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Within-school segregation in the Chilean school system: What factors explain it? How efficient is this practice for fostering student achievement and equity?☆

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ABSTRACT

This paper analyzes the segregation within schools in Chile, looking at the related institutional factors and the effect that this process has on students' academic performance. To analyze the relationship between institutional factors and within-school segregation, it uses a logistic regression, controlling for a set of school characteristics. This analysis finds that within-school segregation is related to institutional factors such as school size and the characteristics of their students. To determine the effects of within-school segregation on academic performance, a multilevel regression model is used, organized in three levels: school, classroom and student. The results show that within-school segregation has negative consequences on educational quality, efficiency and equity, since internal segregation reduces the average educational outcomes of the schools and mostly affects students of middle groups within the school in both academic achievement and socioeconomic terms.

1. Introduction

School segregation is one of the most relevant topics in countries with high levels of inequality in education and low levels of social mobility, such as Chile (Nuñez & Espinoza, 2014; Nuñez & Miranda, 2011; OECD, 2010). International evidence has shown the negative effects of school segregation on quality and equity (Gorard & Fitz, 2000; Harker, 2004), the distribution of learning resources (Borman & Dowling, 2010), and future job possibilities (Orfield, Kucsera, & Siegel-hawley, 2012).

During the last decade, Chile developed an active research agenda for understanding academic and socioeconomic segregation between schools (Bellei, 2013; Hernando, Niklitschek, & Brieba, 2014; Valenzuela, Bellei, & de los Ríos, 2014). These studies show the high magnitudes of segregation in both absolute and relative terms (Valenzuela, Bellei, & De los Ríos, 2008), that limit the capacity of the school system for providing equal opportunities. Findings also show that segregation impacts social cohesion and the possibility that students socialize with individuals of diverse social origins (Villalobos & Valenzuela, 2012; Wormald, Flores, Sabatini, Trebilcock, & Rasse, 2012).

Despite the progress on understanding between-school segregation, the grouping of students in different classrooms within the school has received little attention. Internationally, this has been a recurring theme since the creation of modern school systems (Betts, 2011; Dupriez, 2010; Ireson & Hallam, 2001). Segregation is a multilevel phenomenon that occurs between schools, between classrooms in the same school and between groups of students within the same classroom, with clear relationships across these different levels (Dupriez, 2010; Ireson & Hallam, 2001; Slavin, 1990).

This paper aims at studying the educational segregation within schools—among classrooms—in Chilean high schools, looking into both the school factors that are related to within-school segregation and the relationship that within-segregation has with students' academic performance. The extreme levels of inequality in the country; the context of high socioeconomic and academic segregation in schools; and, the market oriented Chilean school system for >30 years, make this study particularly interesting. The paper aims at understanding how schools manage student academic diversity before students make any track decision within the school, during the first two grades of secondary education.

The text is organized in four sections. First, we present the key literature for understanding within-school segregation. The second section

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describes the methodology and data. The third section shows the results, which respond to the following questions: What are the factors that explain the probability that schools segregate students by ability in different classrooms? Is there any relationship between academic performance and within-school segregation? If so, what is the distribution of academic performance for students of different ability (and SES) in schools that group by ability? Finally, the fourth section presents conclusions and the main topics for future research in Chile.

2. Background and framework

2.1. Characteristics of the Chilean school system

The Chilean educational system can be considered a unique case in the world, because of its market orientation and the rationality of competition (Bellei, Cabalin, & Orellana, 2014). The market orientation of the system is characterized by four features: i) a mixed provision system with strong participation of private subsidized schools; ii) the consolidation of a funding system based on per-pupil vouchers paid on the basis of average attendance; iii) the institutionalization of for-profit private-subsidized schools and the possibility that private-subsidized schools charge tuition fees to students; and, iv) the creation and development of strong accountability incentives and penalties for schools and teachers.

These features have led to a development of the school system with three key characteristics. First, the school system is increasingly based on private providers funded by the state, with the consequent loss of enrollment of public education (Bellei, González, & Valenzuela, 2010). Thus, while in 1981 private schools enrolled about 15% of the students; in 2010 this number exceeded 40%, with a consequent decline in public enrollment of >30% during that period. The privatization process has been based on the creation of thousands of new private schools, most of them non-religious and for-profit (Elacqua, 2012), and this situation has made of Chile one of the countries with the highest levels of private participation in the school system in the OECD (OECD, 2010).

Second, during the last decade, the number of schools in the system (public and private-subsidized) has been stable, while the number of students has declined due to a slower population growth. This caused a decrease in the average enrollment of schools and produced a decrease in the number of schools that have two or more classrooms (see Fig. 1). This is important for this study, because in order to study within-school segregation among classrooms, it is necessary that schools have, at least, two classrooms in each grade. The data shows that <30% of primary schools have two or more classrooms offering first grade, while nearly 65% of the secondary schools (secondary education goes from 9th to 12th grade) have two or more classrooms of the same grade. Therefore, this suggests that, by the composition of the system, it is more likely that within-school segregation takes place in secondary schools.

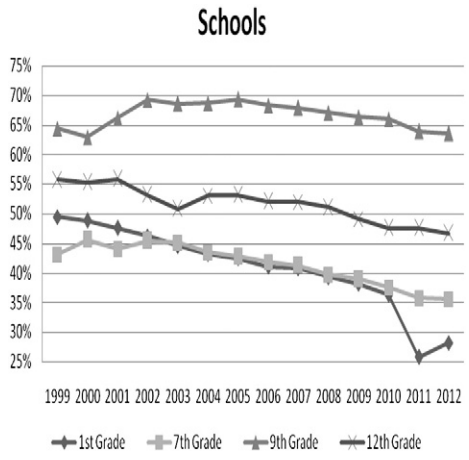

Fig. 1. Percentage of schools with two or more classrooms per grade.

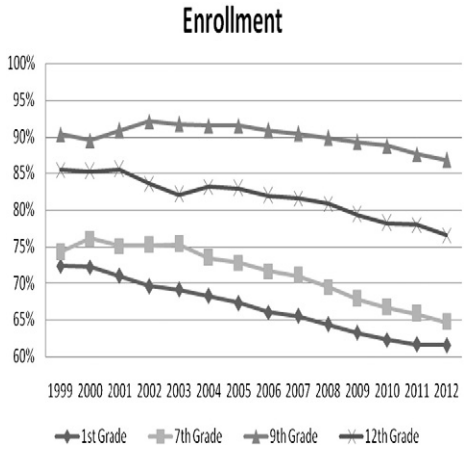

Fig. 2. Percentage of enrollment in schools with two or more classrooms per grade.

It is important to notice that secondary schools with two or more classrooms offering the same grade serve the vast majority of the students in 9th grade nationwide. Fig. 2 shows that these schools serve >85% of the national enrollment in 9th grade. This means that analyzing within-segregation in secondary education involves the study of a large proportion of secondary education students in Chile.

Third, there has been a process of socioeconomic segregation between schools. The school system is divided into closed segments, produced by the combination of selection processes in the school, the choice of parents, the charging of tuition fees and residential segregation. In general, public schools tend to concentrate the most socially disadvantaged students, the middle-low and middle class attend private-subsidized schools and the high class goes to private schools (García-Huidobro, 2007).

2.2. The debate about the segregation within schools

Research has found that segregation within schools is a "second generation" phenomenon, since it appears as a direct consequence of the unequal distribution of students between institutions (Meier, Stewart, & England, 1990; Mickelson, 2002). The logic for grouping students of similar ability in the same classroom is based upon two assumptions. The first states that by grouping together students of similar ability, teachers can adapt instruction to students' skills and implement more effective practices (Betts, 2011; Duflo, Dupas, & Kremer, 2011; Dupriez, 2010). The second assumption is that these skills are innate, genetically inherited and immutable, and that it is possible to determine precisely and unambiguously the intelligence of the students and, even more, the educational performance and opportunities for adult life (Ireson & Hallam, 2001).

Beyond the conceptual debate, educational research has found evidence both in favor and against the use of within-school segregation. Evaluations using experimental designs have found positive effects of segregation by ability (Robinson, 2008), whereas observational, quasi-experimental and case studies have found negative effects (Clark-Ibáñez, 2005; Dupriez, 2010; Venkatakrishnan & Wiliam, 2003). Moreover, the literature review on this issue by Dupriez (2010) shows that in two important meta-analyses the effects are zero in elementary and in secondary education (Crahay, 2000; Slavin, 1987, 1990).

The evidence maintains open the question about the effects of grouping by ability on learning. It appears that the effects in the context of the normal functioning of schools (without an experimental intervention with specific measures for teachers to meet the learning needs of students with major difficulties) ability grouping produces negative consequences among students with lower ability, and this loss is not necessarily offset by the gains of the most advanced students

(Braddock & Slavin, 1995; Dupriez, 2010; Hoffer, 1992; Ireson & Hallam, 2001; Oakes, 1985; Resh & Dar, 2012; Slavin, 1990; Venkatakrishnan & Wiliam, 2003).

The negative effects of grouping by student ability seem to happen because the assumption that teachers adapt instruction to meet students' needs does not hold in reality. On the contrary, evidence suggests that teachers reduce their expectations when they are assigned lower ability classes (Boaler, Wiliam, & Brown, 2000). Furthermore, teachers of the lower ability students implement less challenging instructional strategies, and their pace of instruction is slower, with emphasis on repetition and memorization, promoting basic skills of low complexity (Clotfelter, Ladd, & Vigdor, 2005, 2006; Toledo & Valenzuela, 2015). Therefore, separation by ability does not improve the skills of lower ability students in a way that equalizes them with their more advanced peers. In fact, ability grouping often contributes to increasing the gap between students (Gamoran, Nystrand, Berends, & Lepore, 1995), an effect that has been confirmed by studies on school desegregation in the United States since the nineties (Burris & Garrity, 2008; Pool & Page, 1995; Rui, 2009; Wheelock, 1992, 1994; Zimmer & Toma, 2000). Also, segregation produces significant adverse effects on the emotional development of students, especially those who are assigned to lower ability groups. Being the school the main place for children's socialization outside the family, the students' self-esteem is affected significantly when classified as laggards (Braddock & Slavin, 1995); this applies both to general and academic self-esteem (Ireson & Hallam, 2001; Oakes, 1985). Also, there is a gap between the students' self-perception of ability and the level of the group to which the student is assigned, which affects self-esteem and raises questions about the grouping method (MacIntyre & Ireson, 2002). Finally, due to ability grouping, the students reduce their educational expectations and, from an early age, blame themselves for lagging behind rather than putting the responsibility on the school (Braddock & Slavin, 1995; Oakes, 1985); this also affects their behavior and future expectations (Walsemann & Bell, 2010).

Given this evidence it is necessary to ask, why do schools segregate? Within-school segregation is a mechanism to manage the heterogeneity of students, and it is widely used when schools have a massive demand and have multiple classrooms for each grade (Cruikshank, 1995; Ireson & Hallam, 2001; Oakes, 1985). Schools are more likely to segregate based on social, racial or skills characteristics of the students when they have both a large student population and a wide racial, social and academic performance diversity among their student bodies (VanderHart, 2006).

3. Data and method

The analyses are based on four sources of information. First, we use the national standardized test of Chile (SIMCE) database on reading and mathematics for the period 1999–2012, for students of 4th, 8th and 10th grades. These tests are applied to the whole population of students. Second, we use the surveys completed by the parents of students participating in SIMCE tests, which have nearly 90% of coverage and provide information about socioeconomic variables. Third, we use the registry of schools, provided by the Ministry of Education, which includes variables that individually characterize both the schools and their students. Finally, information from the General System Student Information (SIGE in Spanish) is used, which contains data from the academic performance (grade point average, GPA) of each student.

The data sources were useful in determining both the socioeconomic status of the students and their academic ability. Using principal component analysis we estimated the socioeconomic status (SES) of the students, considering three variables: mother's years of education, father's years of education and household per capita income. This methodology is frequently used in the research national studies (Contreras, Sepúlveda, & Bustos, 2010; Mizala & Torche, 2012; Valenzuela et al., 2014). The academic ability of the students was defined in relation to two different variables. First, we use the SIMCE scores as a proxy for academic ability. This variable has been already used in different studies proving to be important for understanding the processes of segregation of the school system (Mizala & Torche, 2012; Valenzuela et al., 2014).[1] It is important to mention that the evaluation system in Chile publishes individual test scores only for research purposes, and without any variable that may lead to the identification of individual students. This means that the school staff does not know the test scores of the individual students. A second way of defining academic ability is through the GPA of each student. Although the GPA may not be necessarily comparable between schools, it is a piece of information known by school staff, and they can use it as a proxy of ability when deciding how to distribute students among classrooms in the school. For this same reason, the GPA is an important variable for analyzing within-school segregation.

The paper presents different analyses. First, a logistic regression studies the factors associated to the probability that schools segregate their students into different classrooms according to their academic ability. Second, a series of multilevel models analyze the relationship between within-school segregation and test scores in two ways. First, it estimates the average school gain associated to within-school academic segregation. Second, it estimates the distribution of such gain at student level, through an interaction between a variable that identifies if the school segregate and a set of variables that define the quartile of academic achievement and SES of the students within the same school.

To analyze the relationship between school factors and within-school segregation, we use a logistic regression, as suggested by VanderHart (2006). The analysis model can be summarized as follows:

$$P(Y_j = 1|Z_j = z_j) = \exp(\gamma_0 + \gamma_1 Z_j)/1 - \exp.(\gamma_0 + \gamma_1 Z_j) \quad (1)$$

where Y_j represents the existence of within-school segregation in school j. Within-school segregation is defined as a dichotomous variable that takes the value 1 when the school segregate students among classrooms according to academic ability (Clotfelter et al., 2006; Clotfelter, Ladd, & Vigdor, 2008).[2] The determination of within-school segregation was made by comparing independently the past SIMCE scores and the Grade Point Averages of the students in 9th grade in different classrooms, using the Kruskal-Wallis test (Siegel & Castellán, 1998) with a p-value of 0.01.[3] When the difference of any of these two variables between classrooms of the same school is statistically significant, the indicator of within-school segregation takes the value 1, which means that it is internally segregated. As independent variables in Z_j, we control for school variables such as enrollment, SES and academic diversity of the students, vulnerability and academic results. Other distinguishing characteristics of the schools in the Chilean school system are also included, such as the type of school (public or private subsidized), type of school (Scientific-Humanistic or Technical-Vocational), geographical location, religious orientation, and the amount of tuition fees they charge. Descriptive statistics are presented in Table 1.[4]

[1] The use of standardized tests has received criticisms, mainly in relation to its use to impose incentives and sanctions on schools (Elacqua et al., 2013; Mintrop & Sunderman, 2009; Sahlberg, 2008). The current analyses required a comparable measure of achievement across schools, and the SIMCE meets that requirement, and there is not a substitute indicator in our system that can meet such criterion. It is necessary to acknowledge that SIMCE share the limitations of standardized tests (for more details see (Au, 2007)).

[2] Unlike other measures of within-school segregation (Collins & Gan, 2013; Conger, 2005; Walsemann & Bell, 2010), we decided to use a dichotomous measure of segregation as a way of trying to model the school's decision to use (or not) this mechanism to manage students' heterogeneity.

[3] We tested three levels of p-value: i) 0.1; ii) 0.05; iii) 0.01. The differences of these measures are around 10% of the identification of the schools. Following Neyman-Pearson paradigm (Gigerenzer, 2004), we use the smallest p-value, as a way to reduce type I error and to concentrate in schools with different levels of internal segregation.

[4] In Table 1 we compare the sample of high schools which start at 9th grade with those high schools which also offer elementary education. Both school groups are statistically different in many aspects. In spite of these differences, the use of the sample of schools that start in 9th grade provides an appropriate identification strategy for measuring both within-segregation and its relationship with student achievement.

Table 1
Descriptive statistics. Schools that begin in the 9th grade and have two or more classes by grade, and other schools with two or more classes by grade (2010).

	School that begin in the 9th grade and have two or more classrooms per grade			Schools that do not begin in 9th grade and have two or more classrooms per grade			
Variable	Obs.	Mean	SD	Obs.	Mean	SD	Difference
Within-school segregation (dicot.)	633	0.50	0.50				
No of students in 9th grade	633	183	109	1883	141	104	41.55***
SD SIMCE test 2009	633	41.00	4.35	1088	28.39	4.28	12.61***
SD SES Index 2009	633	0.65	0.10	1088	0.54	0.18	0.11***
Grade Point Average 2009 (8th grade)	633	5.13	0.51	1883	4.96	0.59	0.16***
Vulnerability Index 2010 (percentage)	629	0.75	0.11	1846	0.66	0.14	0.09***
Public School (dicot.)	633	0.58		1883	0.33		0.39***
Private- subsidized for profit school (dicot.)	633	0.15		1883	0.31		−0.15***
Private- subsidized non-profit school (dicot.)	633	0.16		1883	0.22		−0.05**
Private school (dicot.)	633	0.00		1799	0.11		−0.11***
Delegate Administration (dicot.)	633	0.11		1883	0.04		0.06***
Rural Schools (dicot)	633	0.09		1883	0.05		−0.04***
Humanistic track (dicot.)	633	0.19		1883	0.75		−0.56***
Vocational Training track (dicot.)	633	0.39		1883	0.20		−0.19***
Humanistic and Vocational Training track (dicot.)	633	0.42		1883	0.05		0.37***
School in Metropolitan Area (dicot.)	633	0.25		1883	0.38		−0.13***
Religious (dicot.)	633	0.25		1865	0.59		−0.15***
Amount of funding shared ($ Chilean per month)	181	14,900	14,130	877	23,814	18,505	−8914***

Note: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.
Source: Elaborated based on SIMCE, SIGE and MINEDUC data.

Multilevel models are used for examining the relationship between within-school segregation and student achievement and equity in learning, similar to those generated in recent studies (Chmielewski, 2014; Mizala & Torche, 2012; Taut & Escobar, 2012). The analysis of the efficiency of within-school segregation is based on a three level hierarchical linear model, which general form is presented in Eq. (2) below:

$$Y_{ijk} = \beta_{0ijk} + \beta_1 X_{1jk} + \ldots + \beta_n X_{njk} + e_{ijk} \quad (2)$$

$$\beta_{0jk} = \gamma_{00k} + \gamma_{01k} C_{1jk} + \ldots + \gamma_{0nk} C_{njk} + u_{0jk}$$

$$\gamma_{00k} = \pi_{000} + \pi_{001} WS_{1k} + \ldots + \pi_{00n} R_{nk} + r_{00k}$$

where Y_{ijk} is the outcome variable representing the individual student SIMCE score in 10th grade, X_{ijk} represents a set of control variables for students, such as the score of SIMCE in 4th grade, the final GPA in 4th grade, the gender and the socioeconomic and cultural (SES) index, all these variables at the student level. Also, at the classroom level, the model includes a set of covariates (C_{njk}) on the intercept (β_{0jk}) of the level one, such as the classroom average SIMCE score of 2002, the proportion of students that have repeated grade until 4th grade of primary education in the classroom, the GPA of the classroom using data from 2002, and the SES index of the classroom. Finally, the school level of the model includes the variable that indicates if the school segregate students among classrooms (WS_{1k}) and a set of covariates (R_{nk}) such as the SES index, if the school is public or private-subsidized, and the school average SIMCE score based on the results of students in 2002.

The model specification used to measure the distribution of the efficiency related to within-segregation is the following:

$$Y_{ijk} = \beta_{0ijk} + \beta_1 Q1SIMCE{*}WS_{1jk} + \beta_2 Q2SIMCE{*}WS_{2jk} + \beta_3 Q2SIMCE{*}WS_{3jk} + \beta_4 Q4SIMCE{*}WS_{4jk} + \ldots + \beta_n X_{njk} + e_{ijk} \quad (3)$$

$$\beta_{0jk} = \gamma_{00k} + \gamma_{01k} C_{1jk} + \ldots + \gamma_{0nk} C_{njk} + u_{0jk}$$

$$\gamma_{00k} = \pi_{000} + \pi_{001} R_{1k} + \ldots + \pi_{00n} R_{nk} + r_{00k}$$

Eq. (3) shows the specification for the analysis of the distribution of the efficiency gain (or loss) of within-school segregation by introducing into the model a set of interactions between SIMCE's 4th grade scores (and SES) quartiles of the students within the school and the variable that denotes if the school performs segregation among classrooms (*WS*). Note that both previous SIMCE scores are uncorrelated to the current school and classroom effects and this variable is used at the student level. Also, the model excludes the variable of within-school segregation from the school level equation. In general, while the methodology has been used in recent research to analyze school grouping (Chmielewski, 2014; Leckie, Pillinger, Jones, & Goldstein, 2011), the novelty of the analysis is the addition of a third level: the classroom. Thus, a three-level analysis will be performed (student, classroom and school) in order to analyze the effect of within-school segregation (for details refer to Appendix A).

Socioeconomic status, the GPA and the previous SIMCE scores are included in the three levels of the model. The variables at classroom and school level are included as the mean of the student values aggregated at the respective level. In the level of student and classroom the three variables are centered to the group level. The SES, GPA and previous SIMCE school means are centered to the grand-mean, because in this way we try to disentangle compositional effects (Raudenbush & Bryk, 2002) in order to understand the association of within-school segregation with achievement within the schools instead of the average effect of internal segregation in all schools.

Finally, it is important to acknowledge that HLM models assume that school and classroom effects are uncorrelated (Milla, San Martín, & Van Bellegem, 2015). However, fulfilling this assumption depends on an appropriate identification strategy that ensures exogeneity of the covariates. The following paragraph explains our identification strategy.

Table 2 presents two samples in order to explain the two steps of the identification strategy. First, the identification strategy of the study focuses on the subset of high schools that offer secondary education starting at 9th grade –the first grade of secondary level education- and have more than one classroom per grade, called complete sample. Although secondary education starts officially at 9th grade, there are several schools that offer education from pre-k to 12th grade, while other secondary schools start their offerings at 7th grade. By restricting the analysis to schools that start at 9th grade and have two or more classrooms of the same grade, we ensure that the clustering in these schools is due to policies of the school, and is not based on previous knowledge of the students. The total enrollment for this subset of schools accounts for >40% of students in 9th grade in 2010 and involves 576 schools. However, the complete sample does not satisfy the assumption for the exogeneity of covariates, as it is explained in the following step of our analytical strategy. The second stage of the identification strategy

Table 2
Descriptive statistics. Sample used in the multilevel analysis (2008).

	Complete Sample					Restricted Sample				
Variable	N	Mean	D.E.	Min.	Max.	N	Mean	D.E.	Min.	Max.
Student's level										
Math SIMCE 2008 standardized	34,426	0.10	1.00	−2.39	3.31	21,789	0.08	0.99	−2.39	3.31
Language SIMCE 2008 standardized	34,426	0.09	0.99	−2.85	3.23	21,789	0.07	0.98	−2.85	3.23
Math SIMCE 2002 standardized	34,426	0.08	0.99	−3.18	2.63	21,789	0.07	0.98	−3.08	2.63
Language SIMCE 2002 standardized	34,426	0.07	0.99	−3.29	2.57	21,789	0.06	0.99	−3.29	2.57
Grade Point Average 2002 standardized	34,426	0.10	0.94	−10.77	1.75	21,789	0.08	0.93	−10.77	1.75
Repetition up to 4th grade	34,426	0.04	0.20	0.00	1.00	21,789	0.04	0.2	0	1
SES Index 2008 standardized	34,426	0.06	0.97	−3.38	5.41	21,789	0.06	0.95	−3.37	5.28
Gender (Girl = 1)	34,426	0.51	0.5	0	1	21,789	0.5	0.5	0	1
Classroom's level										
Math SIMCE 2008 standardized	2857	0.02	0.99	−2.48	3.25	1811	0.05	0.95	−2.19	3.25
Language SIMCE 2008 standardized	2857	0.02	0.98	−3.16	3.42	1811	0.06	0.91	−2.82	3.42
Math SIMCE 2002 standardized	2857	0.02	0.98	−4.23	3.14	1811	0.06	0.93	−4.23	3.08
Language SIMCE 2002 standardized	2857	0.01	0.97	−2.82	3.17	1811	0.04	0.93	−2.82	2.91
Proportion of students that have repeated grade per classroom (up to 4th grade of primary)	2857	0.05	0.07	0.00	0.62	1811	0.05	0.07	0	0.62
Grade Point Average 2002 standardized	2857	0.04	0.97	−3.74	2.78	1811	0.06	0.89	−3.57	2.76
SES Index 2008 standardized	2857	−0.03	0.96	−3.13	4.32	1811	0.02	0.95	−3.07	4.32
School's level										
Math SIMCE 2008 standardized	576	−0.51	0.66	−1.92	1.91	399	−0.52	0.68	−1.92	1.91
Language SIMCE 2008 standardized	576	−0.55	0.66	−2.01	1.90	399	−0.56	0.68	−2.01	1.9
Math SIMCE 2002 standardized	576	245.26	19.64	195.79	308.18	399	245.04	20.17	195.79	308.18
Language SIMCE 2002 standardized	576	249.20	18.93	195.58	311.84	399	248.56	19.52	195.58	311.84
Public school	576	0.59	0.49	0.00	1.00	399	0.5	0.5	0	1
Private-subsidized school	576	0.30	0.46	0.00	1.00	399	0.36	0.48	0	1
Within segregation (Yes = 1)	576	0.55	0.50	0.00	1.00	399	0.47	0.5	0	1
SES Index 2008 standardized	576	−0.73	0.42	−1.80	1.22	399	−0.72	0.44	−1.8	1.22

Source: Elaborated based on SIMCE, SIGE and MINEDUC data.

focuses on a sub-sample (restricted sample) of schools that start in 9th grade, because we detected 177 schools that did not segregate in 9th grade but did segregate in 10th grade. As our measurement of the efficiency of within-school segregation involves student achievement in 10th grade, we restricted the sample to 399 schools starting in 9th grade that might have segregated in such grade, but they did not re-segregate in 10th grade. In comparison with the complete sample, which includes schools that segregate in 10th grade, the analysis of the restricted sample should produce less biased results and ensure exogeneity of the covariates. For this reason, we focus our analyses in the restricted sample.

4. Results and discussion

4.1. Institutional factors related to within-school segregation

During the 90′s the literature analyzed the relationship between school characteristics and within-school segregation, showed that variables such as school size or the presence of minorities were related to higher levels of clustering within the schools (Braddock, 1990; Hallinan, 1992; Loveless, 1999). Variables such as the heterogeneity of academic results, level of school performance or parental influence, were not unanimously significant in all studies. More recently, the study by VanderHart (2006), indicates that there are two key variables that explain within-school segregation: a high number of students in the school and the academic diversity of the student body in the school. Additionally, the author shows how academic segregation might be used as an "underground" way to implement grouping by race or class.

The results of the logistic regression models for this set of variables in the Chilean school system are presented in Table 3, organized in three models. Model 1 includes the variables of composition of the schools, while Models 2 and 3 add variables of management and location of schools, as well as other relevant variables of the Chilean school system. The outcome variable is a dichotomous variable for identifying within-school segregation. The interpretation of the results is based on the odds ratios. An odds ratio higher than 1 indicate that the odds of grouping by ability of the school with such characteristic are higher than the odds of schools without such feature. Conversely, a school has lower odds of segregating by ability when the odds ratios are lower than 1.

Four findings are salient in the models. First, in all models the school size is a variable positively associated with the existence of within-school segregation, which is consistent with other results (Loveless, 1999; VanderHart, 2006). This may indicate that larger schools have both more opportunity and pressure to segregate internally, because the larger potential ability heterogeneity.

Second, the existence of a heterogeneous student body in socioeconomic terms (SD SES Index) is more important than the presence of academically diverse students (SD SIMCE test) in explaining the odds of performing within-school segregation. This may suggest that schools with students from different SES tend to do more grouping, and this could be due to the need of attracting and retaining students with higher abilities, considering the market competition for students present in the Chilean school system. Also, schools with higher levels of vulnerability have higher odds of clustering students academically. Both findings show the importance of socioeconomic variables over academic variables in explaining the odds of segregating. These results contrast with those of VanderHart (2006), but are in line with the findings of Hallinan (1992).

Third, the results show the importance of school management variables in explaining the odds of within-school segregation. For-profit and municipal schools have higher odds of segregating. This may indicate that subsidized schools have different behaviors depending on their orientation to profit. On the other hand, Scientific-Humanistic schools have higher odds of clustering than Technical-Vocational schools. This may be due to the need to differentiate between ranks of abilities of students. Finally, the religious orientation and the presence of tuition fees are not relevant in explaining within-segregation. The magnitude of tuition fees is related to between-school segregation, generating a homogeneous student body within schools, which reduces the pressure to handle

Table 3
Logistic regression: factors related to within-school segregation by ability. 9th grade, 2010.

	Model 1	Odds ratio	Model 2	Odds ratio	Model 3	Odds ratio
No of students 9th grade	0.0016***	1.0067	0.0017***	1.0067	0.0017***	1.0066
	(0.0002)		(0.0003)		(0.0002)	
SD SIMCE test 2009	0.0029	1.0083	0.0003	1.0015	0.0005	1.0023
	(0.0051)		(0.0054)		(0.0055)	
SD SES Index 2009	0.829***	27.598	0.566**	9.6159	0.565**	9.5952
	(0.2220)		(0.2400)		(0.240)	
Vulnerability Index 2010	1.000***	54.654	1.306***	185.78	1.268***	159.63
	(0.235)		(0.2930)		(0.304)	
Grade Point Average 2009	−0.0122*	0.6128	−0.0139	0.9459	−0.0167	0.9352
	(0.0508)		(0.0593)		(0.0595)	
Private- subsidized for-profit school[a]			−0.0149	0.9422	0.0038	1.0153
			(0.0674)		(0.0819)	
Private- subsidized non-profit school[a]			−0.303***	0.2650	−0.279***	0.2995
			(0.0612)		(0.0724)	
Delegate Administration[a]			−0.173**	0.4873	−0.172**	0.4902
			(0.0740)		(0.0746)	
Rural School			−0.0584	0.7907	−0.0572	0.7944
			(0.0950)		(0.0957)	
Polivalente school (offers both Scientific-Humanistic and Technical-Vocational Training tracks)[b]			−0.118*	0.6331	−0.115*	0.6302
			(0.0678)		(0.0681)	
Technical-Vocational school[b]			−0.299***	0.2881	−0.298***	0.2905
			(0.0678)		(0.0680)	
School in Metropolitan Area			0.0024	1.009	−0.00244	0.9904
			(0.0604)		(0.06139)	
Religious					−0.0417	0.8458
					(0.0619)	
Amount of funding shared					−0.0000	0.9999
					(0.0000)	(0.0000)
Obs.	629		629		629	
Pseudo-R^2	0.50		0.49		0.49	

Note: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.
[a] These variables represent a set of dummies, where schools public schools are excluded from the model and represent the reference for comparison.
[b] These variables represent a set of dummies, where schools offering Scientific-Humanistic tracks are excluded from the model and represent the reference for comparison.

heterogeneity (Valenzuela, Villalobos, & Gómez, 2013). This means that variables relevant to explaining between-school segregation may not be relevant to explaining within-school segregation (Dupriez, Dumay, & Vause, 2008).

4.2. Relationship of within-school segregation and student performance

The analysis of multilevel models was conducted using SIMCE math scores.[5] Table 4 includes the results of the null model (without incorporating explanatory variables) for the restricted sample of schools that start in 9th grade that do not segregate students in 10th grade. They show that the variance in math is distributed 31.08% between schools, 6.32% between classrooms in schools and 62.60% among students within classrooms. Model 1 estimates the efficiency of within-school segregation in terms of SIMCE scores. The results suggest that when within-segregation is implemented it is associated with a decrease on the school SIMCE mean score of (0.089 s.d.).

Models 2 and 3 focus on understanding how the efficiency loss is distributed among groups with different levels of SIMCE and different SES status within the schools. This model introduces four interactions at the student level between quartiles (SIMCE or socioeconomic status) to which students belong and a dichotomous variable identifying whether they are enrolled at a school which segregates between classrooms.

Model 2 shows that the efficiency loss is not distributed equally, because students in both the top (4) and bottom (1) quartiles of SIMCE, recorded no gain or loss in efficiency related to within-school segregation. However, their classmates in quartiles 2 and 3 showed losses in learning associated with academic segregation. The losses are 10.7% of a standard deviation for the quartile 3 students, and 12.3% for the quartile 2 students. Therefore, those students in the middle groups of ability pay the highest price for within-school segregation.

Model 3, which studies the distribution of the loss in efficiency according to the socioeconomic status of students, indicates that the loss is concentrated among students from the two upper quartiles of socioeconomic status. The loss is about 8.8% of a standard deviation for quartiles 3 and 4.

Within-school segregation by ability is related to inefficiencies in learning. Schools with internal segregation show lower average SIMCE results in math. This finding is consistent in both the complete and restricted sample. Academic segregation is also inequitable. Students in the middle quartiles of socioeconomic status and achievement bear the burden of the costs of academic segregation. Consistent with the international literature, internal segregation in Chilean schools is more a recipe for a decrease rather than an increase in learning.

5. Conclusions

The management of student heterogeneity via segregation is a common practice in the Chilean school system, first, dividing students between schools according to their socioeconomic status and, second, separating students by ability in different classrooms.

The findings of this study, in line with other research, show that school size and the characteristics of the students are factors related to probability that schools segregate among classrooms. This may be due to the market characteristics of the Chilean school system, which could be driving schools to implement within-school segregation to retain students with higher academic performance. Also, the results show that within-school segregation is more common among larger, municipal, private-subsidized for-profit, Scientific-Humanistic and vulnerable schools.

The assumption that grouping students with homogeneous academic skills facilitates effective teaching does not hold according to our

[5] Results in reading are similar and available upon request to the authors. There are also multilevel analyses for the complete sample which are available upon request to the authors.

Table 4
Multilevel model for estimating the relationship between within-school segregation and individual scores on standardized student SIMCE in math. 10th grade 2008. Restricted sample.

	Null model			Model 1			Model 2			Model 3		
Variable	Coeff.	SE	Sig.	Coeff.	SE	Sig.	Coeff.	SE	Sig.	Coeff.	SE	Sig.
Intercept	−0.122	0.029	***	0.077	0.049		0.064	0.049		0.064	0.049	
School's level												
SES Index				−0.068	0.054		−0.048	0.054		−0.042	0.054	
Public school				−0.158	0.054	**	−0.163	0.056	**	−0.163	0.056	***
Private-subsidized school				−0.062	0.055		−0.061	0.056		−0.060	0.056	
Within segregation (Yes = 1)				−0.089	0.034	**						
Math SIMCE score 2002				0.469	0.021	***	0.460	0.021	***	0.460	0.021	***
Classroom's level												
Proportion of students that have repeated grade per classroom (up to 4th grade of primary)				−0.087	0.157		−0.094	0.159		−0.090	0.158	
SES Index				0.028	0.020		0.029	0.020		0.031	0.020	
Math SIMCE score 2002				0.301	0.019	***	0.300	0.019	***	0.301	0.019	***
Grade Point Average 2002				0.090	0.020	***	0.089	0.020	***	0.090	0.020	***
Student's level												
Math SIMCE score 2002				0.396	0.008	***	0.393	0.009	***	0.396	0.008	***
Final Grade Point Average 2002				0.102	0.007	***	0.102	0.007	***	0.103	0.007	***
Repetition up to 4th grade				−0.098	0.025	***	−0.101	0.025	***	−0.097	0.025	***
Gender (Girl = 1)				−0.148	0.012	***	−0.147	0.012	***	−0.148	0.012	***
SES Index				0.017	0.005	***	0.017	0.005		0.021	0.007	***
Quartile 1 Math SIMCE 2002 * Within segregation							−0.032	0.036				
Quartile 2 Math SIMCE 2002 * Within segregation							−0.123	0.037	***			
Quartile 3 Math SIMCE 2002 * Within segregation							−0.107	0.037	**			
Quartile 4 Math SIMCE 2002 * Within segregation.							−0.013	0.042				
Quartile 1 SES Index 2008 * Within segregation										−0.063	0.038	
Quartile 2 SES Index 2008 * Within segregation										−0.052	0.037	
Quartile 3 SES Index 2008 * Within segregation										−0.088	0.037	*
Quartile 4 SES Index 2008 * Within segregation										−0.087	0.036	*
Variance	% Variance for level			Variance remainder	% Explained Variance		Variance remainder	% Explained Variance		Variance remainder	% Explained Variance	
School level	0.295	31.08%		0.079	73.10%		0.080	72.86%		0.080	72.82%	
Classroom level	0.060	6.32%		0.041	31.67%		0.041	31.89%		0.041	31.56%	
Student level	0.595	62.60%		0.431	27.50%		0.430	27.63%		0.431	27.52%	

Note: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

results. The analysis of secondary schools that start in 9th grade suggests that within-school segregation, rather than reducing academic differences, is a mechanism that amplifies inequalities and diminishes the academic performance of students in the middle range of academic ability and SES within the school.

Since the topic of within-school segregation is mostly unexplored in Chile, we identify three areas of future research on this topic. First, it is necessary to analyze the rationality behind these segregation processes within-schools. A plausible hypothesis about the decision to segregate internally by institutions is that they are influenced by the incentives of competition existing in the Chilean system. For example, schools that receive the most vulnerable population may segregate internally as a competitive strategy to maintain enrollment and give priority treatment to students with higher GPA. More studies are necessary to test this hypothesis. Second, it is necessary to understand the logic that makes of within-school segregation a widespread practice in the school system. In a highly segregated school system of Chile, it is necessary to study the cultural, political, social and pedagogical factors at the basis of this practice. Thirdly, it is necessary to study those schools with high heterogeneity that are able to improve student learning in general, and reduce within-school academic inequalities. Such cases may shed light on how to effectively deal with student differences and reduce achievement gaps. These types of evidence will shed light on both how schools manage individual student and what are the most effective practices to meet student learning needs.

Appendix A. Methodological elements of multilevel analysis

The different models solve analytical challenges, including the problem of nesting data. In the case of educational data, students are nested in rooms and these, in turn, into schools. This means that students in the same classroom or school are not independent, which violates one of the assumptions of linear regression. In addition to solving this problem, multilevel analysis allows a proper explanation of the relationship between segregation and academic achievement, and separates the influence of individual variables of group (classroom and school) on student achievement. In our case, the constructed model is based on three levels. At level 1, student, the following general formulation is proposed:

$$Y_{ijk} = \beta_{0ijk} + \beta_1 a_{1jk} + \ldots + \beta_n a_{njk} + e_{ijk} \quad (4)$$

where Y_{ijk} is the SIMCE score for each student i, which participates in the classroom j of school k; β_{nijk} are the coefficients of the independent variables of level 1 student, they go from 0 to n; a_{njk} are the independent variables and student level; e_{ijk} is the random effect of level 1. Additionally, in level 2, corresponding to the classroom, each coefficient of level 1 becomes a dependent variable. However, in the case of this study, only fixed effect models or random intercepts are adjusted. This means that the units of nesting are allowed to vary only the intercepts and are presumably constant across classrooms. Therefore, the classroom level is

predicted only on the intercept, and the general equation is written as follows.

$$\beta_{0jk} = \gamma_{00k} + \gamma_{01k}x_{1jk} + \ldots + \gamma_{0nk}x_{njk} + u_{0jk}$$

where γ_{0nk} corresponds to the coefficient in level 2; x_{njk} refers to the predictor variables as level 2, and u_{0jk} is the random effect of level 2. Additionally, as in the previous case, each of the coefficients of level 2 becomes a dependent variable in the school level (level 3). That is, the school level variables predict coefficients in the classroom level. Following a similar strategy, only models with fixed effects are adjusted, which means that it allows the intercept to vary only in the classroom level. The school level equation is:

$$\gamma_{00k} = \pi_{000} + \pi_{001}w_{1k} + \ldots + \pi_{00n}w_{nk} + r_{00k}$$

where π_{00n} corresponds to the coefficient in level 3; w_{nk} refers to the predictor variables as level 3; and r_{00k} is the random effect of level 3. However, multilevel models allow for the estimation of the proportion of variance in achievement between schools, classrooms and students. The indicator is known as intraclass correlation, in the case of a three-level model, estimated using the variances of each level, which are defined as follows.

$$\text{Variance of level 1} : Var\left(e_{ijk}\right) = \sigma_1$$

$$\text{Variance of level 2} : Var\left(u_{0jk}\right) = \sigma_2$$

$$\text{Variance of level 3} : Var\left(r_{00k}\right) = \sigma_3$$

Finally, in the multilevel analysis, particularly in the type performed in this study- the compositional effects are important. These refer to the way a variable aggregated in different levels can affect student performance (Raudenbush & Bryk, 2002). For example, individual SES may have important effects on learning, but the average socioeconomic level of the school, the compositional effect, has been considered the most powerful predictor of learning in Latin America (Treviño et al., 2010). Therefore, the organizational effect is greater than the individual effect.

In the case of segregation within schools, this is particularly important since, the relationship between organizational variables (in this case, the classroom) on individual learning. Measuring this effect adequately is essential to estimating the compositional effects, and this is achieved through centering multilevel model variables.

The dependent variables in a multilevel model can focus on the grand mean, the mean of the group or stay with their natural metrics. The centering of the variables involves subtracting the natural metric average, and the magnitude of closeness coefficient represents the mean. In this analysis it was decided to center the variables to the group-mean at the student and classroom level, while the variables of the school level were centered to the grand-mean. The aim of this specification is to separate the effects of the variables of the student at the school and classroom level in the individual learning (Raudenbush & Bryk, 2002). The main reason for centering of variables in the group rather than the grand mean is because we want to know the relationship of the variable of ability and socioeconomic status within the schools, as it seeks to understand the relationship of within-school segregation in learning and not the average effect of internal segregation in all schools.

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