}} \right|$$

$$D_{School-Parish} = \frac{1}{2} \sum_{i=1}^{S_{parish}} \left| \frac{PE_{school}}{PE_{parish}} - \frac{nonPE_{school}}{nonPE_{parish}} \right|$$

School segregation is measured for the 84 public primary schools distributed across the 24 Lisbon parishes. Moreover, given the lack of available data for private schools, we restricted the analysis to the public sector only.

The third and last step is the estimation of residential segregation using data from Census. In order to measure the residential segregation level, an estimation of the dissimilarity index is performed in three dimensions for the year of 2011: education (HE), unemployed status (UNEMP) and immigrant inhabitant status (Im'). The indicator higher education corresponds to the proportion of Lisbon inhabitants that have higher education. Unemployed status refers to Lisbon inhabitants who are unemployed. Finally, immigrant inhabitant status means that the citizenship of the inhabitant is not portuguese.

$$D_{Parish-Lx} = \frac{1}{2} \sum_{i=1}^{parish} \left| \frac{HE_{parish}}{HE_{Lx}} - \frac{nonHE_{parish}}{nonHE_{Lx}} \right|$$

$$D_{Parish-Lx} = \frac{1}{2} \sum_{i=1}^{parish} \left| \frac{UNEMP_{parish}}{UNEMP_{Lx}} - \frac{EMP_{parish}}{EMP_{Lx}} \right|$$

$$D_{Parish-Lx} = \frac{1}{2} \sum_{i=1}^{parish} \left| \frac{Im'_{parish}}{Im'_{Lx}} - \frac{nonIm'_{parish}}{nonIm'_{Lx}} \right|$$

In order to compare residential segregation with school segregation, I have estimated the Duncan index for the dimensions of parents' education and immigrant status for the year 2011, using data regarding students in public primary schools (MISI).

$$D_{Parish-Lx} = \frac{1}{2} \sum_{i=1}^{parish} \left| \frac{PE_{parish}}{PE_{Lx}} - \frac{nonPE_{parish}}{nonPE_{Lx}} \right|$$

$$D_{Parish-Lx} = \frac{1}{2} \sum_{i=1}^{parish} \left| \frac{Im_{parish}}{Im_{Lx}} - \frac{nonIm_{parish}}{nonIm_{Lx}} \right|$$

5.3 Descriptive Statistics

Table 3 (in appendix) displays descriptive statistics. The mean is relative to the period between 2006 and 2016.

The variable subsidized lunch refers to students receiving subsidized lunch at Lisbon public primary schools. We can see that the percentage of students receiving subsidized lunch strongly increased from 20% in 2007/2008 to 50% in 2015/2016. The indicator immigrant status corresponds to the proportion of immigrant students attending public primary schools. The percentage of immigrant students remains constant around 6% from 2007/2008 to 2011/2012 and increased to 7% from 2011/2012 to 2015/2016. Parents education indicates having at least one parent with a university degree. According to the results, only 25% of parents have higher education. The proportion of parents with higher education have been substantially increased over the years. Moreover, the percentage of pupils attending private schools in Lisbon was around 44% from 2007/2008 to 2015/2016, which is a quite high percentage. The number of Lisbon parishes decreased from 53 to 24 after a law change in 2012.

Figure 16 (in appendix) is a representation of the number of schools, inhabitants, and inhabitants between 0 to 14 years old by parish. Accordingly, Olivais, Lumiar, Marvila, and Benfica are the parishes with more inhabitants, while Santo António, Beato, and Santa Maria Maior have fewer inhabitants.

Relatively to the number of schools and inhabitants between 0 to 14 years old, São Vicente,

Santo António, Santa Maria Maior are the parishes with the higher percentage of children between 0-14 years old by the number of inhabitants, 50%, 44% and 32% respectively. Despite, these are not the parishes with the higher number of schools. There exist three public primary schools in São vicente, two in Santo António and only one in Santa Maria Maior. The parishes with only one public primary school are Campolide, Areeiro, and Santa Maria Maior.

6 Empirical Results

Measures of segregation between schools and segregation within schools of the parish have been estimated along three dimensions: subsidized lunch, immigrant status and parents' education. Measures of residential segregation have also been calculated for three dimensions: education, unemployed status and immigrant inhabitants status. This makes possible the comparison between segregation across schools with segregation across residential areas within the city.

6.1 Segregation Between Schools

Table 1 summarizes the patterns of segregation between public primary schools from school years 2006/2007 to 2015/2016 for the three dimensions mentioned above.

Table 1: Segregation between schools

	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16
Subsidized Lunch										
Duncan Index	0.563 (0.007)	0.640 (0.007)	0.428 (0.005)	0.391 (0.004)	0.380 (0.004)	0.443 (0.004)	0.423 (0.004)	0.395 (0.004)	0.410 (0.004)	0.392 (0.005)
R ²	0.329	0.579	0.338	0.250	0.250	0.287	0.290	0.241	0.292	0.290
Immigrant Status										
Duncan Index	0.381 (0.004)	0.383 (0.004)	0.373 (0.004)	0.409 (0.004)	0.437 (0.004)	0.418 (0.004)	0.401 (0.005)	0.382 (0.004)	0.423 (0.005)	0.405 (0.004)
R ²	0.055	0.051	0.063	0.072	0.076	0.069	0.052	0.049	0.073	0.072
Parents' Education										
Duncan Index	0.548 (0.007)	0.530 (0.007)	0.531 (0.007)	0.537 (0.007)	0.526 (0.006)	0.511 (0.006)	0.491 (0.006)	0.498 (0.006)	0.495 (0.006)	0.480 (0.006)
R ²	0.288	0.251	0.266	0.293	0.293	0.318	0.322	0.321	0.395	0.464

Note: values in brackets correspond to standard errors.

The first, second and third rows contain the estimated values of both the Duncan and R^2 index for the students receiving subsidized lunch, for immigrant students and for the students whose parents have higher education, respectively. The results presented in the table allow us to draw several conclusions:

In what concerns the Duncan Index estimates, the first row of the table displays the segregation indices between pupils receiving/not receiving subsidized lunch. Segregation rose from 56% in 2006/2007 to 64% in 2007/2008, when it reached its maximum. After this period, segregation declined to 38% until 2010/2011. Then, the value of segregation started slowly increasing again until 2011/2012. After 2012, segregation decreased and reached the value of 39% in 2015/2016, meaning that 39% of the subsidized lunch pupils in attending Lisbon public primary schools would have to be moved to another school to achieve a distribution that corresponds to a random allocation.

Segregation by immigrant status was around 38% between 2006 and 2008. Between 2007/2008 and 2008/2009 segregation slightly declined from 38% to 37%. In 2008/2009 segregation values started increasing and reached its maximum value of 44% in 2010/2011 and then dropped to 38% in 2013/2014. In 2014 segregation started to increase again until 2015. From school year 2014/2015 to 2016 segregation decreased to a level of 41%. According to the Duncan index, 41% of the immigrant students in the Lisbon public primary schools in 2015/2016 would have to be moved to another school to achieve a distribution that corresponds to a random allocation. The comparable number in 2006/2007 was 38%.

The third row reports the results on parents' education. Segregation across schools started decreasing from 55% in 2006/2007 to 53% in 2007/2008. Then, segregation values slightly increased from 53% to 54% until 2009/2010. Between 2009/2010 and 2012/2013 the value of segregation strongly decreased from 55% to 48%. It increased again between 2012 and 2014 and after this period, decreased until reach the value of 48% in 2015/2016.

Summarizing, we can see that the values of school segregation are above 39% for the subsidized lunch and parents' education dimensions. Relatively to the indicator immigrant status, the segregation values are lower compared to the other variables results. It is possible to note that

segregation between schools decreased between 2006/2007 to 2015/2016 for the dimensions of subsidized lunch and parents education but increased for the immigrant status dimension. Also, the estimates are precise with small standard errors so that the differences across years are statistically significant.

Regarding the R^2 index estimates, for the subsidized lunch variable, school segregation decreased from 33% in 2006/2007 to 29% in 2015/2016. Comparing segregation values for the immigrant status indicator, we can perceive that R^2 estimates are very close to zero and that segregation increased from 5% in 2006/2007 to 7% in 2015/2016. Concerning parents' education, segregation clearly increased from 29% in 2006/2007 to 46% in 2015/2016.

It is possible to see that segregation decreased between 2006/2007 and 2015/2016 both for the Duncan index and R^2 index for the subsidized lunch dimension. Moreover, we can perceive that both for the Duncan and R^2 index estimates segregation has increased over the years for the immigrant status dimension. On the contrary, in what concerns parents' education, Duncan index estimates show that segregation between schools decreased while the R^2 index estimates show that segregation increased. Despite, in 2015/2016 both the Duncan and R^2 index present similar values.

6.1.1 Segregation curve approach

The dissimilarity index can be obtained from the segregation curve and consists in the maximum vertical distance between this curve and the line of evenness. The segregation curve method to indices is well-established (Duncan and Duncan, 1955; Cortese et al., 1976; Massey and Denton, 1988) because the value of an index developed under the segregation curve method is easily interpretable, facilitating the analysis of whether one distribution of pupils is more uneven than another. Segregation curve approach indices are known as relative indices because the level of segregation is not measured in any absolute sense but is scaled relative to some other group.

It is possible to illustrate graphically the unevenness between two groups. Figure 1, 2 and 3 displays segregation curves created using data for a cohort of students attending Lisbon public primary schools in 2011/2012 for the dimension of subsidized lunch (SL), immigrant status (Im)

and parents' educations (PE) respectively. The segregation curve plots the cumulative proportion of minority group (subsidized lunch students, immigrant students, students whose parents have higher education) against the cumulative proportion of majority group (non-subsidized lunch students, Portuguese students, students whose parents does not have higher education) across areal units, which are ordered from smallest to largest minority proportion. The equality line (red line) represents total evenness. If the segregation curve (blue line) lies on the line of equality, the value of the index is zero and therefore there is no segregation; if the segregation curve traces the x-axis, it means that all minority pupils are concentrated in one school, and hence the value of the index is one and we are in the presence of total segregation. Figure 4. is the representation of the three segregation curves combined. It is possible to observe that parents' education is the indicator with higher segregation levels.

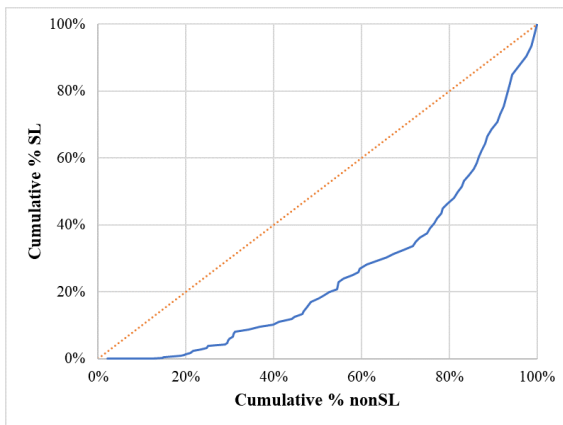


Figure 1: The SL segregation curve.

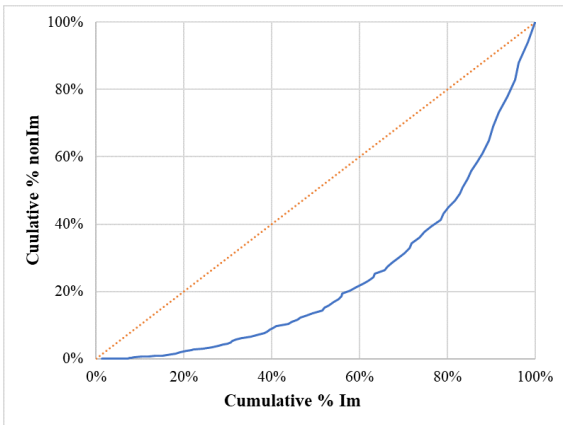


Figure 2: The Im segregation curve.

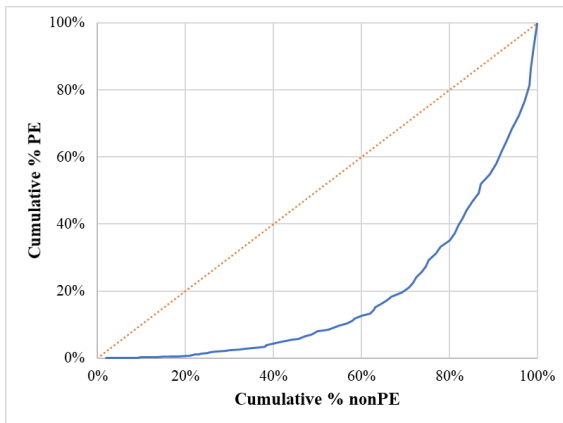


Figure 3: The PE segregation curve.

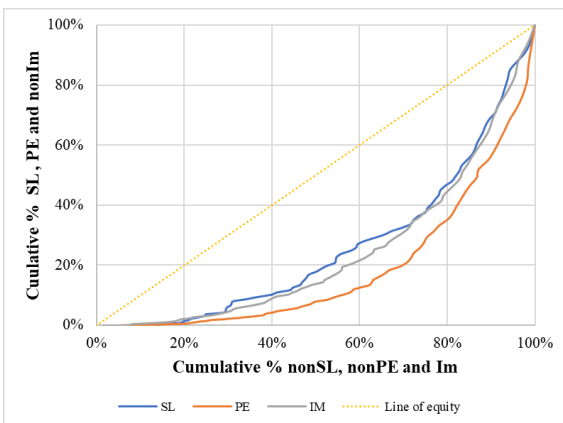


Figure 4: Comparison of curves

6.2 Segregation within schools of the parish

In this section are presented the results of segregation within schools of the parish for the region of Lisbon. Once again, for purposes of segregation estimation, we are always considering the 24 Lisbon parishes and all the public primary schools localized there, which represent a total of 84. Figures 5 to 13, illustrate the patterns of segregation within public primary schools of the parish for three school years 2007/2008, 2011/2012 and 2015/2016 along the three dimensions previously presented: subsidized lunch, immigrant status, and parents' education. Table 4 (in appendix) displays the segregation estimates that are illustrated in these maps and provides the legend of numbers.

6.2.1 Segregation by Subsidized Lunch

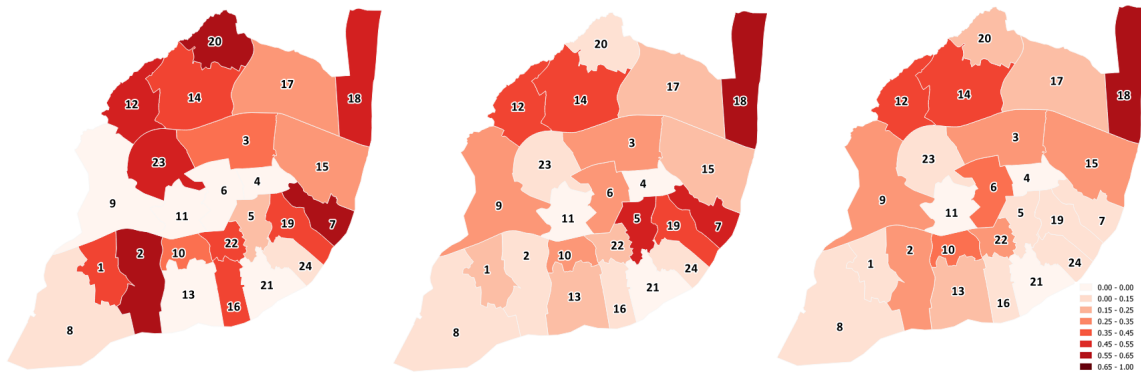


Figure 5: 2007/2008

Figure 6: 2011/2012

Figure 7: 2015/2016

On average, segregation decreased from 2007/2008 to 2011/2012 by -0.099 and from 2011/2012 to 2015/2016 by -0.045 . Segregation by subsidized lunch increased in 10 parishes and decreased in 14 parishes between 2007/2008 and 2011/2012, and increased in 14 parishes and decreased in 10 parishes between 2011/2012 and 2015/2016.

For the school year 2007/2008, the parishes with at least 55% of segregation are Parque das Nações (18), Carnide (12) and São Domingos de Benfica (23). The parishes with at least 65% of segregation are Beato (7), Alcântara (2) and Santa Clara (20). The parishes with lower segregation values, with exception of the ones that only have one school, were Avenidas Novas (6), Estrela (13), Benfica (9), Belém (8) and São Vicente (24).

Relatively to the school year 2011/2012, the parishes with at least 55% of segregation are Arroios (5) and Beato (7). The parish with at least 65% of segregation was Parque das Nações (18). The parishes with lower segregation values are São Domingos de Benfica (23), Belém (8), Alcântara (2), Misericórdia (16) and São Vicente (24).

Regarding the school year 2015/2016, the parish with at least 65% of segregation is Parque das Nações (18). With exception of Parque das Nações, all parishes have segregation levels below 0,55. The parishes with lower segregation values are Belém (8), Ajuda (1), São Domingos de Benfica (23), Arroios (5), São Vicente (24), Benfica (9) and Beato (7).

6.2.2 Segregation by Immigrant Status

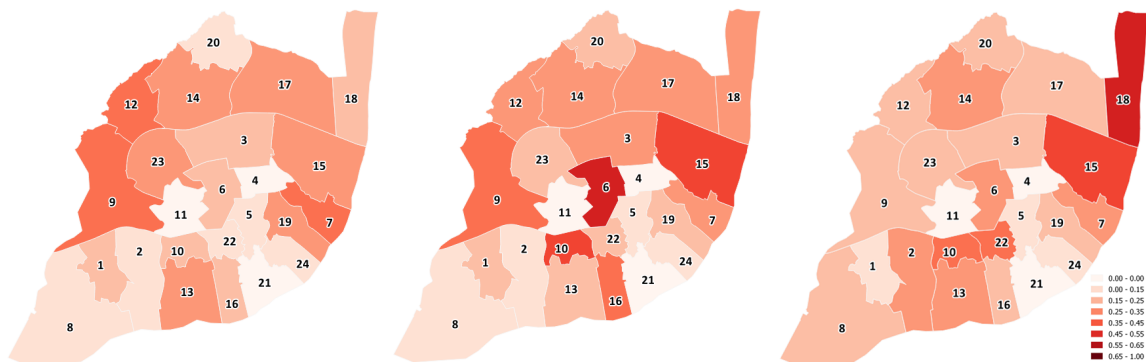


Figure 8: 2007/2008

Figure 9: 2011/2012

Figure 10: 2015/2016

On average, segregation increased from 2007/2008 to 2011/2012 by 0.037 and from 2011/2012 to 2015/2016 by 0.004. Segregation by immigrant status increased in 16 parishes and decreased in 8 parishes between 2007/2008 and 2011/2012, and increased in 14 parishes and decreased in 10 parishes between 2011/2012 and 2015/2016.

Regarding the school year 2007/2008, the parishes with higher levels of segregation are Benfica (9), Carnide (12) and Beato (7). The parishes with lower segregation values, with exception of the ones that only have one school, are Belém (8), Alcântara (2), Arroios (5), Santa Clara (20), Santo António (22) and São Vicente (24).

For the school year 2011/2012, the parishes with higher levels of segregation are Avenidas

Novas (6), Campo de Ourique (10) and Marvila (15). The parishes with lower segregation values are Belém (8), Alcântara (2), Arroios (5) and São Vicente (24).

With regard the school year 2015/2016, the parishes with higher levels of segregation are Parque das Nações (18) and Marvila (15). The parishes with lower segregation values are Ajuda (1), Arroios (5) and São Vicente (24).

6.2.3 Segregation by Parents' Education

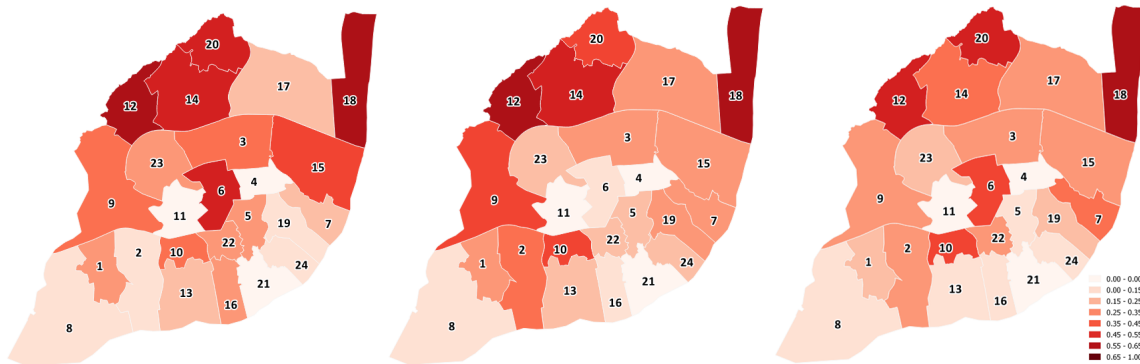


Figure 11: 2007/2008

Figure 12: 2011/2012

Figure 13: 2015/2016

On average, segregation decreased from 2007/2008 to 2011/2012 by -0.019 and from 2011/2012 to 2015/2016 by -0.011 . Segregation by parents' education increased in 12 parishes and decreased in 12 parishes between 2007/2008 and 2011/2012, and increased in 12 parishes and decreased in 12 parishes between 2011/2012 and 2015/2016.

Relatively to the school year 2007/2008, the parishes with at least 65% of segregation are Carnide (12) and Parque das Nações (18). The parishes with at least 55% of segregation are Lumiar (14), Santa Clara (20) and Avenidas Novas (6). The parishes with lower segregation values, with exception of the ones that only have one school are Alcântara (2), Belém (8), Penha de França (19) and São Vicente (24).

For the school year 2011/2012, the parishes with at least 65% of segregation are still Carnide (12) and Parque das Nações (18). The parishes with at least 55% of segregation is Lumiar (14). The parishes with lower Segregation values, with exception of the ones that only have one school

are Belém (8), Misericórdia (16) and Avenidas Novas (6).

Regarding the school year 2015/2016, only Parque das Nações (18) show segregation values above 65%. Carnide (12) and Santa Clara (20) still show segregation values above 0,55. The parishes with lower segregation values, with exception of the ones that only have one school are Belém (8), Misericórdia (16), Estrela (13), Arroios (5) and São Vicente (24).

6.3 Residential Segregation

Table 2. displays results of residential segregation, for the year 2011, along three dimensions: education (HE) unemployed status (UNEMP) and immigrant inhabitant status (Im'). Moreover, to compare residential segregation with school segregation levels, I have estimated the Duncan index for the dimensions of parents education and immigrant status for the same year. While residential segregation was calculated with data from the Census 2011, school segregation was estimated using data regarding students in public primary schools (MISI).

Table 2: Measures of schools and residential segregation

	Census Data 2011	Schools Data 2011
Education		
Duncan Index	0.212 (0.008)	0.349 (0.015)
Employment		
Duncan Index	0.092 (0.004)	N/A
Immigrant Status		
Duncan Index	0.191 (0.007)	0.360 (0.012)

According to Census data estimates, residential segregation by education is 0.212. For the indicator immigrant status, the segregation level is relatively lower: 19%. Also, results show that residential segregation is almost nonexistent for the unemployment dimension (0.092). Moreover, the estimates are precise with small standard errors.

For comparison purposes, I have also measured segregation with data regarding students in public primary schools. The value 0.349 corresponds to the segregation level by parents' education

and the estimate 0.360 refers to immigrant students.

Comparing education indicators, it is possible to notice that, school segregation estimates are higher than residential segregation measures $0.349 > 0.212$. I have also compared the segregation levels of immigrant status in schools and in the city and the results show that segregation between schools by immigrant status is higher than residential segregation by immigrant status in 2011: $0.360 > 0.191$, meaning that residential segregation levels are lower than school segregation ones for both dimensions.

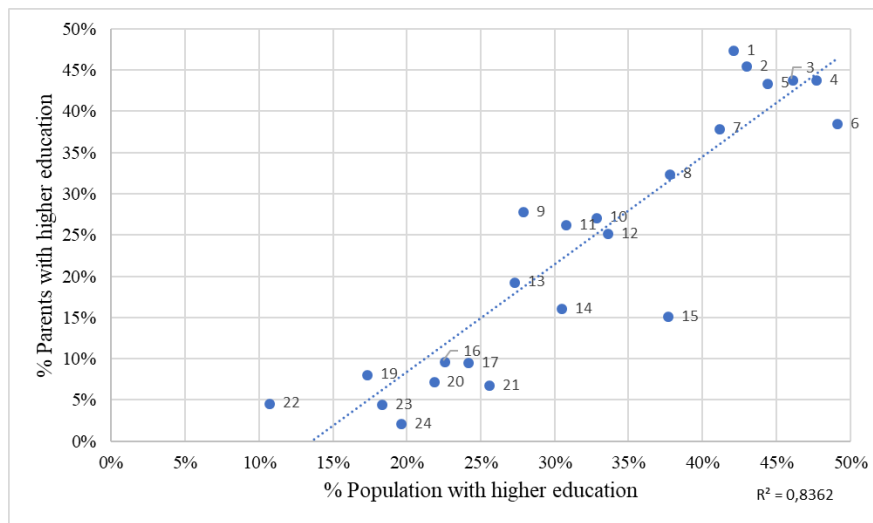


Figure 14: Relationship between parents and inhabitants with higher education.

Figure 14 illustrates the comparison between the percentage of parents with higher education with the percentage of inhabitants with higher education in each parish. There is a positive relationship between these two indicators. The R squared is 0.84 which shows that exists a strong correlation between the two indicators. The parishes with more percentage of parents who have higher education are Alvalade (48%), Areeiro (46%), São Domingos de Benfica (44%), Avenidas Novas (44%), Belém (44%). The parishes with more percentage of inhabitants with higher education are Lumiar (49%), Avenidas Novas (48%) and São Domingos de Benfica (44%).

In Avenidas Novas (6) and Marvila (15), the percentage of the population with higher education is much higher than the percentage of parents with higher education. This may be happening because the population living in these parishes are young without children, or because they have

children and they attend private schools or simply because their children attend schools localized in other parishes.

Figure 15 compares the percentage of immigrant students with the percentage of immigrant inhabitants in each parish. There is also a positive relationship between these two indicators. The value of the R squared is quite high 0.77. The percentage of immigrant students is higher in the following parishes: Santa Maria Maior (21), Misericórdia (16), Campolide (11) and Arroios (5). In these parishes there exist 24%, 21%, 17% and 17% of immigrant students respectively. The parishes with the lower percentage of immigrant students are Olivais (17), Marvila (15) and Carnide (12). In Santa Maria Maior (21) and Misericórdia (16), the percentage of immigrant students is much higher than the percentage of immigrant inhabitants in that parish.

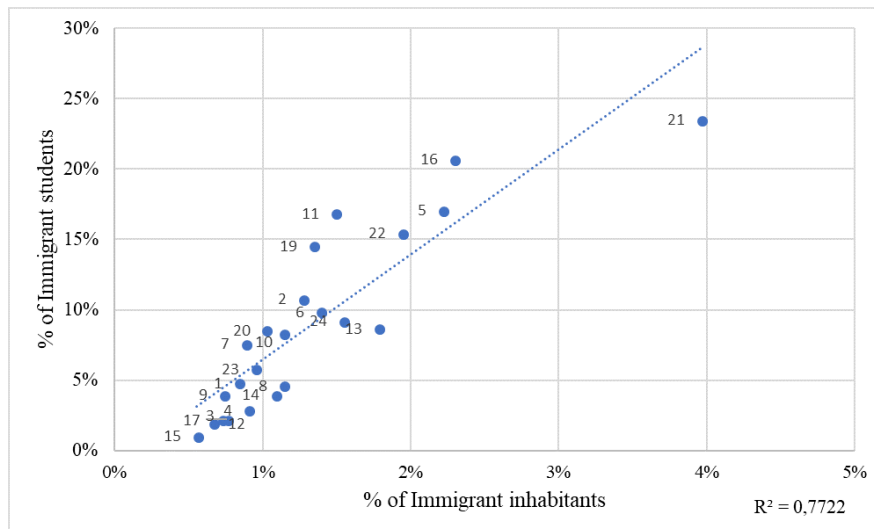


Figure 15: Relationship between immigrant students and inhabitants.

7 Discussion and Conclusions

The subject of school and residential segregation has been a target of intense debate and concern during the last decades. This attention is due to the fact that school segregation is an important feature of the educational system because it affects the quality of schooling and the equity in the distribution of educational opportunities and outcomes.

The main contribution of this paper was identifying public primary school and residential pat-

terns of segregation for the city of Lisbon. The main findings were: we can conclude that segregation between schools by subsidized lunch decreased between 2006/2007 from 56% to 39% in 2015/2016, and segregation by parents education decreased from 54% to 48% during the same period. On the contrary, segregation by immigrant status increased between 2006/2007 from 38% to 40% in 2015/2016. Segregation within schools of the parish by subsidized lunch and parents education decreased from 2007/2008 to 2015/2016, while by immigrant status, the disparity increased. Regarding residential segregation, we can perceive that there is segregation in 2011, but the levels of the estimates are lower compared to the patterns of school segregation.

There may be several factors contributing to the observed patterns of school and residential segregation. School segregation may be a consequence of structural and cultural features of a society and can result from the way the educational system is organized.

There is a large number of private schools in Lisbon, which increases the school choice options. The possibility of students choosing the private school sector might lead to an increase in school segregation. It is important to have in consideration that in this research is only measured segregation between public schools. Segregation values would eventually be much higher if we took into account private institutions.

Besides, usually students are subject to the residence-based admission criteria. However, there is room for students to self-select into better schools that are not those of their residence.

The study faced some data limitations that kept me from drawing definitive causal inferences. First, it prevented me from estimating residential segregation over time, since there was only census data for the year of 2011. It hinders finding relevant differences in residential segregation patterns over the last years for the city of Lisbon. Moreover, there are fewer indicators in the census that allow for comparisons with the selected indicators to characterize schools.

These estimates might be valuable since they allow identifying high levels of segregation in the geographical area of Lisbon. Facing these results, governments and schools systems could consider some possible policy implications, and implement measures to appease this phenomenon. Actually, there is currently a change in the Portuguese law to reduce stratification.

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8 Appendix

Table 3: Descriptive Statistics, means and standard deviations

	Mean	2007/2008	2011/2012	2015/2016
Subsidized lunch	0.437	0.198	0.422	0.501
Immigrant status	0.065	0.064	0.065	0.071
Parents education	0.248	0.194	0.261	0.319
Female	0.476	0.467	0.480	0.471
Percentage of pupils in public schools	N/A	57	56	56
Percentage of pupils in private schools	N/A	43	44	44
Number of parishes	N/A	53	53	24
Number of public primary schools	N/A	84	84	84
Observations / Number of students	N/A	12.660	12.127	12.230

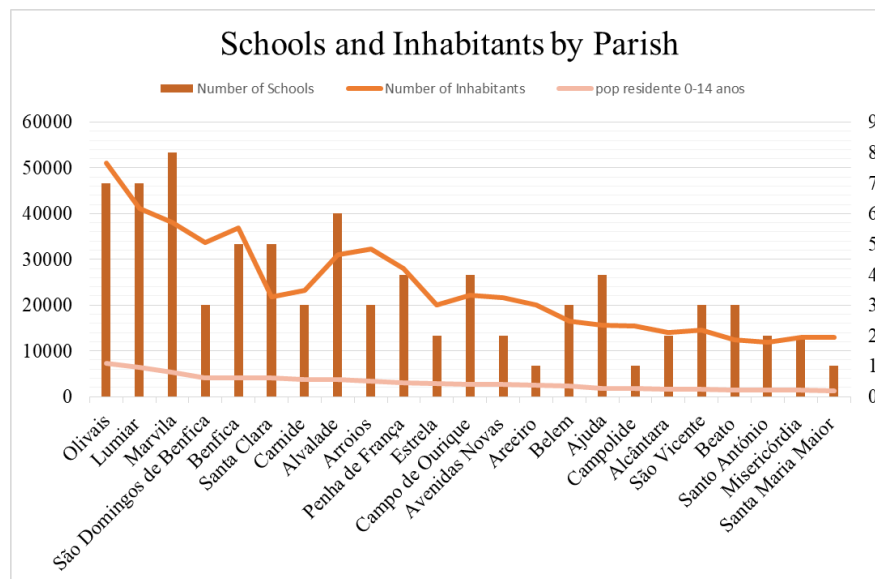


Figure 16: Graphical illustration of the number of schools and inhabitants by parish.

Table 4: Segregation within schools of the parish

	Ajuda (1)	Alcântara (2)	Alvalade (3)	Areiro (4)	Arroios (5)	Avenidas Novas (6)	Beato (7)	Belem (8)	Benfica (9)	C. Ourique (10)	Campolide (11)	Carnide (12)	Estrela (13)
Parents Education													
Duncan													
2007/2008	0.290	0.131	0.376	0	0.280	0.576	0.153	0.061	0.436	0.375	0	0.716	0.193
2011/2012	0.287	0.369	0.331	0	0.156	0.069	0.333	0.078	0.492	0.503	0	0.692	0.209
2015/2016	0.205	0.258	0.337	0	0.119	0.532	0.379	0.110	0.288	0.502	0	0.632	0.114
Diff between 07/08 and 11/12	-0.004	0.239	0.045	0	-0.124	-0.506	0.180	0.017	0.056	0.128	0	-0.024	0.016
Diff between 11/12 and 15/16	-0.081	-0.111	0.007	0	-0.037	0.463	0.046	0.032	-0.204	-0.001	0	-0.060	-0.095
Subsidized Lunch													
Duncan													
2007/2008	0.526	0.781	0.401	0	0.222	0	0.736	0.103	0	0.441	0	0.615	0
2011/2012	0.190	0.145	0.300	0	0.558	0.277	0.646	0.039	0.288	0.320	0	0.454	0.222
2015/2016	0.069	0.282	0.309	0	0.089	0.444	0.058	0.072	0.298	0.378	0	0.527	0.164
Diff between 07/08 and 11/12	-0.337	-0.636	-0.101	0	0.336	0.277	-0.089	-0.064	0.288	-0.121	0	-0.161	0.222
Diff between 11/12 and 15/16	-0.121	0.137	0.009	0	-0.469	0.167	-0.588	0.033	0.010	0.059	0	0.073	-0.058
Immigrant Status													
Duncan													
2007/2008	0.156	0.037	0.235	0	0.081	0.232	0.390	0.101	0.440	0.216	0	0.370	0.252
2011/2012	0.215	0.111	0.258	0	0.037	0.570	0.334	0.090	0.352	0.451	0	0.319	0.245
2015/2016	0.061	0.274	0.208	0	0.108	0.264	0.286	0.190	0.237	0.414	0	0.249	0.310
Diff between 07/08 and 11/12	0.060	0.074	0.023	0	-0.044	0.339	-0.055	-0.011	-0.088	0.234	0	-0.050	-0.007
Diff between 11/12 and 15/16	-0.155	0.163	-0.050	0	0.070	-0.307	-0.048	0.100	-0.115	-0.036	0	-0.071	0.065

	Lumiar (14)	Marvila (15)	Misericórdia (16)	Olivais (17)	P. Nações (18)	P. França (19)	St. Clara (20)	St. Maria Maior (21)	St. António (22)	S. D. Benfica (23)	S. Vicente (24)	Mean (all parishes)
Parents Education												
Duncan												
2007/2008	0.616	0.517	0.263	0.248	0.696	0.083	0.628	0	0.254	0.300	0.147	0.306
2011/2012	0.582	0.329	0.063	0.267	0.692	0.271	0.478	0	0.227	0.218	0.238	0.287
2015/2016	0.447	0.347	0.068	0.262	0.702	0.151	0.592	0	0.316	0.167	0.098	0.276
Diff between 07/08 and 11/12	-0.034	-0.188	-0.200	0.019	-0.004	0.188	-0.150	0	-0.02	-0.082	0.091	-0.019
Diff between 11/12 and 15/16	-0.135	0.018	0.005	-0.005	0.010	-0.120	0.114	0	0.089	-0.051	-0.140	-0.011
Subsidized Lunch												
Duncan												
2007/2008	0.497	0.347	0.511	0.339	0.579	0.529	0.770	0	0.542	0.610	0.134	0.362
2011/2012	0.533	0.246	0.077	0.248	0.792	0.532	0.056	0	0.226	0.129	0.030	0.263
2015/2016	0.504	0.259	0.014	0.232	0.745	0.078	0.203	0	0.309	0.102	0.095	0.218
Diff between 07/08 and 11/12	0.036	-0.101	-0.434	-0.091	0.213	0.002	-0.714	0	-0.316	-0.481	-0.104	-0.099
Diff between 11/12 and 15/16	-0.029	0.013	-0.063	-0.016	-0.047	-0.454	0.147	0	0.083	-0.027	0.065	-0.045
Immigrant Status												
Duncan												
2007/2008	0.275	0.265	0.211	0.315	0.201	0.278	0.129	0	0.075	0.343	0.018	0.193
2011/2012	0.314	0.466	0.357	0.327	0.283	0.167	0.228	0	0.150	0.176	0.059	0.230
2015/2016	0.326	0.501	0.165	0.189	0.643	0.151	0.242	0	0.413	0.241	0.126	0.233
Diff between 07/08 and 11/12	0.039	0.202	0.146	0.012	0.081	-0.112	0.099	0	0.075	-0.167	0.041	0.037
Diff between 11/12 and 15/16	0.012	0.035	-0.193	-0.138	0.360	-0.016	0.014	0	0.263	0.066	0.067	0.004

Table 5: Description of Indicators

Indicators	Definition
SL_{school}	number of pupils receiving subsidized lunch at school i
$nonSL_{school}$	number of pupils not receiving subsidized lunch at school i .
SL_{lx}	number of pupils receiving subsidized lunch in Lisbon.
$nonSL_{Lx}$	number of pupils not receiving subsidized lunch in Lisbon.
SL_{parish}	number of pupils receiving subsidized lunch in schools of the parish i .
$nonSL_{parish}$	number of pupils not receiving subsidized lunch in schools of the parish i .
Im_{school}	number of immigrant students at school i .
$nonIm_{school}$	number of portuguese students at school i .
Im_{lx}	number of immigrant students in Lisbon.
$nonIm_{lx}$	number of portuguese students in Lisbon.
Im_{parish}	number of immigrant students in schools of the parish i .
$nonIm_{parish}$	number of portuguese students in schools of the parish i .
PE_{school} :	number of students at school i whose parents have higher education.
$nonPE_{school}$	number of students at school i whose parents does not have higher education.
PE_{lx}	number of students in Lisbon whose parents have higher education.
$nonPE_{Lx}$	number of students in Lisbon whose parents does not have higher education.
PE_{parish} :	number of students in schools of parish i whose parents have higher education.
$nonPE_{parish}$	number of students in schools of parish i whose parents does not have higher education.
HE_{parish}	number of inhabitants with higher education in parish i .
$nonHE_{parish}$	number of inhabitants without higher education in parish i .
HE_{Lx}	number of inhabitants with higher education in Lisbon.
$nonHE_{Lx}$	number of inhabitants without higher education in Lisbon
$UNEMP_{parish}$	number of unemployed inhabitants at parish i .
$UNEMP_{Lx}$	number of unemployed inhabitants at Lisbon.
EMP_{parish}	number of employed inhabitants in parish i .
EMP_{Lx}	number of employed inhabitants at Lisbon.
Im'_{parish}	number of immigrant inhabitants in parish i .
Im'_{Lx}	number of immigrant inhabitants at Lisbon.
$nonIm'_{parish}$	number of portuguese inhabitants in parish i .
$nonIm'_{Lx}$	number of portuguese inhabitants at Lisbon.