University College London

School Composition and Educational Impacts: Four Papers on Socioeconomic Segregation and Peer Effects.

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Declaration

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Abstract

For decades the stratification of educational systems and schools' socioeconomic composition have been observed as potential causes of inequalities in achievement across social groups. In Chile, these concerns are intertwined with a context of policies promoting both school choice and between-school competition. This work focuses on assessing the evolution of schools' socioeconomic segregation during recent decades and estimating the short- and long-term effects of classmates' characteristics on student academic outcomes.

The first chapter offers a description of the Chilean educational system (as most of the following chapters will use data from this country) and its challenges regarding educational inequality and the separation of social groups across schools. Chapter 2 provides an international comparison of socioeconomic segregation trends in 34 educational systems based on a measure of Dissimilarity (Duncan index). Chapter 3 analyses trends of segregation in Chile since 1999 (using the Square Root Index) and provides new information about how the separation of students from different backgrounds is distributed across school types and related to specific features of the market-oriented system. In Chapter 4, the impact of the socioeconomic characteristics of primary school classmates on secondary level academic outcomes is estimated and analysed. Finally, Chapter 5 continues to investigate the effects of the peer characteristics, but instead focusing on the impact of their academic attributes in the long-run (observing outcomes in entrance to higher education).

The findings in this work suggest that school socioeconomic segregation has not varied significantly over time, either in Chile or other educational systems. Moreover, segregation appears to be impervious to recent attempts to affect schools' social composition. In the case of Chile, features of the system (such as co-payments and student selection) are correlated with greater segregation. However, a significant proportion of the segregation is attributable to within-sector segregation, which may be reflecting parental preferences. Estimates—using a school fixed effects approach—also confirm that students benefit academically from being exposed to wealthier peers at the primary level. Moreover, a more socioeconomically diverse classroom does not lead to negative results. Although the socioeconomic background of the former classroom members exerts a relatively small effect, the impact appears to endure over time (at least in Mathematics). The impact of academic characteristics is negative, suggesting that being exposed to more talented classmates at the primary level has detrimental effects on students' performance on higher education entrance examinations.

Impact Statement

The socioeconomic and academic composition of the schools and its potential effects on children's academic and social outcomes has been a matter of debate during decades around the globe. However, important methodological challenges have impeded reaching a consensus regarding the extent in to which the 'school composition' impacts other students.

The findings in this work may be interesting for scholars around the world. Particularly, the findings in Chapter 2 challenge the increasingly popular narrative about narrowing the achievement gap between social groups and equalising educational opportunities. This work finds that since 2000 no important changes have been recorded in the levels of socioeconomic segregation in the OECD countries. Therefore, if it is in the interest of policymakers, a revision should be made of the effectiveness of the current strategies for reducing the separation of social groups.

Most of the findings of this dissertation are based on Chilean records. In Chile, the debate about social segmentation of the students has been particularly relevant, as the country stands out as having one of the most segregated educational systems in the world. Moreover, the introduction of school choice to promote competition between schools has been controversial and mentioned as a potential aggravating factor of residential segregation. The findings in this work—and the interpretation of the data in relation to previous research—suggest that the separation of social groups did not change between 1999 and 2016. Moreover, some institutional factors (e.g. student selection, co-payment) are associated with greater segregation. As educational systems around the world are increasingly expanding policies based on school choice, the experience of Chile (which embarked on this path almost 40 years ago) should be to the interest of many countries.

Finally, the effects of the ‘school composition’ are far from simple to interpret. According to the findings in this work, exposure to wealthy peers has positive effects on students' academic outcomes, while being educated with high performers has a detrimental effect. Reforms pursuing a social and academic mix (such as that currently being implemented in Chile) must be observed carefully. If greater heterogeneity at schools is achieved, new challenges emerge for teachers and administrators. Furthermore, academics should also be challenged to continue to estimate the impacts of school composition in the long run and not limiting their analysis to the effects during the years of schooling.

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Chapter 1.

Socioeconomic Segregation and Inequalities in a Market-Oriented Educational System: A Brief Introduction

1.1 Introduction

In 2006, thousands of Chilean students began demanding changes in the education system. The student movement paralysed hundreds of public schools across the country and resulted in the biggest demonstrations since democracy was re-established in 1989. Since then, the socioeconomic stratification of the educational system and its failure to provide equal opportunities to all students has been a major topic on the Chilean political agenda. Governments responded to the widespread student movement by seeking consensus on a broad set of regulations for the educational system (not all of which were related to the problem of inequality). However, before the new agenda was entirely implemented, a new cycle of student-led demonstrations (which started in 2011) highlighted the issue of school segregation and inequality again and gave rise to recent and more radical reforms addressing these issues. The new statute—which began to be implemented in 2015—is likely to be the most marked change to the educational system since the market-oriented reform was established in 1981 (as part of the privatisation reform imposed during the Pinochet dictatorship). Despite the intensity and extension of education policies addressing the issue of social stratification of the system, the causes of this problem remain unclear. Scholars investigating this issue also come to different conclusions about the causes of socioeconomic segregation and the contribution of each of its potential drivers. Furthermore, policymakers have assumed that a greater social mix would benefit socioeconomically disadvantaged students through interaction with better-off peers. Although some international literature on the topic supports this view, there is an important debate about the quality of some of the studies and the issue remains contested. In Chile, the effects of schools' socioeconomic composition have not been deeply researched and the mechanisms by which peer effects could operate are still unexplored.

This work aims to contribute to the strand of the literature analysing the evolution of socioeconomic segregation and the effects of school composition (both academic and socioeconomic) on student achievement. At the international level, the case of Chile is interesting as it has a nationwide voucher programme encouraging private provision of education and promoting parental school choice. As several countries have started to implement policies to increase school choice (OECD 2017) or extending voucher schemes in recent decades, the case of Chile can help shed light on the strengths and limitations of this approach. Moreover, this study also adds to knowledge about the effects of socioeconomic composition on student achievement, particularly estimating those effects in a highly segmented setting and observing impacts in the long run.

This introductory chapter provides a description of the market-driven educational system prevailing in Chile and summarises the main discussions about the role of schools' socioeconomic composition in this scenario. The first part of this chapter details the evolution of the educational system, describing its main features and underlining both the changes in education provision since 1981 and the persisting inequality in student achievement across social groups. The second section—based on the existing literature—summarises the main arguments about the causes of socioeconomic segregation and how some specific features may contribute to wide gaps of attainment between social groups. The third section summarises the main policies implemented during the last decade that have the potential to reduce segregation. Finally, the four empirical works to assess socioeconomic segregation and school composition are presented.

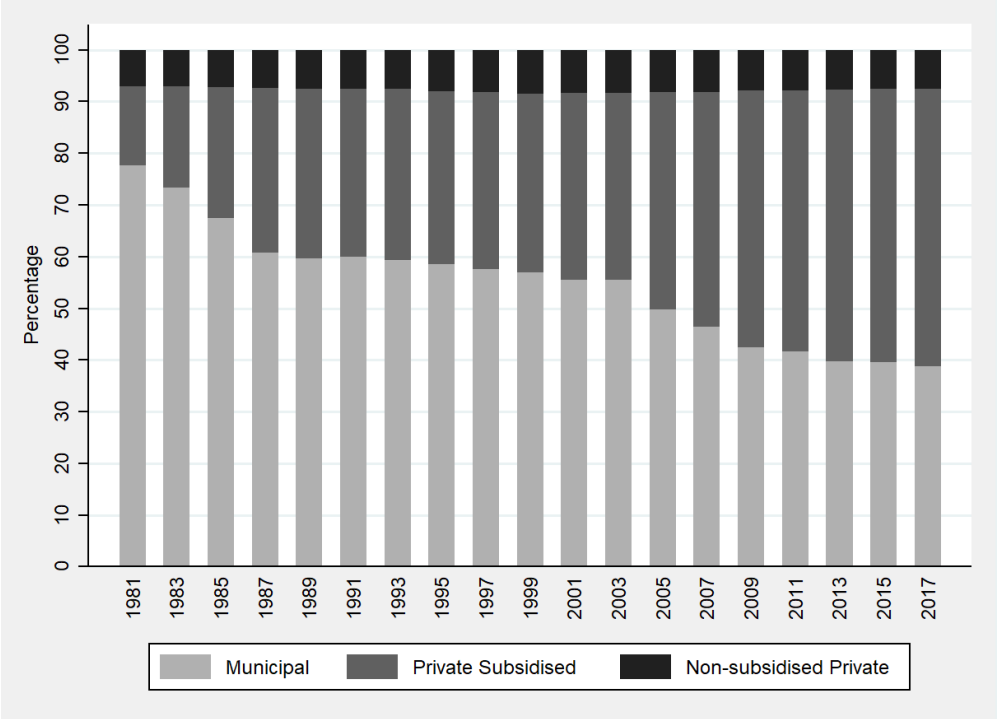
1.2 The Chilean education system: From state-based provision to school competition

Unlike the majority of educational systems, Chile has adopted a nationwide school choice framework for providing education. As part of the privatisation reform implemented during the dictatorship, several areas—traditionally served by the state—were opened up to the participation of private stakeholders. In 1981, the education reform transferred the traditional public schools—owned by the state and managed through the Ministry of Education—to decentralised local authorities (municipalities). This change was accompanied by the promotion of private participation in the provision of education (from pre-school to higher education). Before 1981, the participation of private education providers did exist in Chile, but it was mostly confined to religious institutions serving disadvantaged communities that were supported by the state. As a substantive part of the reform, a voucher system was put into place to fund demand for education. The scheme was aimed to promote increases in education quality through competition between schools to capture the enrolment (and the associated vouchers). In theoretical terms, parents would have their children leave schools if unsatisfied with their performance, moving them to other institutions that better fulfil their expectations and demands. To accomplish this goal, private institutions were allowed to participate as owners and managers of new educational institutions incentivised through allowing profit-making. The expenditure in education—until that time allocated to schools as a subsidy for the provision of education—was subsequently allocated according to the enrolment (and attendance) and followed the students when they moved from one school to another. For schools, this change implied that funding was no longer fixed, but variable according to their capacity to capture enrolment. Parents could exercise their right to choose a school without geographical limitations, privileging those that best fit their demands as

consumers. The policy was expected to benefit the whole system, as all schools would be subject to the competitive pressure. Parents would leave low-quality schools, which would eventually have to close due to low enrolment.

The implementation of the market-oriented reform resulted in significant changes in the pattern of enrolment across school types. The non-subsidised private sector—traditionally serving students from wealthy families—remained stable (capturing around 8% of the pupils since 1981). This sector was—and continues to be—fully-funded by parents and operates with greater autonomy compared with the other types of schools. The private subsidised sector grew significantly after the reform. The number of schools expanded rapidly and enrolment increased from 15% of the total in 1981 to 54% in 2017. As there were fewer legal and administrative constraints to establish subsidised-private schools, many of them were founded in newly-gentrified areas and became the common option for new residents in those areas. The expansion of the private-subsidised sector came at the expense of municipal schools. Figure 1.1 summarises the changes in enrolment since the reform was implemented. Not only has the private-subsidised sector become the primary education provider, but it has also captured more than half of total enrolment since 2010.

Figure 1.1. Trends in Enrolment by Type of School (1981-2017)



The National Constitution established in 1980 stipulated that basic education was mandatory in Chile. In practice that implied eight years of schooling. The provision of education was organised into three main stages. Primary education (from 1st to 8th grade), secondary level

(from 9th to 12th grade) and higher education (which included vocational, professional, and university levels). Under the 1980 Constitution, the state was responsible for providing education at the primary level and relied to a significant degree on private providers for the secondary stage (which was subdivided into vocational and academic tracks in the last two years). However, municipalities were free to open new secondary schools and also received funding under the voucher scheme for the students enrolled at this level.

The market-driven educational system operated from 1981 without any specific features to measure the schools' performance. Although some initiatives to measure the quality of education were implemented during the first decade after the reform, the results were not disclosed to the public. In 1992, the Ministry of Education started to administer the SIMCE test ('System for Measuring the Quality of Education') and shared the results with the public[1]. In 1998 improvements were introduced to the assessment system and the test (Mathematics, Language, Social Science, and Basic Science) was designed using 'Item Respond Theory' (IRT). The schools' performance on SIMCE (which is taken annually in 4th grade and biannually in 8th and 10th grade) has been used as information for parents in the school choice process.

The democratic governments did not make any substantial changes to the school choice framework of the educational system. On the contrary, most of the new policies adapted to the logic and operation of the prevailing system. One of the key features in this period was the use of co-payment as a way to increase total expenditure in education. Private-subsidised schools were authorised to use fees at both primary and secondary level, while public schools were authorised to do so only at the secondary level and when a majority of the parents agreed with this measure. Education in schools using co-payment was funded by both parents and the government under a scheme that considered discounts on the regular voucher regarding the amount of the fees paid by the families. By design, the policy assumed that students in schools with co-payment would have higher expenditure on education compared to those in public schools or private-subsidised schools without fees (as the discounts in the regular voucher

[1] SIMCE is applied in all municipal, private subsidised, and non-subsidised private schools. The main subjects assessed are Mathematics and Language. However, the number of subjects assessed have significantly increased over time (including Social Science, Basic Science, English, and Physical Education, among others). The grades in which the test are taken have also increased. Since its implementation, the periodicity of the application has changed several times. This chapter uses SIMCE information for all years when the test was administered.
Since 2015, the results of the test are used to classify the schools into categories according to their performance. Schools that do not show sufficient progress over time may be shut down. To facilitate the comparison between years and subjects, the scores on the test are adjusted to a scale with a mean of 250 and a standard deviation of 50 in reference to the first application (1999 for 4th grade and 2001 for 10th grade).

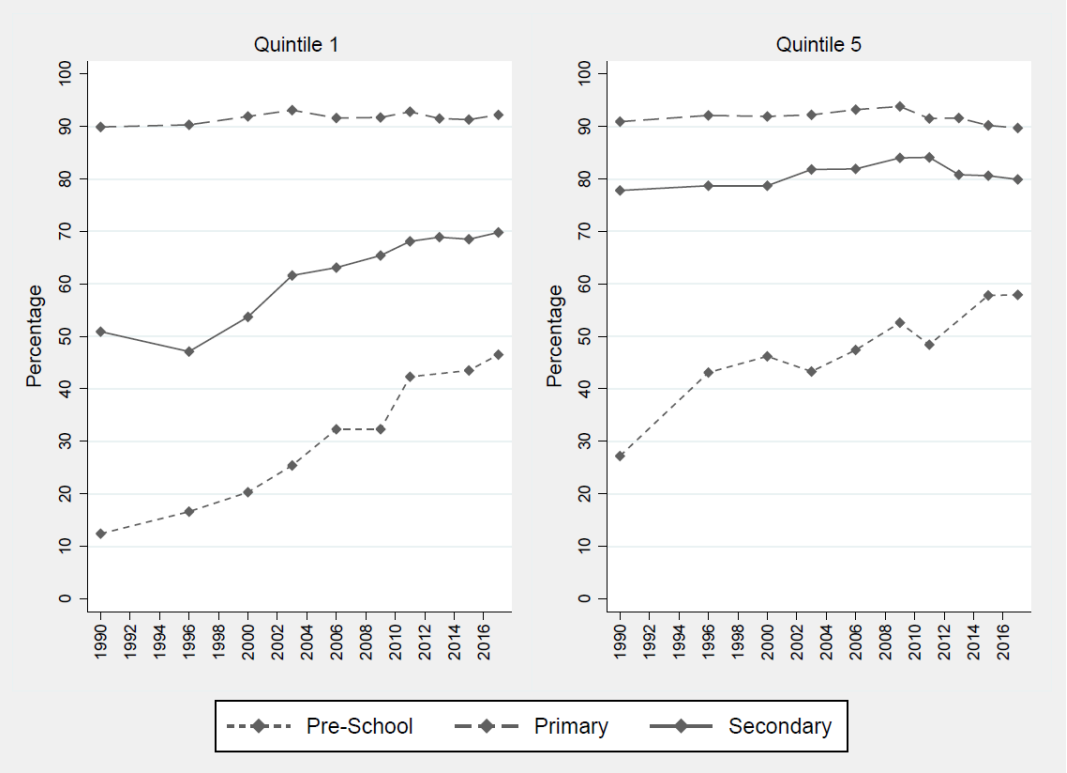
were smaller than the funds provided by the parents). As a result of this policy, in 2014 (before policies restricting co-payment were implemented) almost half of the subsidised-private schools were charging fees to families.

Following the implementation of the 1981 reform, the rates of participation in education saw significant growth. Primary education expanded significantly in the period from 1970 to 1985. Since then, the rate of net participation—meaning the percentage of students of age to attend school and who are also enrolled—has remained stable and at close to 90% at the primary level[2]. If total enrolment is considered—adding the students that are enrolled in a grade other than that expected for their age—the rate of education at the primary level is even higher (reaching almost full enrolment). Since 1990 pre-school and secondary education have experienced remarkable growth. However, the rates of participation are still much lower than at the primary level. In the case of the pre-school level, enrolment increased from 15.9% to 51.2% in 2017, while enrolment at the secondary level rose from 60.3% to 73.4% in the same period. Part of this expansion was explained by new regulations that established 12 years of compulsory education in 2003, including eight years of primary (or basic) education and four years of secondary education. Although a significant expansion took place in the Chilean system, there are still significant differences between social groups. Figure 1.2 summarises the net participation rate at the pre-school, primary, and secondary levels for socioeconomically disadvantaged (quintile 1) and wealthy students (quintile 5). Although gaps between social groups have narrowed over the years, the only level at which the participation of both groups is similar is primary education.

The accomplishments regarding participation in education have been not accompanied by similar achievements in students' performance. According to several international reports (TIMMS, PISA, TERCE), Chile presents some of the highest performance levels among Latin American countries, but they are still far below most developed economies (the OECD average). Although international assessments suggest some slow but constant increases in performance (particularly in Language) from 2000 to 2009, in recent years that trend has become more blurred. Results in national examinations suggest a similar picture. In primary education (tested in fourth grade), an increase equivalent to .28 of a standard deviation was observed in Language from 2005 to 2017.

[2] Data from the national survey for the socioeconomic characterisation of the population, conducted by the Ministry of Social Development. The ages of reference for calculating the net rate of participation are 0-5 years old for pre-school, 6-13 years old for the primary level, and 14-17 years old for the secondary level.

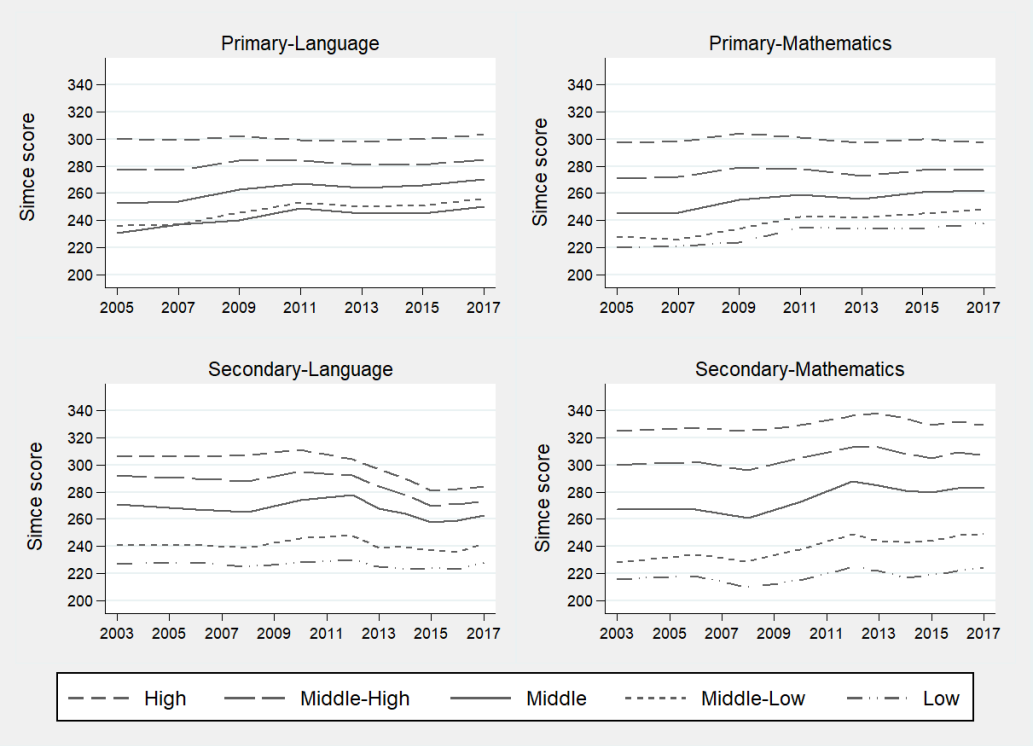
Figure 1.2. Net Participation in Education by Level and Socioeconomic Status



Similarly, in Mathematics, an increase of .26 of a standard deviation was seen in the period. At the secondary level (tested in 10th grade) the progress (from 2001 to 2017) is only observable in Maths (.36 of a standard deviation) but is inexistent in Language. However, the results vary significantly by socioeconomic group. SIMCE provides information on the students, grouping them into five categories. Figure 1.3 shows how inequalities between social groups have been shrinking in fourth grade (both in Maths and Language). At the secondary level, the gap between the rich and the poor students has narrowed in Language, but is mainly explained by the decrease in the performance of the wealthy students. In Mathematics, the differences between better off and underprivileged students have remained remarkably similar over time and vary between one and two standard deviations in the test. These differences hold over time and translate into inequalities in access to higher education (and the subsequent differences in incomes).

The positive effects of the school choice reform are not clear to researchers. Several studies have been conducted during recent decades to determine the impact of the 1981 reform on school performance. However, the results show dissimilar effects. While a group of studies claimed that school competition does not produce significant effects (McEwan & Carnoy, 2000; Hsieh & Urquiola, 2006) other show positive impacts, albeit of a small magnitude (Contreras & Macías, 2002; Auguste & Valenzuela, 2004; Lara, Mizala, & Repetto, 2009; Gallego & Hernando, 2009; Gallego, 2013; Chumacero, Mardones, & Paredes, 2016).

Figure 1.3. SIMCE Scores by Schools' Socioeconomic Status



1.3 School choice reform, socioeconomic segregation and educational inequalities

Evaluation of the effects of the school choice reform in Chile has not been limited solely to academic results, but also the socioeconomic distribution of the students. With nuances, research tends to confirm that the school choice scheme implemented in Chile has contributed to socioeconomic segregation of the students. However, studies diverge on the factors causing the segregation. Two dimensions may affect the school composition in a market-oriented system. On the demand side, parents may cluster their children with pupils from families with similar interests, expectations, and beliefs. As those aspects may be closely related to their social background, parental preferences may be a driver of socioeconomic (and academic) segregation. Some authors have also suggested that parents actively avoid sharing with families from other cultural and social backgrounds (Canales, Bellei, & Orellana, 2016). On the supply side, institutional features may affect the schools' composition. In the Chilean case, the use of co-payment, the presence of student selection, and the design of the voucher may affect the schools' composition.

Prior studies have highlighted that the socioeconomic composition of the schools is an important factor considered by families. Elacqua & Fabrega (2004), use a survey of parents to explore the demand side in the Santiago metropolitan area. The authors conclude that parents

include only a few options in their set choice, making their decision based on very limited information. They emphasise that while families enrolling their children in private-subsidised schools tend to base their decision on curriculum and values, the parents in municipal schools tend to choose based on practical reasons (e.g. distance). Elacqua, Schneider & Buckley (2006) contrast the ‘stated' to ‘revealed' preferences in the process of choosing a school. Drawing on a survey of parents in Santiago, they find that while parents state that ‘academic and curricular characteristics' are the main factor for choosing a school, in practice parents enrolling their children in private-subsidised and non-subsidised schools are more likely to decide based on the ‘academic factor'. In contrast, the distance from school seems to be much more critical for low-income families. Moreover, the authors underline that most of the families construct heterogeneous set choices regarding academic characteristics, but very homogenous choices regarding social composition. Other studies have confirmed these findings and suggest that approaches to school choice differ significantly in the different social groups. Cordova (2014) focused on low-income families in Santiago and suggested that their options are constrained by socioeconomic factors, privileging proximity between the home and school and associating the quality of the schools with the characteristics of the students enrolled. Canales, Bellei & Orellana (2016) analysed choices among middle-class families and concluded that these families develop strategies to separate themselves from socioeconomically disadvantaged groups and cluster themselves in non-municipal and fee-paying schools.

The features of the supply side have also been analysed to estimate to what extent they contribute to produce segregation. Hsieh & Urquiola (2003) underlined that while non-effects are observed regarding achievement, effects on the socioeconomic segmentation of the students were observed. The authors argue that private-subsidised schools responded to market incentives by skimming off the best students and that the school choice scheme produced an exodus of middle-class students from municipal schools (directly affecting the performance of those schools). Furthermore, this study suggests that selective practices carried out by subsidised-private schools may play a role in shaping the schools' composition (as was suggested in previous qualitative or small-scale studies). The role of unregulated school admissions has also been mentioned in several other studies regarding the changes in the educational systems using school choice policies. Drawing on SIMCE information provided by parents, Contreras, Sepúlveda & Bustos (2010) confirmed that selective practices are extended in the private-subsidised sector and suggested that the selective practices may explain part of the achievement gap between subsidised-private and municipal schools. Carrasco, Gutiérrez & Flores (2017) surveyed headteachers to describe selection procedures in Santiago. They confirmed that selective practices are widespread across the schools (even

at the levels where they were formally forbidden), albeit being more prevalent in the private-subsidised sector than in municipal schools. They also showed that selection is associated with more homogenous academic and social school composition. The use of co-payment has also been discussed as a driver of greater socioeconomic segmentation of students. Although several authors have discussed the implications of co-payment for segregation (Beyer, 2007; Mizala, 2007; Beyer & Eyzaguirre, 2014), there is a very limited number of studies addressing the issue from an empirical perspective. This strand of the literature does not offer a clear conclusion either. Valenzuela, Bellei & De los Rios (2014) suggested that larger proportions of fee-paying subsidised schools are associated with greater segregation of the municipal system. In an effort to disentangle causal mechanisms producing segregation, Gallego & Hernando (2009) concluded that the contribution of co-payment to segregation does exist, but is small.

Institutional features affecting the distribution of the students across schools may not be limited solely to school admissions and the use of co-payment. Several authors have claimed that the initial design of the Chilean school choice policy was problematic due to factors associated with the voucher itself (limiting the effects regarding quality and equity in education). On the one hand, the amount of this subsidy remained low for a long time and started growing gradually after the return of democratic government. Secondly, and more importantly for the issue of school composition, the amount of the voucher was flat and did not recognise that poor students required more resources to be educated and compensate initial gaps produced even before primary education.

1.4 Recent policy changes affecting school composition

As a response to the first round of student demonstrations calling for solutions to tackle inequalities in education, a panel of policymakers, student representatives, school owners, and academics—representing a broad spectrum of political perspectives and social sensibilities—was set up[3]. To a certain extent their recommendations inspired some of the political measures adopted by governments in later years. However, a few years afterwards and before many of

[3] The Council for the Quality of Education (Consejo Asesor Presidencial para la Calidad de la Educación -CAPCE) was called by President Bachelet (2006) and formed by 81 members from several institutions related to the education field. Although the report did not reach a consensus on the specific transformations required to address the issue of segregation, the members did agree on the negative nature of a segmented system. In particular, they stated that socioeconomic segregation "restricts the educational experiences of the most vulnerable students, depriving them of interaction with students with higher levels of learning and the stimulus that this implies for compensating inequalities, and reduces the expectations of teachers" (p. 78).

the changes were implemented, the student protests returned (with greater social support) and their demands led to new reforms.

The first major policy change in this regard took place in 2008 when the 'Preferential School Subsidy Law' (SEP) was introduced. This policy was inspired by a political consensus: the system for allocating resources to schools was inadequate, as it did not recognise that students from disadvantaged backgrounds would need more resources to be educated in order to compensate for contextual handicaps. Moreover, as the voucher was flat, schools had incentives to skim off talented students. Drawing on the between-school competition scheme, the new policy offered substantial increases in the voucher associated with poor students ('priority students' according to the law) for schools willing to implement a plan to improve academic results (with consequences monitored by the Ministry of Education)[4]. The policy was implemented gradually, augmenting the subsidy by 60% on average for 'priority students' from the last levels of pre-school education to sixth grade. In later years the policy was expanded to the secondary level. SEP changed a major feature of the system as it moved from a flat voucher to a progressive system, where socioeconomically disadvantaged students received a higher subsidy. The policy also established that 'priority students' were not subject to co-payment and were exempt from taking part in selection procedures. Although participation in SEP was not compulsory, an important proportion of schools took part in the programme. In 2017, 91% of municipal schools and 50% of private-subsidised schools were included in the policy. As this policy is relatively new, only a few studies have assessed its impacts. Mizala & Torche (2017) evaluated its effects on academic achievement, finding positive impacts in both Maths and English. The authors underline that the effects are greater in private-subsidised schools enrolling socioeconomically disadvantaged students. Their findings confirm that the policy produces gains in achievement and equity. In 2013, Valenzuela, Villarroel & Villalobos performed an analysis of the impact of the policy—including effects on socioeconomic segregation—just a few years after its implementation, but did not record any effects in this regard.

A second regulation enacted in the period was the General Education Law, which changed several features of the education system. In practice, this was the first substantial modification to the regulation imposed by the Pinochet regime (1990) and introduced major changes to the "architecture of the system". The new regulation established a prohibition on schools selecting

[4] Although SEP did not have the explicit purpose of reducing socioeconomic segregation, it affected some of the factors mentioned as potential causes of segregation. As it aims to reduce the gaps between social groups, it has often analysed measures related to the topic of the system's socioeconomic stratification as part of the policy.

students from first to sixth grade (in primary education). Although the new rule stated that schools could not select students based on prior performance or their academic potential, at the same time it meant that if there was oversubscription, schools would have to implement transparent and fair systems of allocating the available slots, although this was an apparent contradiction of the rules, simultaneously forbidding and regulating selection (Godoy, Salazar, & Treviño, 2014). Moreover, studies have reported that student selection was still used after the law was put into effect, implying that the law was unable to eradicate selective practices from Chilean schools (Carrasco, Flores, & Gutiérrez; 2017). There are no records regarding the effects of the new regulations on the prevalence of selective practices or school composition.

Although the new set of policies did have components to address inequalities, many of the features of the system remained unaltered. After the new and extensive demonstrations in 2011, another reform was announced. The main components included centralising the school admission process. Although parental preferences are expressed during the application, in oversubscribed schools students are allocated using a random component. Moreover, co-payment was eliminated and the funds provided by the parents were gradually replaced by increases in the amount of the voucher. Finally, profit-making was abolished and all publicly funded schools became non-profit institutions.

Despite the intensity of the debate regarding segregation in Chile, one important topic has been neglected in the literature. The measures aimed at reducing segregation are mainly founded on the notion that segregated schools amplify or at least replicate the inequalities associated with the students' socioeconomic backgrounds. Moreover, it is expected that a greater social mix would benefit poorer students that are exposed to students from families with greater cultural capital. However, very little literature exists in Chile to support—or reject—this expectation. Only two pieces of work have attempted to address this issue, and neither of them have observed any effects after secondary education (these works will be discussed in two of the following chapters).

1.5 Trends of socioeconomic segregation and peer effects

Notwithstanding the gap in the knowledge about schools' socioeconomic segregation and its effects, Chile has put several policies into practice aimed at reducing segregation or affecting factors related to school composition. This work seeks to address a deficit of knowledge in two areas. First, it observes the evolution of socioeconomic segregation over time, both internationally and nationally (in an intensive period in terms of policies intended to reduce

inequalities). Second, it analyses how the schools' composition (based on the socioeconomic and academic background of the students) affects student outcomes in the short and long term.

Besides the introduction, this work is organised in five sections. The second chapter—co-authored with Prof. John Jerrim and Dr. Rodrigo Torres—explores trends of socioeconomic segregation for 34 OECD countries from 2000 to 2015. Previous research has demonstrated how between-school segregation varies significantly across countries, with high levels of segregation occurring in central European nations that 'track' children into different schools and much lower levels in Scandinavia. This paper contributes to this literature by showing whether industrialised countries have made any progress in reducing levels of between-school segregation over time. Using six waves of data on the Programme for International Student Assessment (PISA), this work illustrates how the segregation of rich and poor pupils has remained broadly unchanged across OECD countries. This is despite major economic and political events occurring during this period, along with the introduction of numerous policy initiatives designed to reduce socioeconomic gaps. Therefore, the conclusions indicate that structural factors are likely to be the main drivers of between-school segregation (e.g. neighbourhood segregation or long-standing school admission policies) and that education policymakers may need to be much more radical if they are to foster greater levels of integration between the rich and the poor.

The second chapter continues to analyse segregation trends, but instead focusing on the market-driven Chilean educational system. This study analyses trends of socioeconomic segregation (1999-2016), observing a period with an absence of policies aimed at reducing segregation (1999-2008) and a later stage when policies with the potential to affect the socioeconomic composition of schools were implemented (2008-2016). Using the 'Square Root Index', the dissimilar distribution of the students across schools is assessed by the type of provider, the use of co-payment, and the schools' selectivity status at both primary and secondary level. The results suggest that segregation increased from 1999 to 2010 and has remained stable (and extremely high) since then. Segregation appears to be associated with certain key features of the Chilean educational system, such as the selectivity status of schools or the use of co-payment. Further analysis linking local information with PISA databases suggests that previous estimates of segregation in Chile may be underestimating the level of segregation of some social groups, particularly at the secondary level.

The third chapter focuses on observing the influence of the schools' socioeconomic composition on students' academic outcomes. Drawing on Chilean administrative data, this study investigates the impact of the socioeconomic status (SES) of primary school classmates

on students' achievement at secondary school, the magnitude of the effects, and how they relate to types of schools and the students' SES. Unlike some previous studies, this work explicitly attempts to control the non-random allocation of students in schools, accounts for prior achievement, and uses composite measures to express the characteristics of the SES. The results—based on estimates of school fixed effects—suggest a small positive impact associated with increases in the level of the mean SES of the classmates in both Maths and Language. Greater SES heterogeneity leads to virtually no gains in scores. The magnitude of the impact varies across subjects and according to the students' SES.

Although significant efforts have been made to reveal the impact of peers' academic characteristics on educational outcomes, the long-term effects of early classmates remain unknown. Drawing on rich datasets from Chile, the fourth chapter assesses to what extent the average academic ability and the academic heterogeneity of primary school classmates affect the later educational paths of students (after the post-secondary level). The data features not only allow reliable identification of the peer group during primary school (fourth grade), but also resolve issues derived from the non-random allocation of students across schools (in a context of a nationwide school choice scheme and where early student selection practices are allowed). The results show that increases in the average performance of peers have a negative—although small—effect on higher education entrance exams, which is especially marked in Mathematics. The data suggest that impacts associated with greater academic heterogeneity are virtually non-existent. The academic characteristics of classmates exert a somewhat greater negative influence on low-achieving students in Language. Implications for the equity and efficiency of the Chilean school system are also discussed. Finally, the fifth chapter presents conclusions and policy recommendations based on the findings from the empirical chapters.

Chapter 2

School Segregation Across the World: Has Any Progress Been Made in Reducing the Separation of the Rich From the Poor?

2.1 Introduction

The uneven distribution of students from different social classes across schools is a matter of concern to educational policymakers across the world. Although the extent and mechanisms by which school composition effects are displayed is a matter of dispute, there is a general agreement that composition matters and shapes educational outcomes (Trupp, 1995). Indeed, previous research has suggested that having a higher proportion of students from advantaged backgrounds as one's peers has a positive effect on a range of educational outcomes (Van Ewijk & Sleegers, 2010). Moreover, student performance is more strongly related to socioeconomic status than to other compositional characteristics such as gender, immigrant condition, or race (Rumberger & Palardy, 2005). Consequently, schooling systems which tend to cluster students of low socioeconomic status together could be increasing educational inequality and reducing social mobility over time (Levacic & Woods, 2002). The effects of social segregation between schools is not limited, however, to student achievement alone; previous research has also found that greater levels of between-school segregation also have an effect on school attendance, grade retention, and behaviour (Palardy, 2013; Palardy, Rumberger, & Butler, 2015). The extent of between-school segregation in an education system therefore matters, with some believing that encouraging greater mixing of young people from different social backgrounds is key to reducing educational inequalities. Indeed, some scholars have even argued that socioeconomically segregated schools fail to prepare students for facing diversity (Massey & Fischer, 2006) and may even be a threat to social cohesion (Gorard, 2009; Mickelson & Nkomo, 2012).

Yet despite the significant academic and policy interest that has been shown in school segregation, relatively little work has investigated how between-school segregation compares across countries and whether this cross-national picture has changed over time. This is in spite of comparative benchmarks (be they historical levels of segregation within a country or relative standings compared to other countries) being critical to interpreting the results. In other words, the only way to really judge whether segregation is 'too high' is to draw comparisons either (a) across countries and/or (b) over time. Important exceptions include Gorard & Smith (2004), who use PISA 2000 to estimate segregation levels in 15 European Union (EU) countries. They concluded that segregation based on parental occupation was greatest in Greece and Portugal and lowest in Luxembourg, Sweden, and Ireland. Likewise, Jenkins, Micklewright, & Schnepf (2008) also used PISA data (from 2000 and 2003) to compare school segregation levels in England with 26 other industrialised countries. England was found to have average levels of segregation, with Austria, Belgium, Germany, and Hungary being high-segregation countries, while Scandinavia had comparatively low-levels

of between-school segregation. More recently, Chmielewski & Savage (2015) analysed the segregation of the United States (US) and Latin American countries. Their estimates, based upon PISA 2012, found that Latin American countries were more segregated than the OECD average and the United States. This is consistent with the results of Murillo & Martínez-Garrido (2017), who found that Latin American countries exhibit high levels of segregation—and is perhaps the most socially-segregated region anywhere in the world.

This paper aims to contribute in several ways to this small but growing literature on how between-school segregation compares across the world. First, rather than focusing on only one region or "type" of education system, it includes all OECD countries. This provides a more comprehensive set of benchmarks against which to compare each country. Second, some previous papers have focused upon segregation using a single threshold—typically the median value in a socioeconomic status index (e.g. Jenkins, Micklewright, & Schnepf, 2008). However, such an approach potentially misses out important and interesting differences, such as segregation between the poorest (or richest) students and the rest of the population, and may therefore give only a partial insight into the level of segregation across education systems. In contrast, this paper provides a range of results for each country using different thresholds to separate students into different groups. Third, the two previous cross-national studies on school segregation using PISA based their estimates on the parental occupation of the students (Gorard & Smith, 2004; Jenkins, Micklewright, & Schnepf, 2008). There are some limitations with this measure, since it is based upon parental occupational status alone and is only quasi-continuous. In contrast, this work relies upon the PISA Economic, Social, and Cultural Status index, which is a more comprehensive measure of students' socioeconomic status, encompassing maternal and paternal education, maternal and paternal occupation, and household possessions (a commonly used proxy for household wealth).

Finally, a significant limitation of the existing literature is that it is cross-sectional and has not considered whether countries have made any progress in reducing between-school segregation over time. With six cycles and 15 years of PISA data now available, this represents the first study to consider this issue. This is important as the world has changed in many ways over the last decade and a half, including undergoing a major worldwide recession and significant changes to the distribution of income. Moreover, many countries have introduced educational policies attempting to widen school choice for parents, while also striving to increase competition between schools. At the same time, a lot of policy attention has focused upon 'narrowing the gap' between the richest and poorest pupils, all of which could influence the segregation of students from different social classes into different schools.

With the above in mind, this paper therefore attempts to answer two research questions:

Research Question 1. How does between-school segregation compare across OECD countries? Do particular countries stand out as more highly segregated than others?

Research Question 2. How has between-school segregation changed across the OECD between 2000 and 2015? Which countries have made progress in reducing segregation, and which have regressed?

The paper now proceeds as follows: Section 2 describes common measures of between-school segregation, while section 3 describes the PISA data. The results follow in section 4, with conclusions and directions for future research in section 5.

2.2 Measures of Segregation

A variety of indices have been developed to measure the segregation of individuals across different groups. These indices differ in terms of their statistical properties (Massey & Denton, 1988; Allen & Vignoles, 2007), as well as whether they attempt to measure segregation between just two or multiple groups (Reardon & Firebaugh, 2002). For instance, Massey & Denton (1988) classified indices of residential segregation according to five different dimensions: evenness, exposure, concentration, centralisation, and clustering[5]. In the school-segregation literature, measures usually incorporate "evenness" and "exposure". Evenness refers to differences in the distribution of two social groups among schools in a country. A school system is even if the allocation of students to schools matches their overall proportion at a national level. A school system is uneven if the proportion of students within one or both groups at schools greatly differs from their national proportion.

Exposure refers to the degree of potential contact, or the possibility of interaction, between two different groups within schools in a country. The probability of interaction between groups is given by the proportion of individuals per school who are part of each group. A very segregated school shows low exposure, as there are very few students from other groups than the majority group. Examples of indicators measuring exposure are the interaction index or the isolation index.

The most frequently used indices of segregation in education are the Dissimilarity Index (D), usually called the Duncan Index (Duncan & Duncan, 1955), and the Square Root Index (H), or Hutchens Index (Hutchens, 2001). These two indices will be used in this paper. Both are

[5] Concentration, centralization, and clustering are measures of geographical segregation which take into account the spatial dimension.

measures of evenness, as they assess whether the distribution of students in two defined groups within a school differs or not from the overall proportions in the population.

The Dissimilarity Index is a measure which aims to reflect the different distribution of two groups (e.g. students of high and low socioeconomic status) among specific units (e.g. schools). Formally, and in order to measure school segregation among groups A and B in country c, the D-index is defined as follows:

$$(1) \qquad D_c = \frac{1}{2}\sum_{i=1}^{S}\left|\frac{a_i}{A} - \frac{b_i}{B}\right|$$

In reference to this paper, A and B represent the total number of students in country c who belong to groups A and B, respectively. The total number of schools in country c is S, and the number of pupils in school *i* for group A and B are a_i and b_i respectively. The index ranges from zero to one. A value of zero indicates that the proportion of both groups in every school is equal to the proportions found in the population (i.e. there is no segregation). In contrast, a value of one indicates that there is complete segregation of pupils, such that all schools only have one group of students represented. The dissimilarity index measures may be interpreted as the proportion of students from a minority group that would have to change school—without replacement—in order for each school to have the same percentage of that group as is found in the national population[6].

The Square Root (H) index also aims to reflect the distribution of two groups of students across schools. The main advantage of H over the D index is that it is possible to decompose segregation into different parts (e.g. into segregation that occurs within state schools to segregation that occurs within private schools). Using the same notation as for the dissimilarity index above, the square root index is defined as:

$$(2) \qquad H_c = \sum_{i=1}^{S}\left(\frac{a_i}{A} - \sqrt{\frac{a_i}{A}\frac{b_i}{B}}\right)$$

For each school (*i*) a measure of how far students from group B are from the average proportion of students in group A is estimated. If the proportion of students in group B is exactly the same as the proportion of students in Group A in each school, then there is no

[6] As one of the properties of the index is the 'symmetry between groups', it is expected that the index will produce exactly the same value of segregation regardless of how the groups are labelled. For detailed discussion about the desirable properties for a segregation index see Hutchens (2004).

segregation and the index takes the value zero. On the other hand, when the proportion of Group B students is zero, there is complete segregation, meaning the index is then equal to 1.

When estimating segregation between two groups, the dissimilarity index has several attractive features. It is straightforward to compute, can be interpreted by a wide audience, and has the important properties of composition and scale invariance when measuring segregation between two groups[7]. However, one of its main weaknesses is that it does not comply with the so-called principle of exchanges (see Reardon & Firebaugh, 2002). That is, the D index does not remain constant after a fixed number of students exchange places between two schools which are over or underrepresented in a certain group[8]. It also does not allow for the decomposition of segregation between and within schools.

On the contrary, one of the main advantages of the H index is its property of decomposability, which allows segregation to be decomposed by subcategories. For instance, total segregation can be decomposed between and within schools, or between private and public schools. In practice, however, it produces very similar estimates to the D-index, as it shall be illustrated in this paper (see Appendix 2B). Consequently, the analyses throughout this paper focus on results using the dissimilarity index (D) due to its desirable interpretation and previous use throughout a wide literature spanning the social sciences (e.g. Jargowsky, 1996; Burgess, Wilson & Lupton, 2005; Gorard 2009). Nevertheless, in Appendix 2A the alternative results using the Hutchens index are reported, illustrating that this does not have an impact upon the substantive conclusions presented in this work.

2.3 Data

This work uses data from six waves of the Programme for International Student Assessment (PISA), covering the years 2000 to 2015. Most current OECD members have participated in every round, though a handful began their participation later than 2000[9]. Consequently, this paper considers how between-school segregation compares over this 15-year period for most

[7] Composition invariance refers to the fact that a measure of segregation does not change if all inputs change their scale simultaneously (for instance, if they are weighted for a specific factor). Scale invariance, on the other hand, means that the index will not be affected by the size of the groups under analysis as soon as they are representative.

[8] For instance, if n people from group A are transferred from school x to school y, and another group of n people from group B are transferred from school y to school x, then the final index remains constant if school x or y are under or overrepresented by a certain group.

[9] The following 34 OECD countries are included in the analysis: Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, South Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom and United States. For the United Kingdom, estimates are presented separately for England, Northern Ireland, Scotland and Wales.

of the 36 OECD member states. The analysis focuses upon the OECD nations only as (a) non-OECD members have tended to enter PISA post-2006, and hence have limited data available to consider trends over time and (b) some suffer from the problem of having a significant number of 15-year-olds who are no longer enrolled in school (Spaull 2017).

The PISA target population are 15-year-old students who are in school, irrespective of school type and grade[10]. A two- or three-stage sampling procedure is used in each country in order to draw a nationally representative sample. Specifically, a random sample of schools is first drawn as the primary sampling unit (with probability proportional to size) and then at least 30 pupils are then randomly selected within each school. To be included in the PISA study, the OECD demands each country achieve a high response rate (above 80 percent for pupils and above 85 percent for schools), with most countries able to meet these criteria. Response weights have been calculated by the OECD to correct for non-random non-response, and these are applied throughout the analyses. Although the total number of participating students and schools varies across countries, in each nation at least 150 schools and 2,069 students take part.

To estimate between-school segregation within each country the PISA Economic, Social, and Cultural Status (ESCS) index was used. This combines students' self-reported information on parental occupation, parental education, and household possessions into a continuous index via a principal components analysis[11]. With the release of PISA 2015, the OECD has created a rescaled version of the ESCS index to ensure it is comparable across all years (this is available from http://www.oecd.org/pisa/data/2015database/)[12].

2.3.1 Measuring segregation in schools

The analysis began by dividing the population into two groups and then estimating the Dissimilarity index detailed in equation (1). In other words, the proportion of pupils of "high"

[10] More specifically, PISA covers a set of skills, knowledge, and competences defined by OECD as relevant for personal, social, and economic well-being, in four domains: Mathematical Literacy, Reading Literacy, Scientific Literacy, and Problem Solving Skills. For more information see, for example, OECD (2004).

[11] Although the ESCS is coded for the great majority of students, a proportion of pupils still do not answer the student questionnaire or show incomplete answers. In this case and in case one item was missing, multiple imputation techniques were used to complete the missing information. In case two or more items were missing, the ESCS index was defined as missing. In general, the response rates to the students' questionnaire are very high.

[12] As the ESCS index is based on information provided by the students regarding their parents' occupation and education, concerns about measurement error arise. These concerns are threefold. First, in general students may inaccurately report the parents' characteristics. Second, specific social groups may provide less precise information. Third, the quality of the reports may vary across contexts (e.g. countries). All of these factors may lead to over- or underestimation of the role of the SES. However, the conclusions from recent reports suggest that the impact on the comparative analysis of countries over time is likely to be minimal (Jerrim & Micklewright 2012).

and "low" socioeconomic status within each school was calculated and compared to the proportion of students of high and low socioeconomic status in each country's population. Given that the ESCS index is continuous, any particular cut-off point could be used to divide pupils into high and low socioeconomic groups. For instance, previous international comparative research has chosen the national median of the ESCS index, with half of pupils defined as "high SES" and half the population as "low SES".

However, given that the decision on where to set this cut-off point is arbitrary, a series of results using multiple different values is presented. Specifically, each country is divided into high and low SES groups defined using each national ESCS decile. For instance, to estimate how segregated the poorest 20 percent are from the remaining 80 percent, the population in each country is divided into two groups based upon the 20th ESCS percentile. Later, the formula for the Duncan index given in equation (1) is applied, using the PISA Balanced-Repeated-Replication (BRR) weights to calculate the appropriate standard error. This process is then repeated using a different decile of the ESCS index as a cut-off point (e.g. separating the bottom 30 percent of the national population according to the ESCS index from the remaining 70 percent). This has been done for each OECD country and each round of PISA. For selected countries with interesting findings, graphs illustrating the full set of results are presented. Otherwise, this paper focuses upon:

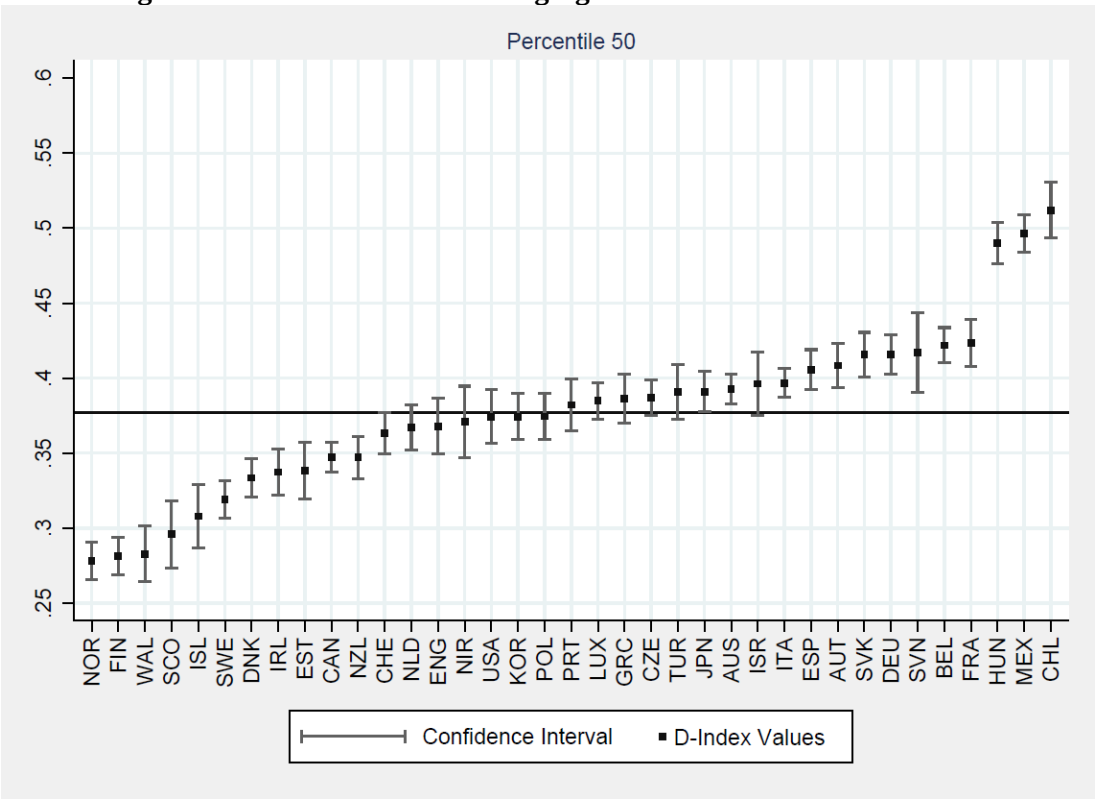
- Segregation of the bottom ESCS quintile from the remaining 80 percent (P20 cut-off point)
- Segregation at the ESCS median (P50 cut-off point)
- Segregation of the top ESCS quintile from the bottom 80 percent (P80 cut-off point)

2.4 Results

2.4.1 Comparisons of segregation across countries

Before considering trends over time, a comparison is presented of how the between-school segregation is displayed across countries. To maximise the sample size for this cross-country comparison, data from all six PISA rounds were pooled together. These results are presented in Figure 2.1, using the median value of the ESCS index as the cut-off point. Alternative results using P20 and P80 are provided in Appendix 2C-2D, with the cross-national picture not differing substantially regardless of which cut-off point is used (indeed, the correlation between results is typically above .90 using the various different threshold values). The horizontal red line in Figure 2.1 illustrates the OECD average.

Figure 2.1. Estimates of School Segregation Across OECD Countries[13]



The average value of the D-index across OECD countries is .38. There are 12 countries where between-school segregation is significantly below this value (Norway, Finland, Wales, Scotland, Iceland, Sweden, Denmark, Ireland, Estonia, Canada, New Zealand, and Switzerland), while 13 other countries have a D-index above this value (Austria, Spain, Australia, Slovakia, Germany, Slovenia, Belgium, Japan, Italy, France, Hungary, Mexico, and Chile). In terms of general patterns, these results are similar to those of Jenkins, Micklewright & Schnepf (2008) in highlighting how Scandinavia has comparatively low levels of between-school segregation, while central and Eastern European countries with heavily "tracked" secondary school systems are amongst the most segregated. However, the results are different for Japan and Australia, which present somewhat higher levels of segregation. This difference may be due to the different measurement of socioeconomic status that is used in this work (the PISA ESCS index rather than the ISEI measure of occupational prestige).

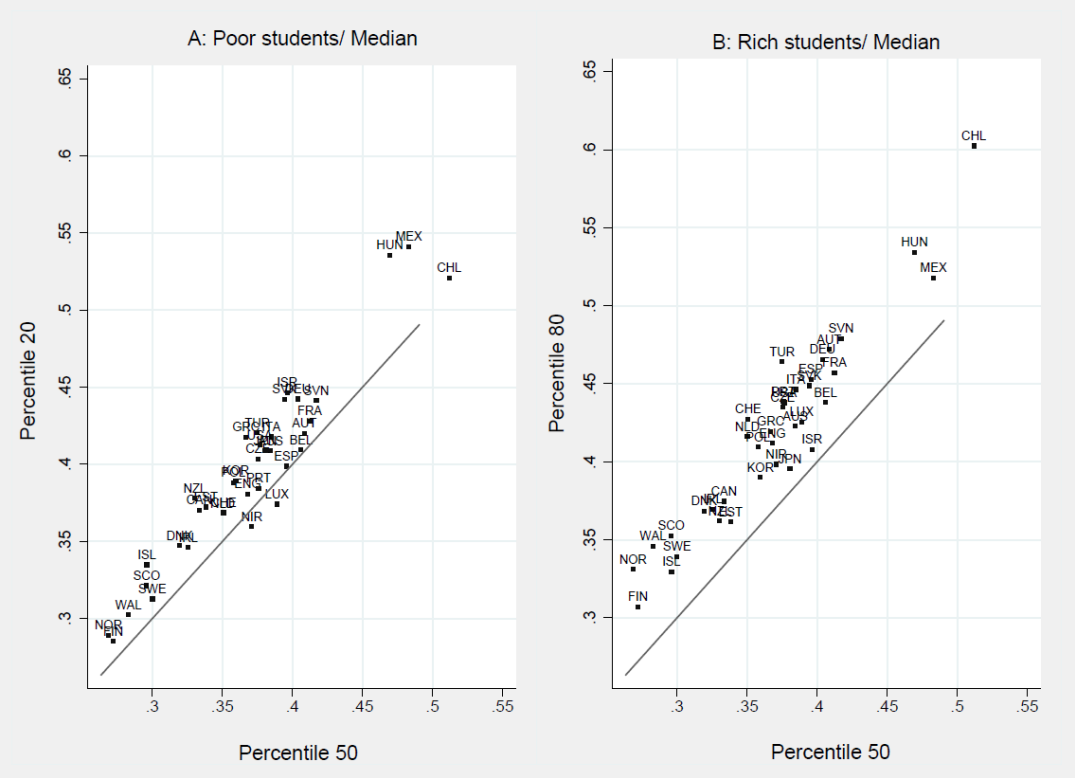
Data suggest that there are important differences in the value of the segregation index depending on the threshold used to define the socioeconomic groups (Figure 2.2)[14]. For the

[13] Figures refer to the value of the D index when dividing students into "high" and "low" socioeconomic groups based upon the national median of the ESCS index. The thin line running through the centre of each bar refers to the estimated 95 percent confidence interval. Final student and balanced-repeated-replication weights have been applied.

[14] D-index values along the x-axis refer to estimates when dividing students into "high" and "low" socioeconomic groups based upon the national median of the ESCS index. The y-axis in the left-hand panel presents the estimated D-index when the 20th percentile of the ESCS is used to separate the most

vast majority of countries, segregation is higher in the extremes of the socioeconomic distribution rather than in the middle of it. Figure 2.2 presents the D-Index values using the 20th and 80th percentiles (representing poor and rich students, respectively) and comparing them with the values obtained using the median (50th percentile)[15]. It is immediately clear that the values of the segregation index are higher for the poorest and richest students—in almost all countries—rather than when the median is used as a threshold. However, there are also some differences in countries where segregation of pupils is most intense. Hungary and Mexico stand out as countries where the most disadvantaged 20 percent of pupils are very highly segregated from the remaining 80 percent. In contrast, Chile has particularly pronounced segregation of the most socioeconomically advantaged students, with radical separation from all the other social groups. Portugal and Luxembourg present similar values of the D-index for the middle-class and wealthy students, but differ with respect to the poorest pupils, where the segregation index is lower. Finally, in some countries, such as England, Belgium, Japan, and Korea, there is less evidence of differences in the segregation index depending on where the threshold to divide socioeconomic groups is drawn.

Figure 2.2. Comparison of D-Index Values for Three Social Groups



disadvantaged 20 percent of children from the remaining 80 percent. In contrast, the y-axis in the right-hand panel uses the 80th percentile of the ESCS index to divide the most advantaged 20 percent of children from the remaining 80 percent of the population. Final student and balanced-repeated-replication weights have been applied.

[15] The D-Index values presented are an average based on the rounds of PISA in which each country participated.

2.4.2 Trends for the OECD and across countries over time

Before analysing the trends of socioeconomic segregation for each country, the data pooled across OECD countries is used to illustrate the aggregate change in school-segregation within developed countries over time. This is done by averaging the segregation index for each of the 25 countries[16] for each round. Figure 2.3 shows the OECD segregation values for each decile of socioeconomic status. No major change has occurred over time, regardless of where the threshold to divide 'rich' and 'poor' pupils is drawn. The results are very similar across each of the rounds, suggesting that segregation in industrialised countries has (on average) not changed over the last decade and a half.

Figure 2.3. Between-School Segregation Across OECD Countries. Comparison Across PISA Waves[17]

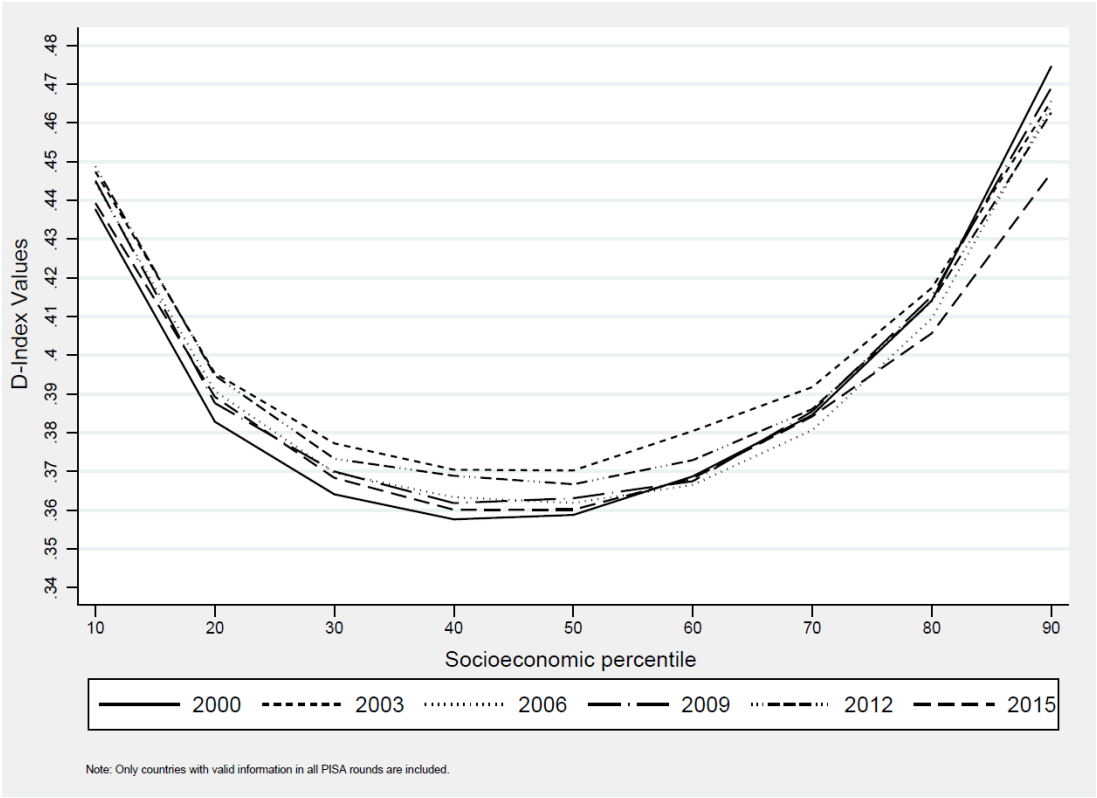


Table 2.1 turns to the country-level results for changes in segregation over time. First, the results using the median as the cut-off point for defining the two socioeconomic are observed.

[16] The countries included are: Australia, Belgium, Canada, Czech Republic, Denmark, Germany, Finland, France, Greece, Hungary, Iceland, Ireland, Italy, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Spain, Sweden, Switzerland, and United States.

[17] Graph based on 25 OECD countries with complete and useable data throughout the PISA 2000 to 2015 period. These 'OECD average' figures have been calculated by averaging the estimated D-index values across the 25 countries in each of the six PISA waves. X-axis values refer to the threshold used to separate pupils into "high" and "low" socioeconomic groups. The y-axis refers to the estimate of the "OECD-average" D index.

Although there are some countries with variation when comparing the first and last rounds (e.g. Luxembourg rises from .34 to .41 from 2000 to 2015, while Poland decreases from .43 to .34 in the same period), there is significant fluctuation in the scores in the intermediate years. Other countries such as Estonia, Slovenia, Japan, or Turkey participated in fewer rounds, making it even more difficult to establish whether the observed changes correspond to a trend. Regarding the most disadvantaged students (percentile 20), the D-index decreases from 2000 to 2015 for Switzerland (.40 to .35), Poland (.44 to .35), and Iceland (.34 to .29), while in Mexico it increases from .50 to .55 over the same period. The D-index values for the wealthy students (percentile 80) show that the Netherlands and Luxembourg present some upward variation between 2000 and 2015 (.35 to .41 and .38 to .46, respectively) and Mexico and Poland show downward variations (.56 to .50 and .51 to .36). However, the general message from Table 2.1 is that countries have typically seen (at best) only minimal changes in the amount of between-school segregation. Overall, the amount of between-school variation in most countries has not changed and it seems to be structurally ingrained.

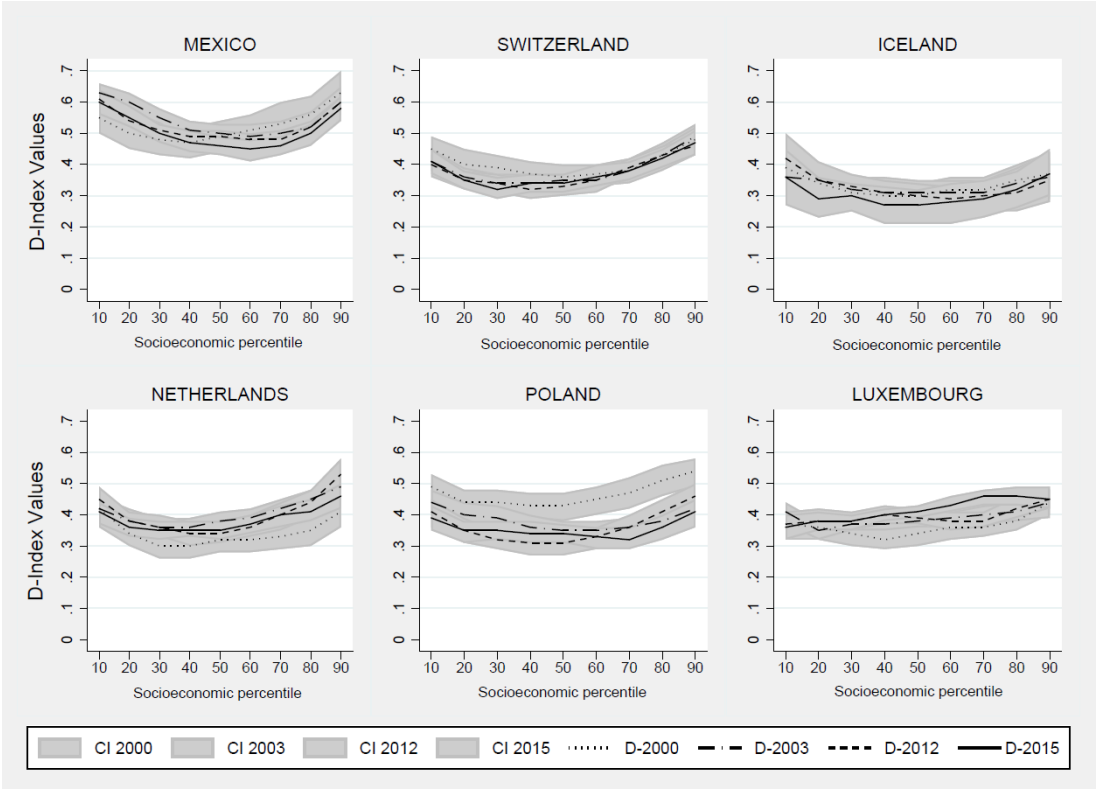
Table 2.1. Estimates of Between-School segregation (D) Across Countries (2000-2015)

Country	Percentile 20						Percentile 50						Percentile 80					
	2000	2003	2006	2009	2012	2015	2000	2003	2006	2009	2012	2015	2000	2003	2006	2009	2012	2015
Australia	.42	.39	.39	.38	.42	.45	.40	.38	.35	.37	.39	.41	.45	.41	.40	.40	.43	.44
Austria	.43	.45	.41	.42		.39	.38	.46	.41	.38		.41	.45	.49	.48	.48		.46
Belgium	.39	.45	.40	.40	.41	.41	.37	.42	.40	.43	.41	.40	.45	.44	.42	.48	.43	.42
Canada	.36	.38	.37	.38	.37	.36	.32	.35	.35	.32	.32	.33	.38	.36	.41	.37	.37	.36
Chile	.52		.53	.51	.54	.51	.51		.52	.52	.52	.49	.60		.63	.59	.62	.57
Czech Republic	.40	.41	.39	.38	.42	.43	.40	.39	.35	.34	.38	.40	.45	.45	.40	.38	.46	.47
Germany	.43	.47	.46	.44	.44	.41	.40	.44	.37	.40	.43	.38	.47	.51	.44	.47	.46	.43
Denmark	.34	.33	.33	.35	.36	.38	.30	.30	.30	.34	.34	.33	.37	.39	.33	.37	.38	.37
England			.36	.40	.39	.37			.35	.38	.36	.38			.40	.43	.41	.42
Estonia				.33	.38	.41				.31	.36	.35				.33	.37	.38
Finland	.29	.28	.27	.27	.28	.32	.28	.27	.26	.28	.26	.29	.32	.30	.29	.31	.30	.32
France	.40	.44	.45	.43	.44	.41	.39	.43	.45	.39	.42	.40	.44	.46	.50	.47	.44	.44
Greece	.38	.43	.44	.42	.44	.40	.34	.38	.37	.39	.37	.35	.42	.42	.42	.42	.42	.42
Hungary	.53	.56	.50	.54	.54	.54	.50	.49	.46	.46	.45	.46	.56	.53	.53	.51	.54	.53
Iceland	.34	.34	.35	.35	.33	.29	.30	.32	.31	.30	.28	.27	.35	.33	.34	.31	.33	.32
Ireland	.32	.36	.34	.35	.38	.33	.31	.33	.33	.34	.33	.31	.35	.38	.38	.39	.37	.35
Israel	.47			.44	.44	.43	.43			.39	.41	.35	.47			.39	.42	.34
Italy	.40	.45	.42	.42	.40	.42	.39	.41	.37	.40	.38	.36	.45	.49	.42	.46	.44	.42
Japan		.42	.46	.39	.39	.39		.41	.39	.39	.36	.36		.43	.39	.36	.42	.38
Korea	.39	.43	.38	.41	.37	.36	.36	.39	.36	.36	.36	.33	.40	.43	.38	.39	.37	.38
Luxembourg	.36	.36	.35	.38	.41	.38	.34	.39	.38	.39	.42	.41	.38	.46	.41	.42	.43	.46
Mexico	.50	.50	.60	.54	.56	.55	.49	.47	.50	.49	.49	.46	.56	.50	.52	.52	.51	.50
Netherlands	.34	.39	.38	.38	.35	.36	.32	.37	.38	.34	.34	.35	.35	.45	.45	.44	.40	.41
New Zealand	.35	.37	.37	.37	.41	.39	.33	.31	.31	.34	.35	.34	.37	.33	.36	.39	.40	.34

Northern Ireland			.34	.37	.37	.36			.35	.37	.39	.37			.37	.38	.45	.39
Norway	.31	.29	.29	.28	.28	.30	.26	.28	.28	.26	.26	.27	.30	.35	.36	.30	.35	.32
Poland	.44	.39	.40	.35	.40	.35	.43	.34	.35	.31	.38	.34	.51	.39	.38	.41	.42	.36
Portugal	.37	.36	.42	.37	.40	.40	.35	.37	.41	.39	.38	.36	.42	.39	.45	.46	.48	.44
Scotland			.34	.35	.30	.30			.32	.30	.28	.29			.33	.35	.37	.35
Slovakia		.46	.44	.39	.47	.45		.41	.40	.37	.42	.37		.46	.45	.42	.48	.44
Slovenia				.44	.46	.42				.42	.42	.41				.47	.50	.46
Spain	.40	.40	.41	.40	.38	.41	.40	.41	.39	.38	.38	.41	.46	.44	.46	.45	.44	.47
Sweden	.28	.31	.30	.32	.35	.31	.28	.27	.31	.31	.32	.32	.31	.33	.35	.36	.35	.35
Switzerland	.40	.40	.36	.35	.35	.35	.36	.37	.35	.33	.34	.34	.43	.44	.43	.43	.42	.42
Turkey		.43	.43	.43	.40	.41		.43	.35	.39	.35	.36		.52	.44	.47	.45	.44
United States	.43	.40	.40	.43	.40	.41	.36	.36	.37	.40	.39	.39	.42	.44	.42	.47	.43	.43
Wales			.32	.29	.30	.29			.30	.30	.27	.26			.35	.37	.35	.32

To further illustrate this point, Figure 2.4 investigates in greater detail the results for six countries where the variation in segregation across the period seems to be greatest. These are Mexico, Switzerland, Iceland, Netherlands, Poland, and Luxemburg. This includes the estimated 95 percent confidence interval for each round, thus illustrating whether one can rule out sampling variation as a potential explanation for any apparent change in between-school segregation that has occurred in these countries over time. For five of the six countries under consideration, the confidence intervals overlap at each socioeconomic decile (the exception is Poland, where the PISA 2000 round stands out as an outlier from the rest). Hence, this strongly suggests that sampling variation is likely to be responsible for the (small) changes in segregation in these countries. In other words, this provides further support for the key finding of this work; that almost no progress has been made in reducing the segregation of rich and poor pupils in any industrialised country since 2000, when the PISA study began.

Figure 2.4. Estimates of Between-School Segregation for Selected Countries Between 2000 and 2015[18]



[18] Figures on the x-axis refer to the percentile used to separate students into different groups. For example, a value of 25 means that the D-index was calculated based on how segregated the most disadvantaged 25% of students are from the most advantaged 75%. Figures for 2006 and 2009 are excluded for clarity of presentation.

2.5 Conclusions

The extent to which social groups mix is thought to be an important factor influencing inequality, social cohesion, and social mobility (Gorard 2009; Levacic & Woods 2002). As long-lasting friendships and peer groups are developed during young people's time in school, the extent of between-school segregation is a key indicator of whether particular social groups live in isolation from one another. Moreover, previous research has suggested that greater levels of between-school segregation may have negative effects on a range of outcomes, including attendance, behaviour, grade retention, and greater inequality in students' test scores. Understanding the extent of between-school segregation is therefore important for a better assessment of social and economic inequality, including how this varies across the industrialised world.

Previous international comparative research on this topic has found countries that separate students into different school tracks at an early age (e.g. Germany, Austria, Hungary) also tend to be more socially-segregated (Micklewright, Schnepf, & Jenkins 2008). The present study has attempted to contribute new evidence to this literature by considering the extent to which industrialised countries have made progress in reducing between-school segregation over the last 15 years. Using six cycles of the PISA data, the key conclusion is that the level of between-school segregation has remained stable within almost every OECD country. This is a striking and perhaps surprising finding, given how much the world has changed over this period. In particular, despite a host of school-system reforms occurring across the world, and major world events such as the Great Recession of 2008, the segregation of students from different backgrounds into different schools has hardly altered at all.

Consequently, in the latest round of PISA data (2015), the data continue to suggest that the Nordic countries are amongst the most socially integrated, whereas Chile, Mexico, and Hungary have particularly socially-segregated schools. In all countries, segregation of the wealthiest and poorest 20 percent of students from other groups remains pronounced, though this pattern is especially marked in countries with high levels of segregation.

There are several possible explanations for this key finding suggesting that school segregation has barely changed in any OECD country over time. First, many factors will have already shaped school segregation before 2000, when the PISA data became available. In other words, one interpretation of the results is that long-term structural factors of a country and its school system (e.g. long-standing admissions criteria used to gain entry into schools) are much more important for between-school segregation than the set of policy changes and economic shocks that have taken place over the last 15 years. Second, in many countries location matters for

parental school choice, meaning residential segregation of parents is pivotal in determining the segregation of students into different schools. In many countries, there may have been less effort in tackling residential segregation than the range of education policy and initiatives that have been implemented. Yet it could be that tackling the residential segregation of parents directly is critical to reducing the segregation of students in different schools, thus enhancing educational inequality and social mobility. Third, many education policy reforms implemented in several OECD countries have attempted to incentivise competition between schools (e.g. the routine publication of schools' results), but may not necessarily have led to changes in the socioeconomic composition of the student body.

It is also important to recognise the limitations of the present study and possible directions for future research. First, the measure of socioeconomic status preferred in this paper is based on information reported by students themselves, rather than by their parents. Although this could mean that measurement error may have some impact on the results, existing evidence from the literature suggests that the impact this is likely to have upon the comparative analysis of countries over time is inclined to be minimal (Jerrim & Micklewright 2012). Secondly, as PISA is a sample survey, the number of schools included in this study for each country per year is quite limited (typically around 150). Hence the results for any given year are subject to a non-trivial degree of sampling error and are surrounded by quite wide confidence intervals. Given this limitation, it is perhaps even more striking how highly correlated the results are between the various PISA cycles; the correlation for the between-school segregation results based upon PISA 2000 and 2015 is .85 for P20, .86 for P50, and .79 for P80 (in Appendix 2F country-level correlations across PISA waves for all applications are available. They are all very high, especially for ESCS percentiles 20 and 50). Third, due to PISA focusing upon the 'within-school' populations, the analysis is this work has been limited to OECD countries only. Further work should consider how robust and comparable measures of between-school segregation can be estimated to include the lower and middle income countries that now also take part in PISA. Fourth, this paper has focused exclusively on between-school tracking and not on the use of 'setting' or 'streaming' within schools. Yet, as noted by Chmielewski (2014), such within-school segregation is likely to be just as significant, effectively cutting off lower socioeconomic status pupils from their peers of higher socioeconomic status. Further work in the spirit of Chmielewski (2014) is required to better understand how countries separate pupils between schools versus within schools. Finally, the analysis contained in this paper has been limited to a medium time horizon (15 years). Although the world has changed dramatically over this period, significant structural factors of a country's education system such as school-segregation perhaps take much longer to change.

Despite these limitations, this paper has made an important contribution to the literature. It has highlighted how, in many countries, the children of the rich are still effectively segregated from the children of the poor. Moreover, it has shown that changes to this situation should not be expected any time soon. Despite a lot of rhetoric and policy efforts designed to 'narrow the achievement gap', provide high quality education to all pupils, and raise the educational attainment of disadvantaged groups, there remains significant levels of school segregation for young people from different social backgrounds. Based on these findings, much more radical thinking will be needed in order to change this situation over the coming 15 years and if real progress is to be made in narrowing the achievement gap between the rich and poor, as many policymakers hope.

Chapter 3

Fifteen Years of Segregation in Chile: Trends in a Market-Driven Education System

3.1 Introduction

The extent to which the socioeconomic composition of schools affects students' educational, economic, and social outcomes has been studied extensively since the publication of the 'Coleman Report' (1966). Although controversial, a significant proportion of studies suggest that the socioeconomic status (SES) of the school peers is closely related to students' achievement (Van Ewijk & Sleegers, 2010). According to this strand of the literature, school composition affects student outcomes not only through peer interaction in the classroom, but also has an impact on several relevant features that are associated with increases in student attainment. Among other things, studies have explored how socioeconomic composition affects teachers' expectations regarding students' achievement (Brault, Janosz & Archambault, 2014), the teachers' efficacy (Belfi, Gielen, De Fraine & Verschueren, 2015), students' educational aspirations (Dupriez, Monseur, Van Campenhoudt & Lafontaine, 2012), and various behavioural and social outcomes (Neidell & Waldfogel, 2008). More recent studies have suggested that the effects of the school's socioeconomic composition may persist to later stages, affecting college enrolment rates, persistence in higher education, and graduation rates (Bifulco, Fletcher, & Ross, 2011; Carrell, Hoekstra, & Kuka, 2018).

Concerns about school composition are particularly relevant in educational systems that introduce 'school choice' policies, as they may accentuate the separation of social groups (Ladd & Fiske, 2001; McEwan, Urquiola, & Vegas, 2008; Söderström & Uusitalo, 2010; Frankenberg, Siegel-Hawley, & Wang, 2011). Several factors in the context of school choice policies may affect the schools' socioeconomic structure and contribute to exacerbating the segmentation of the students. First, parents from disadvantaged backgrounds may benefit less from school choice because they are more likely to base their decisions on 'cost-related' factors rather than the quality of the school. Moreover, low-income families experience greater limitations when choosing schools outside their area of residence or moving to a neighbourhood with an offer of better quality schools (OECD, 2014). Second, the families of students with higher motivation and ability may pursue enrolment in high-quality schools so they can join other children with similar socioeconomic and academic characteristics, causing stratification of the educational systems (Bifulco & Ladd, 2007). Third, parents from disadvantaged backgrounds tend to manage or understand less information about the quality of the schools and have a more limited set choice (West, Pennell & Noden, 1998; Allen, Burgess, & MacKenna; 2014). Finally, not only families but schools may drive this process of segregation too. If regulations on the operation of private schools are not strong enough, schools may have incentives to establish selection procedures to admit only students with the

highest academic ability (West, Ingram, & Hind, 2006) or which belong to specific social groups (e.g. religious).

Chile has emerged as an iconic case in the implementation of school choice policies after the reform started in 1981. Not only does Chile have some of the greatest levels of private education provision among the OECD countries, it also allowed schools to be profit-driven for almost 30 years. Moreover, 93% of students are enrolled in schools operating under a nationalwide voucher scheme (2017)[19]. For several years little effort was made to address the uneven distribution of students across school sectors and between schools. Only in 2008 did a new cycle of policies start to tackle the issue of segregation and—without altering the main features of the educational system—attempt to balance the composition of the student's socioeconomic status (SES) in schools. However, some of these policies have been criticised for not being strong enough to produce the expected changes (Carrasco, Gutiérrez, & Flores, 2017; Valenzuela & Montecino, 2017). A new milestone was seen in 2015 with new and more radical regulations specifically oriented towards tackling the issue of segregation.

This article focuses on presenting trends of socioeconomic segregation in an educational system using parental choice as a driver for educational quality, considering two stages in the development of policies addressing the socioeconomic composition of the schools. In the first period (1999-2007), the composition of the schools was mainly driven by the school choice scheme and complemented by specific features (co-payment, student selection). No relevant policies were established during those years to influence the allocation of students in schools. In the second phase (2008-2016), several measures were introduced to address quality and equity in education. Given their designs, the new policies had the potential to affect—either directly or indirectly—the schools' socioeconomic composition. During these years specific policies and programmes were put in place in an effort to reduce the prevalence of co-payment, student selection, and to 'perfect' the voucher system.

This work advances on previous research in several aspects. First, it uses the 'Square Root Index' (H) to estimate the segregation of the educational system. Despite its advantages, this index has rarely been used to assess segregation in the Chilean context. In particular, the H-index allows the decomposition of the total segregation of the system by several weighted measures of segregation for types of schools (e.g. private/public) and separately identify the amount of segregation 'within' each type and 'between' them[20]. Second, it uses data from a

[19] Several ways of organising subsidies for education have been used around the world. In this work, the term 'voucher' is used to refer to the subsidy for the demand for education. In the case of Chile this sum is directly paid by the government to schools, and 'follows the student' if she/he started attending a new school.

[20] The specific advantages of the 'Square Root Index' are discussed extensively later in this work.

period of more than 15 years (1999-2016) to highlight tendencies of segregation. Unlike other available studies, this work observes the evolution of segregation during the years in which a series of measures were introduced with the potential to reduce socioeconomic segregation. Third, it not only presents trends of segregation at the national level, but also describes tendencies by types of schools (co-payment level, selectivity status, and type of owner), underlining the evolution of the 'within' and 'between' sector segregation. Fourth, this work does not focus on any particular social group, but provides information about the segregation of both rich and poor students over time. Finally, it deals with the issue of high rates of missing data for estimating segregation in secondary schools—a limitation that has been systematically ignored in other available studies—by using a unique database linking PISA datasets and Chilean administrative records to analyse the extent of this problem and how it could affect the estimates.

The following questions guide this work:

a) Did the level of segregation in the Chilean educational system change between 1999 and 2016? Are there any changes associated with the period (2008-2016) when policies with the potential to change the schools' socioeconomic composition were implemented?
b) How does the SES segregation relate to the types of schools (type of owner, selectivity status, and co-payment level)?

This work is developed in five sections. After this introduction, the second part describes the main features of the Chilean educational system and the recent measures aimed at reducing socioeconomic segregation. The third section introduces the data and methods, underlining the advantages of the H-index for measuring segregation. The fourth part presents the results and discusses the issue of missing data for the secondary schools. Finally, the conclusions are presented.

3.2 The Chilean Education System and School Socioeconomic Composition

In 1981 Chile was a pioneer in implementing a school choice reform (Gauri, 1988). This set of policies encouraged private stakeholders to participate as education providers by creating and administrating new schools. As part of this scheme, traditional public schools

(transformed into 'municipal' schools after the reform[21]) and the new private subsidised schools were treated equally in terms of funding by the state. The financing mechanism used a flat voucher assigned to each of the students enrolled in the public or subsidised private school, regardless of their socioeconomic background. Families could enrol their children in any school operating under the scheme, regardless of their place of residence. The market-driven approach operates under the assumption that school competition to capture enrolment will lead to increases in the productivity of the system. As subsidised private schools could be organised as for-profit institutions, greater enrolment would translate into increases in the owners' dividends. Since the implementation of the reform, the subsidised private sector increased its participation from 15% of total enrolment in 1981 to 54% in 2017. The growth of the private subsidised sector came at the expense of municipal schools, which saw their enrolment decrease from 78% of the total to 37% in the same period. Apart from the subsidised schools (municipal and private), a small fraction of the students attend non-subsidised private schools. This sector is fully funded by parents and usually enrols students from wealthy families. The proportion of the enrolment captured by non-subsidised private schools has remained remarkably stable over time, representing between 7% and 8% of the students during the last 30 years.

Although the basis of the educational systems has been unaltered since 1981, several adjustments were introduced in later years. First, in 1994 the private subsidised sector was authorised to charge fees to families. In practice, fees were considered a complement of the regular voucher. The maximum co-payment was defined by the national authority and discounts on the voucher amount were applied as the co-payment increased. Secondary municipal schools were also allowed to charge fees, but only when the majority of the families agreed on that system. In 2015, before new regulations regarding co-payment were implemented, 46% of subsidised private schools were charging fees to families[22]. Second, selection was allowed in practice and schools conducted admission processes based not only on the academic characteristics of the students, but also on their family social, cultural, and economic background. For example, González (2018)—analysing data from 2004 to 2013—concludes that between 40% and 60% of the schools carried out admission procedures, depending on the grade and year under analysis. Both co-payments and student selection have

[21] Not only did the 1981 reform changed the funding system by introducing a nationwide voucher scheme, but it also decentralised the provision of public education, transferring the schools from the national authority to local authorities (municipalities).

[22] In 2016, the highest family fees were around 130 USD. Each school establishes the size of the fees charged to families according to a range provided by the Ministry of Education.

been mentioned as potential drivers of greater segregation in the Chilean context (Valenzuela, Bellei, & De los Rios, 2014)[23].

In 2008 the first measures with the potential of reducing segregation were introduced[24]. The 'Preferential School Subsidy Law' aimed to tackle two major issues. First, up until that time the value of the voucher was flat for all the students regardless of their socioeconomic background. The new system recognised that underprivileged students required additional support in their education process. Therefore, the size of the subsidy for socioeconomically disadvantaged students was increased and poorer students became 'more attractive' to the schools in the enrolment process. Second, students using the extra voucher were exempted from taking part in admission procedures or paying fees to schools. Although the participation in the 'Preferential School Subsidy Law' scheme was voluntary and a significant proportion of the schools decided to join the programme. In 2017—almost 10 years after the start of the implementation of the scheme—93% of municipal schools and 54% of subsidised private schools were using the policy.

In 2009, a new Law—the General Education Act—was passed by Congress. This regulation established a prohibition on municipal and subsidised private schools selecting students—up to sixth grade—based on their socioeconomic characteristics or academic potential. However, the law was unspecific in many regards and there were no public institutions able to enforce it (Carrasco, Gutiérrez, & Flores, 2017).

In recent years, the authorities have started implementing major regulation. In the 'Law for School Inclusion', subsidised schools are now prohibited from charging fees to families and selecting students. The funds that were provided by the families (co-payment) will be now supplied by the state (increasing the amount of the regular voucher). As regards student selection, a new centralised admission process will be implemented that considers parental preferences but uses random allocation in cases where demand for a school is greater than the number of places available. Implementation of this new Law began in 2016 and will be put into effect over more than a decade[25]. This work does not look at the changes produced by the

[23] However, some empirical analysis suggests that the main driver of segregation at schools is the residential segregation and that co-payment only has a marginal effect on segregation (Gallego & Hernando, 2009)

[24] A previous rule (2006) established that all state-funded schools should include 15% of vulnerable students. However, there is no information about the supervision of this norm and it has been interpreted as being "forgotten" or "unknown" by the schools (Treviño, Salazar, & Donoso, 2011).

[25] Additionally, the law establishes that schools are not allowed to make profits. The current for-profit schools will have to change their status to non-profit organisations or become non-subsidised private providers.

‘Law for School Inclusion', but mainly focuses on analysing trends during previous years when the system operated under no regulations to balance the schools' SES composition (1999-2008) or when ‘soft policies' aimed at this goal were in force (2008-2016).

Table 3.1 summarises the main characteristics of Chilean schools from 1999 to 2016[26]. Besides the constant increase in enrolment in the subsidised private sector, the stratified nature of the school sector is evident. While a significant proportion of the students enrolled in the municipal sector come from a disadvantaged background (from 28% to 33% depending on the year), in the private subsidised sector the proportion of students from the poorest quintile is much lower (from 11% to 13%). Conversely, almost all the students enrolled in non-subsidised private schools come from the top 20% of the SES distribution. Slight growth in the proportion of underprivileged students is observed in the municipal sector over time. The proportion of private subsidised schools using co-payment shows an increase during the first few years, with a later period of stability (at around 47%), and then decreases (as expected with the new regulations). The socioeconomic separation of the students is also reflected in the enrolment figures of the students across the different levels of co-payment in the private subsidised sector. As is expected, the higher the fees charged by the schools, the lower the proportion of its enrolments coming from the bottom 20% in the SES distribution. Conversely, in schools with high fees, a significant proportion of their students come from the highest 20% of the SES distribution.

Several studies have investigated socioeconomic segregation in the Chilean educational system. In an international perspective, Chile was one of the 15 countries studied by Murillo and Martínez-Garrido (2017) in their work focused on Latin American education systems. Using the Duncan Index, this study argues that Latin America shows extremely high levels of segregation, with Chile surpassed only by Honduras, Panama, and Peru. Gutiérrez, Jerrim, & Torres (in the second chapter of this work) find that the level of segregation in Chile is one of the highest among the OECD countries for both rich and poor students and state that no significant reduction in the levels of segregation took place at the secondary level from 2000 to 2015. Drawing on Chilean records, Valenzuela, Bellei, & De los Ríos (2014) used the Duncan Index to investigate the magnitude of socioeconomic segregation, describing trends from 1999 to 2008. Their main findings suggest high levels of socioeconomic segregation and a slight upward trend in the levels of segregation of poor students during that period, which was especially appreciable at the secondary level. Moreover, this work establishes that schools

[26] Although there is available information about Chilean pupils and schools prior to 1999, the student-level socioeconomic information is only available since that year. Therefore, the analysis will be restricted to the years 1999-2016.

are more segregated than the municipalities where they are located, suggesting that certain features of the educational system (co-payment, selection) are exacerbating the already high segregation of the areas (although this hypothesis is not tested in the paper). Elacqua (2012) uses several sources of information to estimate the levels of segregation in schools according to their type of funding and religious denomination. He concludes that municipal schools are more likely to serve socioeconomically disadvantaged students. Therefore, the segregation of poor students is lower in public schools than in the private subsidised sector. This study also highlights that for-profit schools are more likely to enrol poor students compared to the non-profit sector and Catholic schools have fewer disadvantaged students compared to the public sector and other private subsidised schools. In contrast with most of the Chilean studies, Paredes, Opazo, Volante & Zubizarreta (2013) do not limit the estimates to the Duncan Index, but also use the Square Root Index. The work focuses on analysing how the co-payment is associated with different levels of segregation at the primary school level (from 2008 to 2010) and suggests that the segregation is mainly explained by the 'within' sector segregation (municipal, private subsidised, and non-subsidised private) rather than the 'between' sector segregation.

Replicating the methodology of the study carried out by Allen (2007), Santos & Elacqua (2016) tested the hypothesis of increases in segregation caused by the school choice policies implemented in Chile. To do so, they generated a counterfactual scenario in which all the fourth grade students (primary level) are allocated to their nearest school. They conclude that segregation is higher in the current scenario and suggest that parental preferences and entry barriers, such as co-payments and selective procedures, may be contributing to the exacerbation of segregation. Valenzuela, Villaroel, & Villalobos (2013) analysed the preliminary effects of the 'Preferential School Subsidy Law' and concluded—based on primary school information in 2011—that the new policy has almost no effect in reducing the segregation of underprivileged students[27].

[27] However, the results of this study must be observed carefully, as the 'Preferential School Subsidy Law' was implemented gradually since 2008. Therefore, the cohort under analysis was first enrolled at school before the policy started and therefore it only can capture the effects associated with students changing schools.

Table 3.1. Descriptive statistics of School (Primary level)

	1999	2002	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Number of schools	5,338	5,978	7,311	7,435	7,650	7,689	7,529	7,805	7,620	7,512	7,551	7,445	7,320	7,284
Enrolment by School type														
Municipal	57.2	55.0	50.0	48.4	46.9	45.1	43.8	42.1	41.1	40.0	38.8	38.2	37.7	37.2
Subsidised Private	35.5	38.8	42.9	44.9	46.3	47.9	49.3	50.8	51.7	53.1	53.7	54.2	54.5	54.7
Non-subsidised Private	7.3	7.0	6.8	6.7	6.9	7.0	6.9	7.1	7.2	7.2	7.5	7.6	7.8	8.1
Percentage of Underprivileged Students (bottom 20%) in each School Type														
Municipal	28.6	28.8	33.2	32.3	31.7	31.9	33.6	32.7	34.3	35.3	34.3	34.3	34.4	35.0
Subsidised Private	11.1	12.3	12.3	11.4	11.0	11.4	12.5	12.2	12.8	13.3	12.9	13.0	13.3	13.7
Non-subsidised Private	0.4	0.6	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.1	0.1
Percentage of Wealthy Students (top 20%) in each School Type														
Municipal	7.6	6.7	6.3	5.9	5.9	5.6	5.0	5.0	4.9	4.7	4.6	4.5	4.5	4.8
Subsidised Private	23.8	23.4	24.8	23.8	24.5	23.5	21.6	22.2	21.1	21.2	20.6	20.3	19.5	19.5
Non-subsidised Private	92.4	89.8	96.1	96.2	95.8	96.5	95.9	96.1	95.6	96.1	96.1	96.1	95.3	94.0
Percentage of Schools Using Co-payment [a]														
Subsidised Private	53.5	52.1	48.0	48.8	44.7	49.6	47.9	48.7	47.8	47.8	48.0	48.0	46.9	30.4
Percentage of Underprivileged Students (bottom 20%) in Co-payment Schools														
Without Fees	23.2	24.5	27.5	26.5	22.9	26.8	27.6	27.3	27.8	29.3	28.1	28.2	27.4	21.7
Low Fees	11.3	13.5	13.4	12.6	11.3	11.8	13.6	12.5	13.5	13.9	13.5	13.3	13.8	12.7
Medium Fees	2.9	3.8	3.14	3.1	2.7	3.0	3.7	3.6	3.5	3.6	3.5	3.4	3.7	4.1
High Fees	0.7	0.5	0.5	0.4	0.3	0.2	0.4	0.5	0.6	0.6	0.5	0.7	0.8	0.9
Percentage of Wealthy students (top 20%) in Co-payment Schools [b]														
Without Fees	12.5	10.5	9.6	9.1	11.0	7.8	7.4	7.1	7.4	6.5	5.8	5.8	5.5	8.8
Low Fees	14.1	12.9	11.9	10.6	10.9	10.7	9.1	9.7	8.9	9.3	9.1	8.8	9.4	10.1
Medium Fees	34.7	34.7	34.5	31.6	32.8	33.2	30.3	31.8	30.7	30.1	29.5	30.2	28.5	29.9
High Fees	71.6	72.2	74.8	71.3	72.3	74.5	69.1	71.8	68.3	67.4	66.1	64.1	62.5	61.0
Percentage of Academically/Socially Selective Schools in each Sector														
Municipal	60.6	62.3	70.0	69.9	75.1	77.2	73.2	73.9	73.7	73.1	74.4	72.3	77.9	77.3
Subsidised Private	59.9	60.6	64.5	65.2	68.9	66.6	65.5	65.4	66.3	68.2	64.1	63.1	63.4	57.6
Non-subsidised Private	87.8	86.2	91.9	92.5	93.8	90.2	91.7	91.4	93.6	95.7	94.7	94.6	94.3	94.3
Percentage of School Taking part in 'Preferential School Subsidy Law' in each Sector [c]														
Municipal	---	---	---	---	---	84.6	85.3	85.2	85.4	86.0	92.1	92.6	91.8	91.5

Subsidised Private	---	---	---	---	---	31.3	37.4	38.6	42.7	44.6	48.4	48.6	49.0	50.9

[a] Only subsidised private schools have been included, as the use of co-payment in municipal schools is rare (less than 0.3 in all periods)

[b] Data refers only to the subsidised private sector.

[c] Non-subsidised private schools were excluded as they are not eligible to take part in this policy.

Although interesting conclusions have emerged from previous studies, most of them look at the first period with available information (1999 to 2008), ignoring potential changes after the implementation of the principal measures affecting schools' composition (and therefore affecting the levels of segregation). Moreover, most of the studies analysing segregation in the Chilean education system rely on local information from SIMCE (a standardised examination administrated by the National Agency for the Quality of Education), which encompasses significant problems regarding (not random) missing data, that could introduce bias into the estimates of socioeconomic segregation.

3.3 Data and Methods

3.3.1 Measurements of segregation

Segregation—or the separation of two or more social groups—has been discussed extensively by academics for several decades. Massey & Denton (1988) reviewed various indices and classified them into five dimensions: Evenness, Exposure, Concentration, Centralisation, and Clustering. In the field of education, the notion of Evenness—used to address the dissimilar distribution of students from a particular background across schools—has been prevalent[28]. During the last three decades, an intense academic debate has taken place about which is the most appropriate way of measuring this dimension (Noden, 2000; Allen & Vignoles, 2007; Gorard, 2009). Specifically, the academic debate has stressed how each of the various indices measuring Evenness fulfil (or not) the axioms for properties of a 'Good numerical Index' (James & Taeuber, 1985; Hutchens, 2004). Estimates in this work rely mainly on the Square Root Index (H), which has been claimed to be a reliable way of measuring segregation based on the "Evenness" dimension (Allen & Vignoles, 2007). This index takes values from 0 to 1, where 0 signifies a complete absence of segregation (this implies that the socioeconomic composition of each school is precisely the same as the composition of the national level), while a value of 1 implies complete segregation (and means that all schools have only vulnerable or non-vulnerable students)[29].

[28] The original classification provided by Massey & Denton referred to residential segregation. Later, several studies in the education field have used the notion of 'Evenness' for assessing segregation in the educational system (and a few have worked using the dimension of 'Exposure'). The other dimensions are more closely related to residential issues and have not been included in studies assessing segregation in educational systems.

[29] In an fully non-segregated system, every school should have the same proportion of poor and wealthy students compared the national level. For example, if at the national level 30% of the students are underprivileged, to achieve full integration, each school should enrol 30% of underprivileged students.

The Square Root Index has two main strengths. First, the total value reported is 'decomposable'. This means that the index shows the proportion of the segregation that is due to segregation 'within' each of the school types and 'between' them. While the 'within' value is calculated by a weighted aggregation of the segregation in each of the sectors, the 'between' component "shows the amount of segregation that would remain if there were no segregation within each sector" (Jenkins et al., p 25). Given this differentiation, values of segregation can be reported for different subgroups (e.g. types of schools), using weights to estimate the amount of segregation in which each type contributes to the 'within' level of segregation. This is an important factor in the scope of this work, which aims to understand how segregation is distributed across different types of schools (regarding ownership, selectivity status, and co-payment) and how it has varied over time (between and within those classifications). Second, it fulfils the seven properties for a "good numerical index" as discussed in the literature (Hutchens, 2004; Allen & Vignoles, 2007; Jenkins et al., 2008). Specifically, it strongly fulfils the "Principle of Transfers". This means that the Square Root Index is sensitive to changes of students from schools with different proportions of socioeconomically disadvantaged students. In addition to its ability to be broken down, this is the fundamental strength of the index in comparison to the index that is most frequently used in the literature on educational segregation; the Dissimilarity Index (Duncan). The latter does not entirely fulfil the 'principle of transfers' because it only varies (increases) when a vulnerable student moves from a school with a low proportion of vulnerable students to a school with a higher proportion of vulnerable students[30].

As the Dissimilarity Index (D) has been widely used in studies on school segregation, estimates based on this index are presented in the appendix 3C-3D (and referred to in the results section). The principle strength of this index—developed by Duncan and Duncan (1955), also to measure the dimension of Evenness—is the simplicity of its interpretation. The values derived from D may be interpreted as the proportion of the minority students that would have to be removed from their schools—without being replaced—to achieve the total integration of the system. Similarly to H, the segregation values shown by D vary from 0 to 1. As most of the studies on the topic report values based on the Dissimilarity Index, the estimates

[30] There is no research analysing the patterns of mobility of the students across schools in Chile, considering the SES of the schools. However, Larroulet (2011) states that 47% of the students move from one school to another during the primary school years (first to eighth grade). As the percentage of students changing schools is high (and the SES characteristics of the schools of origin and destination remain unknown), the Square Root Index is a more sensible option for describing the levels of segregation and variations over time. Selecting an index that fulfils the 'principle of transfers' helps to prevent potential over- or sub-estimates of the values due to the specific SES composition of the schools.

will be used to compare the results to previous studies and to interpret the levels of segregation[31].

In formal terms, the Square Root Index (1) and the Duncan Index (2) can be denoted as:

$$H_c = \sum_{i=1}^{S} \left[\frac{a_i}{A} - \sqrt{\frac{a_i}{A}\frac{b_i}{B}} \right] \qquad (1)$$

$$D_c = \frac{1}{2} \sum_{i=1}^{S} \left| \frac{a_i}{A} - \frac{b_i}{B} \right| \qquad (2)$$

Where:

$H_c =$ Is the value of the Square Root Index at the highest level (in this case, the country level)

$D_c =$ Is the value of the Duncan Index (country level)

$s =$ The schools that are part of the country (or school system) under analysis.

$ai =$ The number of students with a disadvantaged socioeconomic background in a school

$bi =$ The number of students with an advantaged socioeconomic background in a school

$A =$ The total number of students with a disadvantaged socioeconomic background in the country

$B =$ The total number of students with an advantaged socioeconomic background in the country

The threshold to define whether a student comes from a "disadvantaged" or "advantaged" socioeconomic background varies depending on the purpose of the research, but must always be defined as a dichotomous variable (when indices for measuring segregation are used). Yet, binary definitions of social groups are a limited way of expressing SES. To tackle this issue, this work uses a continuous composite variable to express the students' SES (derived from parental education and family incomes). This allows segregation to be assessed using several cut-off points and—in practice—allows more flexible definitions of the socioeconomically deprived or well-off groups. For example, this allows segregation of certain social groups to be to estimated using different parameters (e.g. the 'poor' students may be defined as the bottom 10% of the SES distribution, but alternatively as the lowest 20% or 30%). The construction of the socioeconomic measurement will be discussed later in this work.

[31] According to Massey & Denton (1988), D-index values under .3 correspond to 'Low segregation'; between .3 and .6 is 'Moderate segregation', and 'High segregation' occurs when values are above .6. Other authors (Glaeser & Vigdor, 2004) have interpreted values above .6 as 'Hyper-segregation'.

3.3.2 Data and evaluation (SIMCE, PISA)

The "Education Quality Measurement System" (SIMCE) is the main instrument used in Chile to evaluate student attainment. It was implemented in 1988, but comparisons across years have only been technically possible since 1999. SIMCE tests are taken by every student enrolled in a specific grade, irrespective of the administrative characteristics of the school (public, subsidised private, or non-subsidised private). Several subjects are assessed using this test[32]. SIMCE collects information not only on student achievement, but also on their family's socioeconomic and cultural background. Questionnaires are sent to parents to inquire about specific characteristics of their home and social background. Additionally, surveys are distributed to teachers and headteachers at schools to capture their impressions regarding teaching, students, and current education policies. All the information obtained from the questionnaires is exclusively used to contextualise the results achieved by students on the tests.

Following previous Chilean literature, an index of socioeconomic status was constructed based on three categorical variables contained in the questionnaires submitted to parents on SIMCE: Father's Education, Mother's Education, and Family Income. Using polychoric correlation analysis, a continuous variable was created as a proxy for socioeconomic status (SES)[33]. In all years (both in 4th and 10th grade), the eigenvalues of the component were over 2.0. This component explains at least 70% of the variance of the data each year. This variable was constructed following the same procedure for all years. As a potential limitation in the use of indices for assessing segregation is the binary definition of the social groups under analysis, this study uses a flexible approach to observe 'wealthy' and 'poor' students. Therefore, the students were classified into centiles of SES (although—for reasons of clarity—in some figures deciles are used to illustrate the SES segregation). This allows observation of how segregation is displayed when different cut-off points are used to define the groups.

[32] All SIMCE tests are designed according to the national curriculum. Schools receive a score equivalent to the mean of all their students' performances on the test. The first round of SIMCE has an adjusted distribution of scores. The mean of the test is set at 250 points with a standard deviation of 50 points. In the subsequent assessments those parameters vary according to the results obtained for each cohort of students. Since 2012, head teachers and parents have received information about the distribution of their students on each of three performance levels according to the national standards for student learning. Students are allocated to each level depending on the score (points) obtained in each test. Neither parents or head teachers receive information about the performance level of individual students.

[33] Authors of previous Chilean studies (Valenzuela et al., 2008; Valenzuela et. al., 2014) report using Principal Component Analysis (PCA) to construct the SES index (expressly stating that some variables had been treated as "continuous"). However, the variables mentioned that are contained in the parents' questionnaire are all categorical. Using categorical variables violates the distributional assumptions of PCA. Kolenikov & Angeles (2004) suggest that using polychoric correlation is a better method than other solutions suggested in previous literature on the topic (i.e. using dummy variables for each category).

Several administrative records were used to define the types of schools. As student selection is an unregulated practice in Chile, there is no official classification for selective and unselective schools. Therefore, categorisation of the selectivity status of the schools was done based on the answers to the SIMCE questionnaire. As part of the survey, parents are requested to inform on the admission procedures implemented by the schools when they applied. Two main factors were used to assign a selectivity status to the schools; first, the use of entrance exams. According to previous reports, this is one of the most prevalent ways of implementing pupil selection and it is a practice that is carried out in both primary and secondary schools. Second, the use of interviews with parents. This is considered to be a method of assessing parental involvement and also a way of screening family social characteristics. While the first strategy is more closely related to academic selectivity, the second is used as a proxy for social selection. When more than half of the parents answered that any of these procedures were implemented, the schools was classed as selective. This threshold has been used in previous studies on the topic of school admissions due to the bimodal distribution of the parents' answers to the selectivity questions in schools (Contreras et al., 2009; González, 2018). The classification of schools regarding co-payment is based on administrative records describing the average amount of the fees charged to the families.

One of the main limitations associated with SIMCE datasets for estimating the levels of socioeconomic segregation is the significant rates of non-response to the parents' questionnaire. The missing data is unusually high at the secondary level, reaching 40% in some years. To analyse to what extent the estimates for secondary schools are affected by this problem, a unique dataset is used. In 2012, the Chilean government requested that the Organisation for Economic Co-operation and Development (OECD)—in the context of the application of the Programme for International Student Assessment (PISA)—extend the examination to an additional representative sample of students in the 10th grade. Unlike the regular age-based sample in the PISA examination, the new sample was chosen to be grade-based. Students were selected from the same schools included in the traditional PISA study but were selected only from 10th grade[34]. This strategy allows comparison of information collected in the PISA examination with the data derived from the SIMCE test. The PISA supplementary sample collected information on 5,951 students, with valid socioeconomic information provided on 5,887 of them. Although PISA has several indices that may be used for analysis regarding socioeconomic status, the ESCS (Economic, Social, and Cultural Status

[34] PISA uses a two-stage stratified sample design. In the first stage, schools having 15-year old students are selected from a national framework. In the second stage, students are chosen within the schools selected in the first stage. As in many surveys, non-responses and replacements must be taken into consideration. In the 2012 round of PISA, a school response rate of 91.9% (weighted) was stated for Chile before replacement. After replacement this rate rose to 98.8%.

Index) is used in this work. A continuous variable is derived from student-level information about the highest level of parental education, highest level of occupational status, and household resources. Both measures (SES in SIMCE and ESCS in PISA) are highly correlated (.86), suggesting that the two measurements are consistent for measuring socioeconomic status and the observed differences could be related to missing data and not the measurement of socioeconomic status.

3.4 Results

Chile has recently implemented policies aimed at reducing the extreme separation of rich and poor students described in some international reports. In this section, trends of socioeconomic segregation are provided, focusing on changes by type of school owner, co-payment level, and selectivity status. The analysis emphasises the differences in segregation between the period without governmental intervention and the later period when a series of measures (potentially of reshaping the schools' socioeconomic and academic composition) were put into effect.

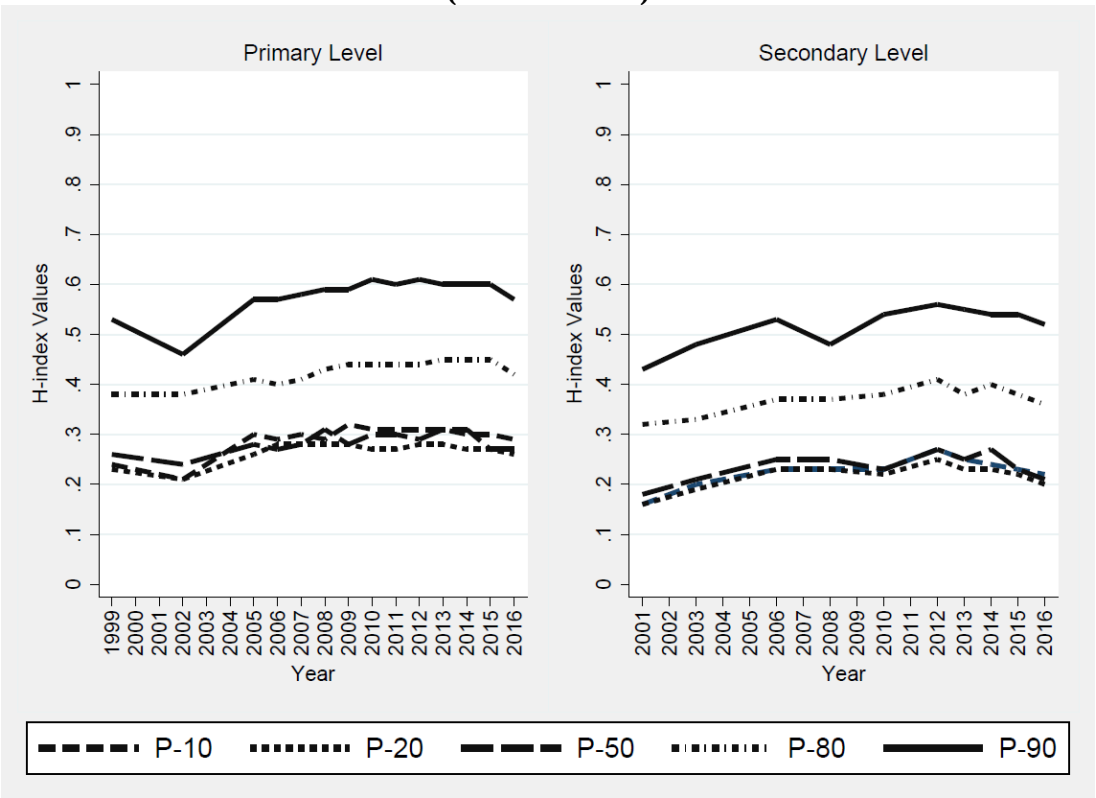
Figure 3.1 shows the trends of socioeconomic segregation at the primary and secondary school levels, using several thresholds to display the values of segregation for different social groups. In this analysis, five cut-off points are used. Percentile 10 shows how segregated extremely underprivileged students are. A second and broader measurement of the disadvantaged group is represented in percentile 20, grouping the students in the poorest 20% of the socioeconomic distribution. The median (percentile 50) separates the pupils into two groups of the same size. Finally, in order to assess the segregation of the wealthy students, two thresholds are used. Percentile 80 serves to evaluate the segregation of the top 20% wealthy students, while percentile 90 is used to assess the segregation of the top 10%.

Regarding the primary level, two main issues must be observed. First, the values of segregation vary significantly according to the threshold defined for the social groups. When percentile 90 is used, extremely high values are observed in the H-index, demonstrating that the better-off students are extremely separated from the rest of the population. When the threshold for assessing the segregation of the richest students is percentile 80, the H-index values remain high, are but lower than for the top 10%. The scenario is considerably different for thresholds 50, 20, and 10, with no greater differences in their H-index values. This means that the level of segregation of the poor students does not vary substantially when different thresholds are used. The H index varies from .46 to .61 for the richest students (percentile 90) and from .21 to .32 for the poorest students (percentile 10). The level of segregation of the poor students is high, while the situation of the rich students could be described as hyper-

segregation[35]. Second, an upward trend is observed for segregation in primary schools in all social groups. Segregation of the unprivileged students shows slow but constant growth during the first 10 years under analysis. After that period the segregation values remain relatively stable, at around .30. A similar pattern is observed for the richest students after an initial decrease in the levels of segregation.

Similar conclusions emerged from the secondary level data. However—and consistent with previous research—the values of segregation in secondary school are lower than at the primary level in all social groups. However, the observed values are still high and represent significant segregation of the social groups.

Figure 3.1. Trends of Socioeconomic Segregation at Primary and Secondary Level (National Level)



The information by type of school (Figure 3.2), also provides new insights. For simplicity, three cut-off points are used: percentiles 20 and 80 represent poor and rich students, respectively; and percentile 50 represents the division of the students into two equivalent groups (each group includes the rich and the poor students). At the primary level, the

[35] The values using D show that the richest students (percentile 90) obtain values from .69 to .79, while the poor students (percentile 10) present levels of segregation of up to .56. In simple terms, this means that more than half of the students should be removed from the schools to achieve the full integration of the system. As mentioned previously, according to Glaeser & Vigdor (2004), D-index values above .60 may be considered Hyper-segregation.

underprivileged students are extremely segregated in the non-subsided sector, with H-index values at close to .8 or higher. An important variation is observed over time, with a peak of segregation in 2009 and a later slight decrease. Although much less segregated, the subsidised private sector also shows considerable levels of underrepresentation of poor students (most of the years between .25 and .3). Interestingly, after an initial increase in the levels of segregation (from 1999-2008), a downward trend can be observed. This trend is relatively constant over time. The lowest value for the entire period in the subsidised private sector is 2016, with an H-index score of .23. In the municipal schools, the levels of segregation are smaller compared to the other sectors, with a slight upward trend in the first 10 years followed by a period of stability (with H-index scores of around .15). Data from the secondary level show a similar picture (although the H-index scores are lower compared to the primary level). A downward trend is also observed in the second half of the period in the private subsidised sector. The municipal sector displays a similar pattern to that observed at the primary level, characterised by an initial slight increase in segregation and a later period of stability.

Figure 3.2 Trends of Socioeconomic Segregation by School Type

When segregation is assessed using the median (percentile 50), the private subsidised schools show H-index values of around .20 at the primary level. As with the poor students, an upward trend is observed from 1999 to 2008. Nonetheless, the subsequent years do not show any reduction in segregation as was observed when percentile 20 was used. At the secondary level, the level of segregation diminishes compared to the primary level in the non-subsidised private sector, but remains high and can still qualify as 'hyper-segregation'. The downward trend observed for the private subsidised schools is also clear.

Finally, the segregation of the rich students shows a striking picture. At the primary level, a very clear reduction in the segregation level of the wealthy students is observed in the second half of the period under analysis in the non-subsidised sector. While in 2008 the H-index value reached .41, in 2016 it was only .27. However, it is important to note that an important part of this reduction took place from 2015 to 2016, probably due to the new and stronger regulations[36]. Municipal schools show a constant growth in the level of segregation of wealthy students. While in 1999 the H-index reached .25, in 2016 the segregation of this group rose to .36. In the private subsidised sector, the segregation of the rich students showed growth from 1999 to 2010, but remained stable thereafter.

The H-index not only provides estimates of segregation, but also differentiates the proportion of the segregation that is due to students' distribution between school types and segregation within each type. Figure 3.2 not only includes the values on segregation for each school type, but also the 'between sectors' value[37]. Segregation in Chile is mostly driven by the distribution of the students within each sector at both primary and secondary school. This feature has not changed over time. However, some differences are observed by social groups. In the case of the poor students, the levels of 'between' segregation show that—even if there were no segregation within each school sector—around 30% of the segregation would remain (percentile 20). On the contrary, in the case of the wealthy students (percentile 80), around 48% of the segregation would remain in the case of 'non-within' sector segregation. For most of the social groups, the 'between' segregation accounts for less than half of the total segregation. As only a small fraction of the students is enrolled in the non-subsidised private sector, this data suggest that students at municipal and private-subsidised schools are similar in their socioeconomic characteristics to some extent, but are separated into schools that are very homogenous in their SES composition. Although the levels of segregation of the

[36] The new reform established a gradual elimination of co-payment. A school that did not want to participate in the new scheme could opt to become 'fully private' or non-subsidised private. This may be driving changes in the levels of segregation, as former private-subsidised schools are now considered to be 'non-subsidised'.

[37] The detailed figures of 'between types segregation' for each decile are available in the appendix in tables 3C-3F.

secondary schools is lower than at the primary level, the proportion of the segregation due to the between-sector differences is similar at both levels for every social group. This confirms that segregation in Chile is mostly driven by the uneven distribution of the students within each school sector, rather than between them.

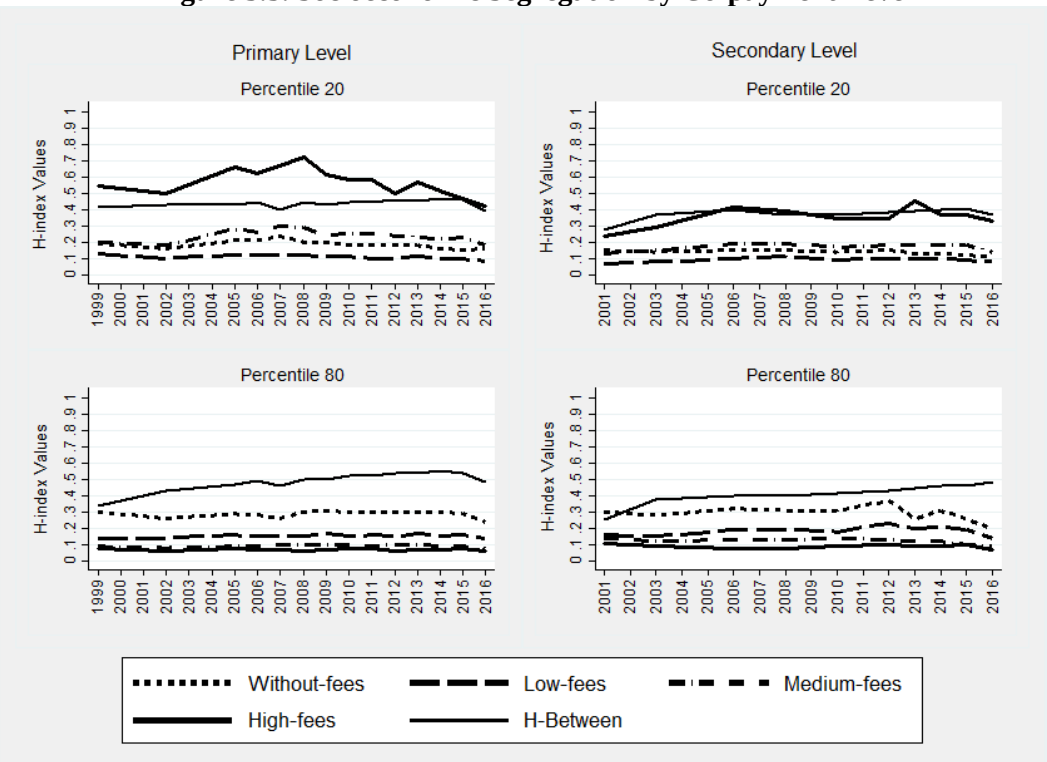
A particular feature of the private-subsidised sector is the possibility of charging fees to families. Around half of private subsidised schools charged fees to families from 1999 to 2015 (Table 3.1). Since 2016—and associated with new regulations—a dramatic decrease in the proportion of schools with co-payment has been observed. Data regarding segregation at the primary level (Figure 3.3) suggest that underprivileged students show extreme levels of segregation at schools with high fees. In most years, segregation of poor students is above .50 on the H-index. This suggests that co-payment is a barrier for poor students to access this type of school and that this social group is significantly underrepresented among schools with high fees. However, segregation in schools charging high fees appears to have been shrinking gradually since 2009. The rest of the schools using co-payment show different levels of segregation, with indices increasing as the size of the co-payments rises. While schools using medium-sized fees also show considerable levels of segregation (albeit with a downward trend over time), schools with low fees show much lower figures (with indices close to .1 in all years). Schools without co-payment present greater levels of segregation compared to schools with low fees and have slightly smaller levels compared to schools with medium fees. This implies that sector of schools that do not charge fees enrol a relatively diverse set of students, but the schools within that sector are very homogenous in terms of their socioeconomic composition.

Students from advantaged backgrounds (percentile 80) show greater segregation in free schools. Although still considerable, the level of segregation of rich students in schools without co-payment (around .3 in most of the period) is far lower than the segregation of poor students in schools with high co-payment. Segregation of wealthy students decreases as the levels of co-payment increase. Unlike the downward trend observed at the primary level regarding segregation of poor students in schools with high fees, no reductions are observed in the levels of segregation for wealthier students in any of the types of school. The differences in the levels of segregation according to co-payment levels are less marked at the secondary level. However, the same structure remains. For underprivileged students, the most segregated schools are those with high fees. Only small differences can be seen between the other types of school. Although there are some fluctuations, the period between 2001 and 2013 is characterised by high levels of segregation in schools with high fees and a later decrease. The other types of school do not experience significant variations over time. Wealthy students are

more segregated in the first years under analysis (2001-2013) and there is also a slight decrease from 2013 to 2016.

A significant change has taken place in this sector over time (Figure 3.3). The proportion of the total segregation explained by differences in student distribution between the schools using different levels of co-payment increased sharply between 1999 and 2015. For example, in 1999, 40% of the total segregation of poor students (percentile 20) in private subsidised primary schools was due to differences between school types and 60% was due to segregation within each school type. In 2015, the proportion of the total segregation in the sector attributable to 'between' segregation was 46%. This figure is much more marked in terms of the segregation of wealthy students. While in 1999 the 'between' segregation explained 34% of total segregation of rich students (percentile 80), in 2015 it was 54%. In 2016, the proportion of 'between' segregation decreases significantly, coinciding with the implementation of a new reform eliminating co-payments. At the secondary level, the proportion of the total segregation explained by 'between' segregation is lower than at the primary level, although the same trend can be seen. At both levels, the increase in the segregation attributable to 'between' segregation is much marked in the first years under analysis, when no policy was in place for reducing segregation. The data does not allow it to be ruled out that the policies implemented have helped change the trend in segregation, which is characterised by a significant level of segregation associated with co-payment. This is consistent with the reductions in the segregation levels of poor students in private subsidised schools observed in Figure 3.2.

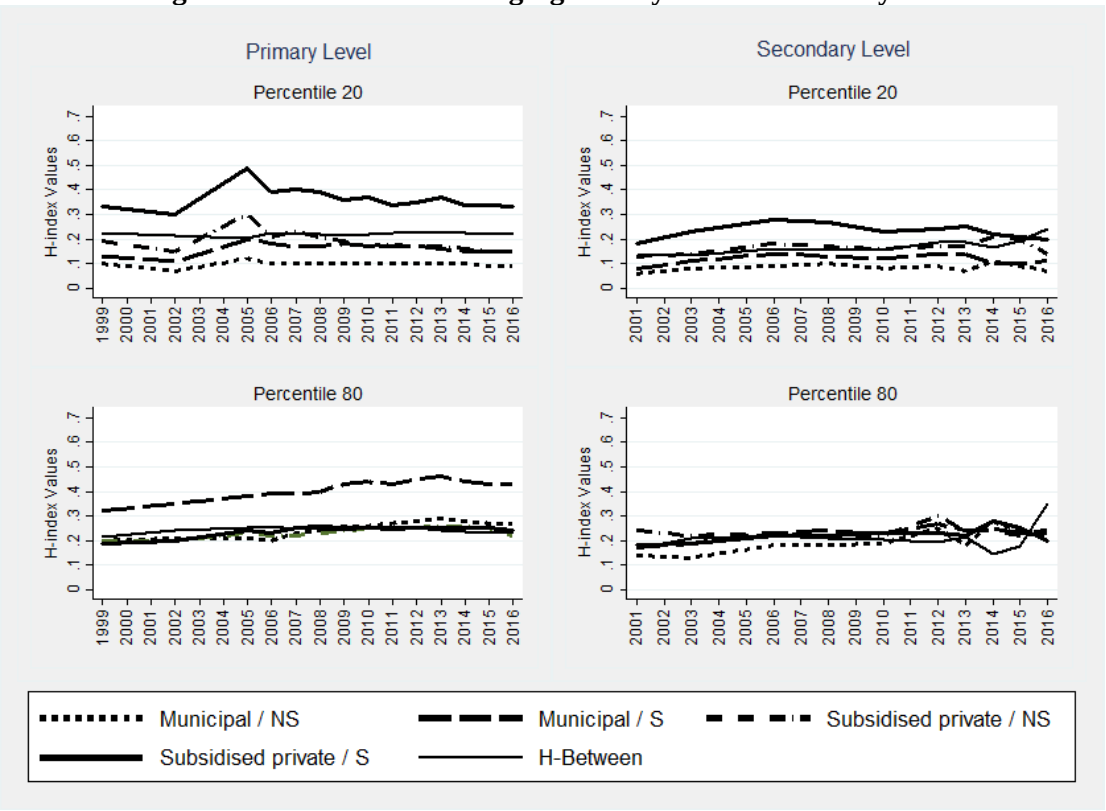
Figure 3.3. Socioeconomic Segregation by Co-payment Level



School selectivity is one of the features of the educational systems that has been claimed to be shaping school composition and accentuating segregation. The data suggest there is an association between the selectivity status of the schools and the level of segregation of students (Figure 3.4). At the primary education level, poor students (percentile 20) appear to be extremely segregated in selective private subsidised schools, with H-index values varying from .30 to .48 (depending on the year). The segregation levels of poor students in selective private subsidised schools have remained high over time, albeit with some fluctuations, although a slight downward trend can be observed. As expected, non-selective private subsidised schools show a lower level of segregation for poor students, with H-index figures similar to those for selective public schools. The non-selective subsidised private schools also present a decrease in the levels of segregation over time. In the public sector, differences also emerge between selective and non-selective schools, with selectivity being associated with greater segregation. The segregation of the affluent students is not different according to the selectivity status, except for selective public schools, which show higher levels of segregation. There is also a marked upward trend for this group, with H-Index values rising from .33 in 1999 to a peak of .45 in 2013. At the primary level, the data suggest that selectivity is associated with greater segregation, as selective schools show higher values of socioeconomic segregation in both the municipal and subsidised private sectors. Although with lower values of segregation, at the secondary level the picture remains similar. The segregation of unprivileged students is higher in selective schools (in both municipal and private subsidised schools). A reduction in the level of segregation can be observed, especially for the selective private subsidised schools (although they remain the most segregated). At the secondary level, segregation of the affluent students (percentile 80) is higher for each type of school than for poor students. No differences are observed based on the selectivity status of schools and no greater variation over time is seen.

Since 1999, in terms of selectivity, most of the segregation is explained by differences within each sector and not between them. While at the primary level, ‘between' sector segregation has remained stable and represents around 20% of total segregation, at the secondary level significant growth is observed. While in 1999, for underprivileged students (percentile 20) 13% of the total segregation was attributable to differences ‘between' sectors, in 2016 this number rose to 24%. Similarly, for affluent students (percentile 80) in the same period, the proportion of segregation due to differences between the sectors climbed from 16% to 35%.

Figure 3.4. Socioeconomic Segregation by School Selectivity Status



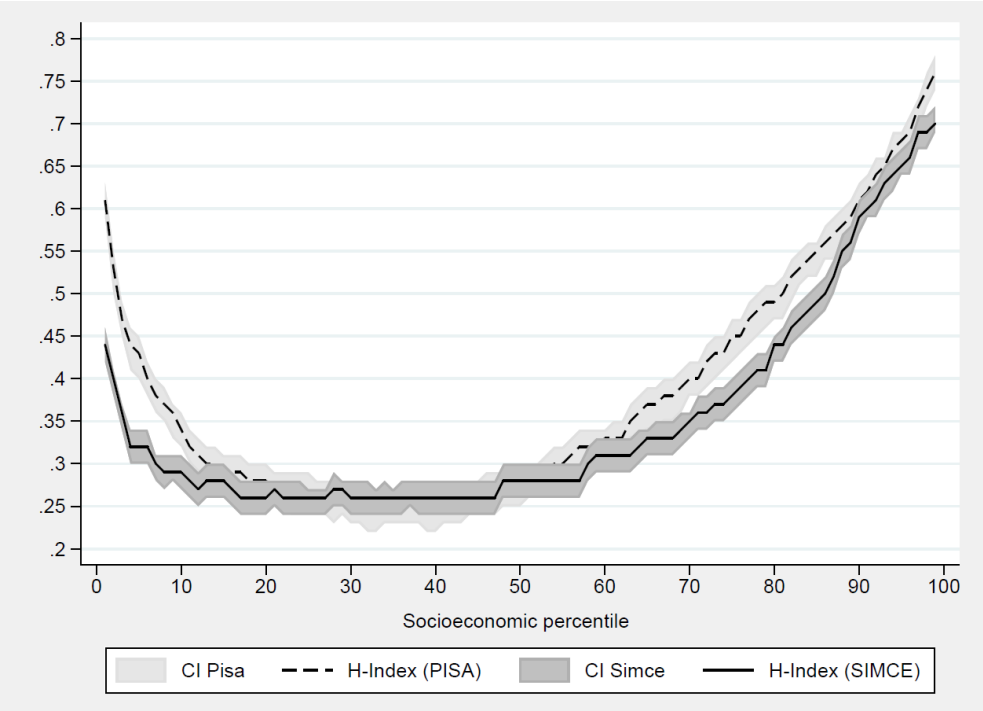
3.4.1 The problem of missing data

The figures in this work suggest that socioeconomic segregation is greater at secondary level than in fourth grade. This finding is consistent with previous research on the topic. Two main factors explain why the secondary level shows higher levels of segregation. On the one hand, students in primary school are less likely to enrol in schools outside their neighbourhood. On the other hand, as there are fewer secondary schools than primary schools, students have to mix more at the secondary level. A third unexplored option is due to flaws in the data. The average response rate is 79.2% in fourth grade, with a minimum value of 74% in 2016. In 10th grade, the response rate is even lower, with a 72% average and a minimum of 60% in 2014. The missing information is not random. The chi-squared test suggests that the missing information is not independent from the socioeconomic level of the schools or their type (municipal, subsidised private non-subsidised private).

To tackle this issue, a database of students participating in the PISA examination in 2012 was linked to SIMCE records. In contrast to the regular PISA sample, this is not an age-based sample, but is grade-based. This implies that the same group of students was evaluated in SIMCE and PISA during that year. Linking the students' level on PISA with the SIMCE records allows estimation of the correlation between the socioeconomic composite variable

used in each examination and rules out that those differences in the estimates of segregation are due to dissimilar ways of expressing the SES. Pearson's correlation coefficient is high (.86) and suggests that both measurements are consistent in expressing the students' socioeconomic status. Figure 3.5 shows the H-index values for the whole sample in the SIMCE test in 10th grade in 2012 (n=203,156) and the estimates using the PISA grade sample (n=5,887). The results are highly consistent in the measurements. As the confidence intervals overlap for most of the thresholds, it can be deduced that both sources show similar levels of segregation[38]. However, some differences emerge when evaluating the segregation of extremely underprivileged students (percentile 10), where estimates based on SIMCE information tend to show lower segregation values. A similar situation is observed for middle-high socioeconomic groups. The levels of segregation are higher according to PISA compared to SIMCE when using the 70th or 80th percentiles. This implies that estimates based on SIMCE may be underestimating the levels of socioeconomic segregation for particular social groups. The differences observed between measurements are not trivial and reach more than 10 H-index points, in percentiles 10 and 80.

Figure 3.5. Comparison of Socioeconomic Segregation Using Two Samples: PISA and SIMCE



[38] Confidence intervals were calculated for each sample. In the case of SIMCE, bootstrap was implemented (100 replicates). In the case of PISA, Balanced Repeated Replication (BRR) was used. According to the PISA technical report: "Weights for a given replicate are obtained by applying the adjustment to the weight components that reflect selection probabilities (the school base weight in most cases) and then re-computing the non-response adjustment replicate by replicate." For more details see OECD (2012)

3.5 Conclusion

The socioeconomic composition of Chilean schools and the stratification of the country's educational system have been debated at length. As segregation may have detrimental effects on economically disadvantaged students, policies aimed at influencing the SES composition of the schools have been put in place. This work describes the trends of segregation in Chilean primary and secondary schools since 1999, including those years when policies with the potential of reducing socioeconomic segregation were implemented.

Concordantly with previous studies of levels of socioeconomic segregation, the new estimates in this investigation suggest that Chile presents extremely high levels of socioeconomic segregation, which are particularly marked at the primary school level. Separation of students based on their socioeconomic background is particularly acute for wealthy students. The stratification of Chilean education has two main characteristics. First, the subsidised schools (both private and municipal) have almost no enrolment of affluent students. Second, a very significant proportion of segregation of the poor students (around 70% and 65% at the primary and secondary level, respectively) can be attributed to the sorting of the students in very homogenous schools (in terms of SES) within each sector (municipal, subsidised-private, and non-subsidised private). This feature has remained steady over the years.

Segregation is also lower at the secondary school level. This is a particularity of the Chilean educational system that may be due to the structure based on parental choice. While in many other systems, the students' choice is confined to catchment areas or districts, in Chile there are no restrictions based on geographic criteria. As research suggests, the distances that secondary students travel to schools are higher compared to the pupils at the primary level. This free movement could be helping to reduce segregation, as students are not confined to schools in already segmented neighbourhoods. Moreover, as there are fewer schools at the secondary level than at primary level, schools tend to be more mixed at the later stage. A second possible explanation is based on data. On the one hand, the secondary level presents higher rates of missing data in SIMCE (although at the primary level this is also an issue, it is less severe). Comparisons between SIMCE and PISA information suggest that estimates based on the former source may be underestimating the levels of segregation, in particular for the very poor students and, at some thresholds, for assessing the wealthy group. On the other hand, there is still a proportion of students that drop out from the educational system before 10th grade (when the SIMCE information is collected). As the cessation or discontinuation of studies is mainly associated with unprivileged students, this factor may be affecting the estimates (as the national level of reference against which the segregation of the schools is

calculated does not include the poor students that have abandoned school and were part of the educational system at the primary level).

At the primary level, the upward trend in segregation from 1999-2008 (or 2010 in some cases) observed in previous works is confirmed. Data suggest that after 2008 (when policies with the potential to reduce segregation were put in place) the upward trend stopped and a period of stability began. Although it is impossible to establish a causal link between the levels of segregation and the new policies, data suggest that in the period when the policies were implemented, no reduction of segregation is observed. However, it is not possible to rule out that the new measures have helped interrupt the increase in the levels of segregation.

The stability in the general levels of segregation does not imply that nothing has changed. This work has advanced in providing new information about how segregation is distributed within and between sectors (public/private subsidised, non-subsidised private) and according to the levels of selectivity and co-payment. The display of segregation has not varied significantly over time in any of the school types, predominantly being the separation of the students within each sector. This may be interpreted in two non-exclusive ways. First, within each sector—and especially in the subsidised private one—the schools are differentiated from each other significantly regarding their attributes in generating extremely stratified subgroups. In that sense, the "school sector" becomes a very broad category, in which schools coexist with very different types of enrolment due to differences in parental preferences. Second, the educational market distributes the students across schools based on some factors that—along with the parental preferences—shape the schools' intake. The results in this work suggest that co-payment seems to play a more decisive role in the segregation of the students compared to admission procedures. The changes in within/between segregation are particularly relevant for the subsidised private schools according to the use of fees. The segregation between these types has increased over time for both the poor and the wealthy groups and is particularly marked in the latter, suggesting that these subgroups are increasing their differentiation over time. However, these changes are not powerful enough to affect the general values of segregation by school sector or at the national level.

Chapter 4

The Effect of Peers' Socioeconomic Characteristics on student Achievement: Evidence From Chile Using School Fixed Effects

4.1 Introduction

Since the Coleman report (1966) highlighted school socioeconomic composition as the main factor explaining students' academic outcomes, several studies have challenged this claim or attempted to reveal the ways in which peer characteristics affect students from different backgrounds. While some authors have asserted that the socioeconomic stratification of schools and education systems—understood as the uneven distribution of pupils based on their SES characteristics—may lead to effects on the students' self-esteem and social relations in the long-term (Wells & Crain, 1994; Schofield, 1995), others have underlined impacts on their academic achievement (Willms, 2010). The socioeconomic characteristics of peers may affect not only the academic outcomes of students, but could also increase the gaps between social groups (Rumberger & Palardy, 2005). As the peers' characteristics may have significant long- and short-term consequences, the institutional factors determining the school composition, such as tracking and school choice, have been increasingly scrutinised by both academics and policymakers.

Although many studies have addressed the issue of school composition, major methodological and conceptual challenges have hindered development of a definitive consensus on the topic. There are two marked sources of disagreement. First, most of the studies estimating compositional effects are based on cross-sectional data, with the subsequent limitations for inferring causal results. These studies have been criticised for failing to use adequate controls of student and school level characteristics, and particularly for ignoring students' prior achievement. A recent meta-analysis conducted by Van Ewijk & Seleegers (2010) on socioeconomic school composition found that more than half of the studies on the topic were not based on longitudinal data. In spite of their methodological limitations, these works are very influential and have been used to support policy changes (Armor, Marks, & Malatinszky, 2018). Second, the results vary significantly across educational systems and for subgroups, making interpretation of the findings even more difficult. As estimating the influence of the peers implies significant methodological challenges, some authors have critically addressed the literature and questioned the existence of peer effects (Nash; 2003) and consider some of them to be "statistical artefacts" rather than actual measurable impacts (Marks, 2015).

This paper—focused on estimating the relationship between the classmates' socioeconomic characteristics and student attainment—follows the definition of peer effects provided by Sacerdote (2011), in which any externality produced by the school composition on student outcomes is included as part of the peer impact. Under this approach, the influence of peers may operate in different ways: the interaction between pupils in the academic environment,

the pressure of parents on the academic staff to improve education at the school, or in how the students' characteristics affect the teachers' performance and expectations. This implies that—as stated by other authors—peer effects are not limited to 'peer group interaction' but also include 'instructional' and 'school organisational and managerial processes' (Thrupp, 1999)[39].

Drawing on Chilean data, socioeconomic peer influence is estimated using school fixed effects to tackle the self-selection problem. This approach allows controlling for non-observable variables related to the non-random distribution of students across schools. Addressing the self-selection problem is particularly relevant in the Chilean context, where school choice policies have been promoted extensively[40]. Since parental choice is not restricted to catchment areas and schools are supposed to compete for enrolment by offering differentiated educational projects, a portion of the segregation between schools may be explained by families' preferences. The use of school fixed effects not only allows control for non-observable factors common to the families in a certain school, but also for other features such as educational programmes implemented within schools or government programmes which schools may voluntarily decide to join.

The studies on peer effects have gradually incorporated the notion of non-linearities. Hoxby & Weingarth (2005) suggest—in a study including multiple measurements of peer characteristics—that the impacts are not linear and that pupils at the extremes of the academic distribution tend to be affected more strongly by their peers. This work uses the same principle to analyse the heterogeneous impacts of socioeconomic status on student achievement for both socioeconomically advantaged and disadvantaged students.

The aim of this work is to contribute to the understanding of the effects of the socioeconomic characteristics of classmates on student achievement. In particular, this work addresses the following questions:

[39] It is not the aim of this work to reveal the specific mechanisms by which the peer effects take place, but to estimate how the socioeconomic composition may affect student outcomes.

[40] In 1981 the Chilean government implemented a nationwide voucher programme to fund both public and subsidised private schools, which now accounts for 93% of enrolment (2017). Since the implementation of this policy, private subsidised (PS) schools have faced almost no restrictions—regardless of the level—on selecting students (Carrasco, Gutiérrez, & Flores, 2017). In 1993, schools were also allowed to charge fees to families. Several studies suggest that both families' preferences and institutional settings shape the school intake (Flores & Carrasco, 2013) and are associated with greater socioeconomic segregation of the educational system (Valenzuela, Bellei, & De los Rios, 2014). Additionally, the social stratification and its relationship with academic outcomes have been analysed (Mizala & Torche, 2012)

a) What is the effect (if any) of the socioeconomic characteristics of primary school peers on the academic achievement of students in Chilean secondary schools? Are these effects equivalent across the school sectors (public, subsidised private, and non-subsidised private) and school selectivity?
b) Are the effects divergent for students in different parts of the socioeconomic distribution?

This work makes two main contributions. First, it presents estimates that address most of the most critical issues that hinder adequate identification of the peer influence. It not only observes the effect of the classmates (rather than in a cohort or school level), but also controls for the students' prior attainment. Moreover, it uses a composite variable for expressing SES, including information about parental education and incomes. As will be described later, only a few studies in the field simultaneously address all of these issues. As the results depend to a significant extent on these factors, tackling them is crucial. Second, it provides information on how the peer influence is displayed in the context of high socioeconomic segregation. Most of the studies in the field have been developed in predominantly comprehensive systems. Under those institutional arrangements, factors such as early student selection and stratification of students by types of schools are less acute than in a highly unregulated choice-driven educational system. Accounting for this context, this work presents estimates by type of schools (municipal, subsidised private, and non-subsidised private) and their selectivity status (socially selective, academically selective, non-selective).

Besides the first section (introduction), this paper is organised into five parts. Section two describes the Chilean educational systems and certain specific features that have been claimed to be connected with the schools' socioeconomic composition. The third part outlines the main findings in the literature on socioeconomic peer effects and the methodological challenges of these studies. The fourth section presents the data and introduces the empirical model. The fifth section displays the results of the model and the robustness checks and, finally, the conclusions are presented.

4.2 Chilean Educational System: Socioeconomic Segregation and Academic Stratification

The Chilean education system operates under a school-choice scheme started in 1981. The state funds the operation of both municipal and private subsidised schools in proportion to the size of the enrolment. The third type of schools (non-subsidised private) do not operate under

this system and parents fully finance them. Since the implementation of the voucher scheme, the municipal sector has decreased its enrolment (from 78% in 1981 to 37% in 2017), while the private subsidised schools have grown (from 15% to 54% in the same period). The municipal sector has a lower average student SES, while the subsidised private sector is characterised by significant heterogeneity regarding students' SES.

One major concern regarding school choice policies—such as that implemented in Chile—is their possible effects on the social and academic stratification of the educational system. Since the implementation of the voucher scheme, several authors have analysed to what extent the school choice scheme affects the between-school segmentation of the students. Auguste & Valenzuela (2004) find evidence of 'cream-skimming' associated with the increases in the proportion of private subsidised schools. Concordantly, Hsieh & Urquiola (2006) suggest that the implementation of the voucher system leads to greater stratification of the educational system, with talented students from the municipal sector migrating to the new subsidised private schools. In the same work, they do not find effects of the new voucher system on any indicator of productivity. Later, by comparing parental 'stated preferences' and 'revealed preferences', Elacqua, Schneider & Buckley (2006) conclude that the socioeconomic composition of the schools plays an important role in establishing parental preferences. Other studies (Gallego & Hernando, 2009; Chumacero, Gomez, & Paredes, 2011) have highlighted that parents take into consideration factors related to the academic quality of the school when making the decision to enrol.

The concerns about the segmentation of the students—between schools and school sectors—is also driven by two main features of the Chilean educational system that also play a role in shaping the student composition of schools. First, schools face no restrictions on implementing admissions procedures to select students based on academic, social, or economic background. Several studies have highlighted that the use of selection mechanisms is a practice used extensively by Chilean schools (Contreras, Sepúlveda, & Bustos, 2010; Carrasco, Gutiérrez, & Flores; Godoy, Salazar, & Treviño, 2014). However, the magnitude of the selection—understood as the proportion of children that are not admitted by the schools— remains unknown. Second, schools are allowed to charge fees to families on top of state funding. Therefore, students experience limitations regarding the set of schools to which they may apply, based on their socioeconomic position (Flores & Carrasco, 2013).

Additionally, recent reports have stated that segregation not only occurs between schools but within them too. According to Treviño, Valenzuela & Villalobos (2016), within-school sorting takes place—more markedly at the secondary level—based on indicators of academic ability.

These authors also state that sorting practices are associated with negative effects of equity and quality of the schools.

4.2.1 Background on Socioeconomic Peer Effects

Several theoretical explanations have been offered in the literature on peer effects—and the related topic of contextual effects—to explain how the peer influence operates. A first explanation is the association between certain 'institutional factors' and particular group compositions. In this perspective, Lauen & Gaddis (2013) argue that socioeconomically deprived classrooms are related to lower parental involvement in schooling, less rigorous curriculum implementation, and teacher quality failings, among other factors. Concordantly, other studies have suggested that peer impacts are not only limited to interaction between students, but also include 'instructional' and 'school organisational and management processes' (Thrupp, 1999). The second level of influence is due to 'peer interaction'. Based on epidemic or contagion models, this approach assumes that students from disadvantaged backgrounds present the worst educational indicators (school drop-out rates, achievement, attainment) partially due to the exposure to peer groups promoting or embodying those behaviours (South, Baumer & Lutz, 2003). As stated by Armor, Marks & Malatinszky (2018), the institutional factors are more related to school level, while the contagion mechanisms are more likely to take place at the classroom level. However, not all models consider that 'wealthier peers' would be beneficial to socioeconomically disadvantaged students (or that poor students exert a negative influence on the rich ones). For example, Crosneoe (2009) tests the idea of a 'frog pond effect'—where students benefit from standing out from their peers—and finds that low-SES students do not benefit from being placed in higher SES-schools and even experience aggravation of their psychosocial problems. Moreover, Hornstra et al. (2015), analysing racial composition, state that 'students in disadvantaged classrooms may set a norm of high motivation and may encourage achievement' (p.128), based on reports where students from ethnic minorities have shown higher levels of academic motivation.

The existence of socioeconomic peer effects is a hotly contested issue. While some authors report no impacts from the peers' SES, other find large and significant associations (Van Ewijk & Sleegers, 2010). Scholars analysing the studies in the field of peer effects have underlined that the results vary significantly depending on the features of the data (longitudinal or cross-sectional data), the use of modelling techniques for addressing the issue of self-selection in schools, the level at which the peer characteristics are observed (school, cohort, or classroom),

and the type of variable used to express the socioeconomic status of the peers (binary, composite, etc)[41].

Almost none of the studies focusing on socioeconomic peer effects develop strategies to address all the issues mentioned above. McEwan (2003) draws on Chilean records (1997) to explore the impact of classroom peers on student attainment (Language and Maths) using parental education and other proxies of SES. Unlike the majority of the studies in the field, McEwan explicitly attempts to tackle the non-random distribution of the students across the schools by using school fixed effects, finding positive impacts for several indicators of SES (especially mothers' education). As Chile allows parental choice with no formal restrictions, this work controls for unobserved heterogeneity, assuming that students within each school share non-observable characteristics but those may vary across the schools. A similar approach to address self-selection was followed by Schneeweis & Winter-Ebmer (2005) in their study using PISA datasets (and complementary administrative data) for the Austrian school system (with effects equivalent to .16 of a standard deviation) where the type of school is a critical factor in the context of a tracking system. Both studies face the same limitation: the absence of information about students' previous attainment, which may lead to overestimation of the peer influence. As stated by Van Ewijk & Sleegers (2010), the problem of excluding prior attainment measurements—inherent to cross-sectional data—comes from two main sources[42]. First, the past attainment of the student might have determined the type of schools for current enrolment (e.g. low-achievers may be less likely to follow an academic track or attend academically selective schools). Not accounting for prior achievement could be misleading, meaning that greater influence of the peers is assumed. Second, the past attainment of the students is also affected by the peers. If this issue is not controlled, the current measurements of peer effects will be also affected by the past group of peers.

Recently, other studies have attempted to tackle the non-random allocation of students to schools by using student fixed effects. Armor, Marks & Malatinszky (2018) compare several models for estimating peer influence, some of them using a student fixed-effect approach in the context of value-added estimates, and find no significant impacts associated to school SES. These results are consistent with estimates by Lauen & Gaddis (2014), who find virtually no effects in Maths and Reading and heavily criticise studies excluding measurements of previous attainment in estimating the influence of the peers. Alternatively, Rivkin (2001) used an instrumental variable regression—an approach rarely used in the study of socioeconomic peer

[41] Both Thrupp, Lauder & Robinson (2002) and Van Ewijk and Sleegers (2010) offered detailed discussions about the characteristics of the studies on the topics of peer or compositional effects.
[42] In the meta-analysis conducted by these authors, less than half of the studies analysed included measures of prior attainment. The studies that did not account for prior attainment almost doubled the size of the effects compared to those surveys including this covariate.

effects and more popular in research addressing their academic influence—finding effects of small magnitude (equal to .04 of a standard deviation). From this set of studies, only Lauen & Gaddis included classroom-level information to construct the peer measurements.

The reasons to opt for classroom-level information rather than cohort or school-level data are twofold. From a theoretical perspective, the main argument is that the students are much more likely to be affected by the classroom peers, given that they have a shared natural environment where most of the channels described in the literature on peer effects are displayed. While the 'institutional' mechanisms for peer effect operate at both classroom and school level, it is assumed that the 'contagion' or any other mechanism of peer interaction is more closely observed at the classroom level. Moreover, in a context where students may be sorted into classes (within-school), capturing the characteristics of the classroom peers is even more important. From an empirical perspective, aggregating the peer characteristics from levels greater than the classroom may add a downward bias to the estimates (Burke & Sas, 2013) in observing the influence of the academic characteristics of the peers.

Not only is the level at which the peer effects are observed a substantial factor, but also the type of variable used to express the socioeconomic composition. Studies in the field use several dimensions to construct a measurement of peer SES. While some authors utilise 'Parental Education' as a proxy for SES (e.g. Rumberger & Willms, 1992; McEwan, 2003), others rely on measurements of 'Parental Occupation' (e.g. Willms, 1986; Harker & Nash, 1996). A relevant proportion of the studies opt to use composite measures constructed based not only on the aforementioned dimensions, but also on 'Home Resources' and 'Family Incomes'. Other studies that have chosen to express the peer SES by using dichotomous measures—usually the percentage of the students with a specific characteristic that could be considered as a proxy of SES—have been criticised for their low reliability. As argued by Van Ewijk & Sleegers (2010), using 'composite measures' of SES is preferable because they best capture the various dimensions that are part of this concept and have been discussed in the literature (Sirin, 2005).

Typically, scholars have used two methods to calculate the influence of the peers. Virtually all the studies using a continuous variable or composite measurement rely on the mean of the students' SES. Other studies also include the standard deviation of the group's SES. Raitano & Vona (2013)—drawing on PISA datasets— analyse the differentiated impacts of the peers' heterogeneity between comprehensive and early tracking systems. They find that while in comprehensive systems greater SES heterogeneity has adverse effects, in the early tracking systems there is a positive influence due to increases in the levels of SES diversity. Other studies have found no effects due to greater social heterogeneity (Schindler-Rangvid, 2003).

Apart from the study conducted by McEwan (2003), there are few surveys on socioeconomic peer effects using Chilean data. Taut & Escobar (2012) use a multilevel model to estimate the impact of both the peers' socioeconomic and academic characteristics on student attainment. Using panel data (2004-2006) they find positive impacts in Maths and Language, but without making any explicit attempt to control for the non-random distribution of the students across the schools. Furthermore, this work includes several variables to express the SES (average family income, standard deviation of family income, percentage of mothers with indigenous background), but they does not include information about parental education[43]. Also using a multilevel approach—but accounting for unobserved selectivity by estimating a two-step model—Mizala & Torche (2012) study the related topic of school stratification, emphasising the differences in attainment between and within schools across the different types of schools in the context of a widely implemented voucher programme. They find a stronger relationship between the school SES and student achievement in private subsidised schools than in the public sector. However, this work does not include prior attainment measurements based on standardised tests, but only measurements of pre-school attendance and grade repetition.

This work draws on detailed Chilean datasets to estimate the socioeconomic influence of the peers on Maths and Language. To deal with self-selection, this work follows a similar strategy to that used by McEwan (2003) by including school fixed effects, but advances on that by including measurements of prior attainment and a more sophisticated measurement of peer socioeconomic status[44]. In contrast to the countries in which socioeconomic peer impacts have been estimated, Chile has a highly segregated educational system (Elacqua, 2006). Given this specificity, this work also includes differentiated estimates for each of the types of schools operating in the educational system that, according to the aforementioned studies, show significant variations in their levels of socioeconomic segregation. Furthermore, recent studies have suggested that admission procedures may shape the socioeconomic composition of the schools. To address this issue, estimates are presented for schools according to their selection status based on academic and social characteristics. As in previous studies, this work analyses whether the peer characteristics have heterogeneous effects on students in different parts of

[43] An additional issue for studies including measurements of academic peer effects—although known as 'endogenous' effects—is the 'Reflection problem', referring to the simultaneous nature of the peer influence. Among the peers, the influence is a bidirectional process, where each student is simultaneously affecting the group of peers and being influenced by it. Innovative recent studies (Sund, 2009; Gibbons & Telhaj, 2016) are not limited to including lagged measures of peer characteristics, but also takes advantage of the transition between school levels (e.g. primary to secondary) to separate the academic outcomes of the students at the secondary school from the peer influence by using information on former classmates. As part of the robustness check, estimates addressing the issue of reflection are included in this work.

[44] Although the analysis in this work focuses on school socioeconomic composition, a measure of peer academic characteristics has been included in the estimates. Using both measures simultaneously helps separate the effect of the academic and the socioeconomic characteristics of the classmates.

the socioeconomic distribution or how greater socioeconomic diversity in the classroom is associated with the students' socioeconomic status.

Finally, additional analyses are conducted (robustness checks) using different samples. First, estimates are conducted based on the group of students that moved from a primary school to a different secondary school. Specifically, the analysis focuses on the group of students that experienced an important change in the composition of their peer group during the transition from primary school to the secondary level. As in this case the peer characteristics are not parallel in any way to the performance in 10th grade, the problem of reflection is ruled out. Second, estimates are also compared for schools with within-segregation based on ability and those that do not implement such procedures. These two processes help rule out within-school segregation as a confounder in the estimates. However, other sources of bias, such as non-random distribution of teachers within the schools, cannot be ruled out due to limitations in the data.

4.3 Data and Methods

4.3.1 Data

Chilean administrative data allows identification of the school, grade, and classroom in which each student has been enrolled during their educational trajectory. This information can be merged with data from the "*Sistema de Medición de la Calidad de la Educación*" (SIMCE)[45], which contains the scores of the students on standardised tests for several subjects. SIMCE is applied every year as a census. However, since its implementation in 1997, there have been important variations regarding the grades and subjects assessed in each round of the test. Due to these discontinuities in the application, there are only a few cohorts of students that have been assessed on two or more occasions during their school trajectory. One exception is the cohort of students that started their education (first year) in 2004. This group of students (n=106,630 in Language/ 106,919 in Mathematics)[46] participated in the SIMCE test in 8th

[45] The "System for measuring the quality of education" considers the application of a test to all students enrolled in several grades (in both public and private schools). Since 1997, Maths and Language have been frequently assessed. The results of the examination are used for school accountability purposes, the allocation of monetary incentives to schools and teachers, and to provide information for school choice. The test uses Item Respond Theory (IRT) and in its first round had standardised results with a mean of 250 points and a standard deviation of 50 (and in the following assessments these parameters varied according to the cohorts' performance). However, for this work, the scores for each subject were standardised to a mean of zero and a standard deviation of one.

[46] This number only includes students that were assessed in both grades. Therefore, students repeating grades, absent for one or two assessments, or with incomplete background information are not included in this study. The number is similar to other studies. For example, Taut & Escobar (2012) based their estimates on 112,591 students for a cohort of students assessed in the same grades, but in 2004/2006.

(2011) and 10th grade (2013). The students in the cohort under study are distributed among 3,921 schools and 6,266 classrooms in primary education, and 2,770 schools and 6,893 classrooms at the secondary level. This is consistent with the structure of the Chilean educational system, which has fewer but larger schools at the secondary level compared with primary education. For reliable identification of the peer influence, classes with fewer than 10 students were excluded from the analysis. The class-size (the peer-group in the framework of this study) varies from 10 to 49 students (with a mean of 20.9 students), although more than 95% of the observations come from classes with 33 or fewer pupils.

Not only does SIMCE provide information (scores) for each student assessed, but it also collects data from parents to characterise their social, economic, and cultural background. In each round of assessment, questionnaires are submitted to parents requesting information on several matters that are relevant to contextualise the results and for research purposes. This information is not used to allocate benefits to students/families and is not required to apply to social support programs. Based on this information, a composite variable of socioeconomic status is calculated based on three main variables: mother's education, father's education, and family income. The composite variable was derived using polychoric correlation[47]. This continuous variable serves not only as a measurement of the students' socioeconomic status, but also to calculate the average SES of classroom peers and the standard deviation of the classroom peers' SES.

A critical issue for peer effects studies is the identification of the group of reference. All the classmates with valid information in 8th grade were used to construct the measurements of peer characteristics, even if during the transition from primary to secondary school they dropped out from school, repeated a grade, or did not take the SIMCE examination in 10th grade. This ensures that the appropriate group of students is looked at, avoiding observing the students' academic outcomes and the peer characteristics at the same time. Two measurements of peer characteristics are used in this study. First, the average SES of the peers, which expresses how wealthy or poor the classmates are. This measurement has been calculated for each student, considering the individual SES of the classmates. Similarly, a measure of socioeconomic diversity was calculated based on the SES of the classmates. The standard deviation of the SES values expresses how diverse in the classmates are terms of the SES. Both measurements have been standardised to a mean of zero and a standard deviation of 1 to facilitate interpretations of the effects. Additionally, a measurement of the academic characteristics of the peers has been included in all the estimates. This measurement expresses the mean performance of the classroom peers in the SIMCE examination, capturing the lagged

[47] The polychoric correlation showed an Eigenvalue of 2.25 for the first factor (used to construct the SES measurement). The factor accounts for .752 of the variance.

achievement level of the peers. Its value has also been standardised to a mean of zero and a standard deviation of 1. Table 4.1 shows a description of the main variables used in the analysis.

Table 4.1. Variables and descriptive statistics[48]

Variable	Description	Type	Mean	Std. Dev
Language Score 10th Grade	Dependent variable. Refers to the student performance in Language (2013). Standardised.	Continuous	0	1
Maths Score 10th Grade	Dependent variable. Refers to the student performance in Maths (2013). Standardised.	Continuous	0	1
Language Score 8th Grade	Independent variable. Refers to the student performance in Language (2011). Is a measurement of prior achievement. Standardised.	Continuous	0	1
Maths Score 8th Grade	Independent variable. Refers to the student performance in Maths (2011). Is a measurement of prior achievement. Standardised.	Continuous	0	1
Student SES	Is the synthesis variable derived from polychoric correlation and summarises the student socioeconomic status. Standardised.	Continuous	0	1
Number of Books at Home	Refers to the number of books at the student's home. Is used as a proxy for cultural capital. Takes values from 1 to 5 for the following categories: "No books at home"; "From 1 to 9"; "From 10 to 50", "From 51 to 100" and "More than 100".	Categorical	---	--
Years of Pre-school Education	Refers to the number of years of pre-school education for each student. It takes values from zero to 5.	Continuous	2.46	1.36
Parental Expectations	Refers to the level of education the parents expect their children to achieve. Take value 0 for "Uncompleted Secondary or less", 1 for "Completed Secondary", 3 "Undergraduate HE", and 4 "Post-graduate HE"	Categorical	---	--
Indigenous Background	Takes values of zero when neither of the parents reported having an indigenous background.	Binary	---	--
Class Size	Number of classmates of student i (8th grade).	Continuous	20.94	6.78
Peers' Mean Ability	Refers to the average score in SIMCE (8th grade) of the peers. The values have been standardised to a mean of zero and a standard deviation of 1.	Continuous	0	1
Peers' Mean SES	Refers to the average SES of the peers (8th grade). The values have been standardised to a mean of zero and a standard deviation of 1.	Continuous	0	1
Peers' SES Heterogeneity	Refers to the heterogeneity of the classmates in terms of SES. The values have been standardised to a mean of zero and a standard deviation of 1.	Continuous	0	1

Note: Statistics only reported for continuous variables.

Based on the information provided by the parents in the SIMCE survey, selective schools were identified. All parents are requested to provide information about the procedures in which they

[48] Additionally, a set of tables displaying descriptive statistics of the control variables for each of the subgroups used to present the results is available in the appendix (4E-4J).

had to participate and information they submitted when applying to schools[49]. Schools are considered to be academically selective when at least 70% of the parents responded that—during the admission process—the student had to take an entrance exam, participate in play sessions (at the lower levels), or present reports about the grades at the former school or assessments from pre-school education. Schools were considered to be socially selective when 70% or more of the parents stated that the school requested information for certifying baptism, marriage (civil or religious), and family incomes, or requested that parents participate in an interview with part of the school staff. Some 53% (n=2,089) of the primary schools were considered to be academically selective and 17% (n=680) to be socially selective.

Not only can the peer group of the students be defined through admission procedures carried out by the schools, but also within-school sorting of the students into classes. For determining which schools allocate the pupils into different classes based on their academic ability, the composition of each school was tested. Following the approach used by Clotfeltter, Ladd & Vigdor (2006) and used in later works in the field on peer effects (Shure, 2017) and within-school segregation (Treviño et al., 2016), a Chi-squared test was performed for each school with two or more classes in eighth grade. The distribution of the students across classes was tested using quintiles based on the average qualifying grades in the first three years of primary school (years five, six, and seven) prior to the SIMCE test and the percentage of students that had repeated a grade during their educational trajectory. All schools rejecting the null hypothesis of a similar distribution of students according to their academic performance or distribution of repeating students[50] were included for this confirmatory analysis. According to this estimate, sorting was present in 24% of primary schools with two or more classes per level (n=2003) and in 14% of the total number primary schools (n=3,921).

4.3.2 Empirical model

Peer effects can be displayed through different channels. The main purpose of this work is not to reveal the specific mechanisms by which the peer influence operates, but to determine whether the socioeconomic characteristics of peers have an impact on student attainment and whether this influence might vary for students with different socioeconomic backgrounds. In concordance with the school-choice scheme in place in Chile, the empirical strategy assumes that students within a school share certain non-observable factors (motivation, expectations of

[49] The indicators of selectivity have been used in previous studies. Carrasco et al. (2014) compared the responses in the SIMCE questionnaire to a survey of headteachers asking detailed information about the selection procedures and concluded that both instruments provide consistent information.
[50] Only schools with $p<.05$ in the $\chi 2$ test were included in the analysis.

education, values). To control for those factors, a school fixed effects approach is implemented. The basic model can be described as follows:

$$A_{icst} = \alpha + \beta_1 A_{icst-1} + \beta_2 F_{icst-1} + \beta_3 \overline{SES}_{-icst-1} + \beta_4 SDSES_{-icst-1} + \beta_5 \overline{SIMCE}_{-icst-1} + \beta_6 C_{icst-1} + \gamma_{st-1} + \delta_{st} + \mu_{icst}$$

Where A_{icst} is the score in 10th grade (secondary) for student *i*, in classroom *c*, school *s*. A vector of variables to control for prior achievement (A_{icst-1}) is included for each student based on the test score for each subject in eighth grade (primary) and the attendance in pre-school education. F_{icst-1} is a vector summarising the socioeconomic and cultural status of student *i* at the primary school level. It includes the socioeconomic status of the student, an indicator of the indigenous background of the parents, the numbers of books at home (a proxy for cultural capital), and the expectations of the parents regarding the students' education. The term $\overline{SES}_{-icst-1}$ is one of the variables of interest for expressing peer characteristics and shows the average SES of the classroom in which student *i* was enrolled in primary school, excluding his/her own SES. This variable expresses how poor or wealthy the peer group was. $SDSES_{-icst-1}$ is the second variable of interest and expresses the standard deviation of the SES of the classroom in which student *i* was enrolled in primary school, excluding his/her own SES. This variable denotes how diverse the group of peers is in terms of SES. The term $\overline{SIMCE}_{-icst-1}$ expresses the lagged mean score of the classmates in SIMCE (eighth grade), and it is a measurement to express academic peer influence. C_{icst-1} is a vector of variables of the classroom and schools in which student *i* was enrolled at primary level, such as the class size. The terms $\gamma_{t-1}$and δ_t represent school fixed effects for primary and secondary school, respectively. Finally, μ_{icst} corresponds to the error term.

Two features must be taken into consideration regarding this model. First, it simultaneously includes measurements of the socioeconomic and academic characteristics of the peers. Although the focus of this work is to observe the impacts of the social (usually refer as 'exogenous' in the literature) background of the peer group, the academic may be also playing a role in shaping the students' outcomes. Excluding the measure of the academic composition may introduce bias into the estimates. Second, the model uses lagged scores for measuring the peer composition in both the social and academic background. This is implemented to avoid the mutual influence between the outcome (student scores) and the peer group characteristics.

Beyond the general estimates of the average impact of the classmates' socioeconomic characteristics, several group-specific estimates are run. In these cases, the sample is restricted

to specific groups, such as education sectors, terciles of students' socioeconomic status, or the selectivity status of the school. As the results may be biased by within-school segregation and the problems of reflection (which is not completely ruled out by using lagged measures), two robustness checks are presented. First, the estimates are run separately for schools without student sorting. Like many other studies in the field, this work suffers from the risk of confusing the influence of the socioeconomic status of the peers with other unobservable characteristics of the students. If the students are sorted into classes within the schools based on their academic ability, the results may be biased. Second, estimates are conducted based on the group of students that moved from a primary school to a different secondary school. Specifically, the analysis focuses on the group of students that do not have any former primary school peers at the secondary level. As in this case the peer characteristics are not parallel in any way to the performance in 10th grade, the problem of reflection is ruled out. Additionally, this section also discusses the effects of the inclusion/exclusion of prior attainment peer-group variables.

Although this study attempts to control for the main factors hindering proper identification of peer effects, two caveats are important when interpreting the findings. First, a significant part of the results are driven by large schools (with more than one class per level), as for the students enrolled in them there will be greater variation in the peers' characteristics compared to those in schools with a single class per level. The extent to which this issue affects the estimates is discussed later. Second, the non-random distribution of teachers within the schools may affect the estimates. The issue of the distribution of teachers has been addressed recently in some works in the Chilean context, but mostly focusing on how they are allocated across the school system. So far, only Toledo and Valenzuela (2015) have explicitly taken into account the within-school distribution of teachers, observing whether teachers with different educational background and experience are randomly distributed in primary schools with more than one class per level. This research finds systematic patterns of allocation into classes, being more likely for students in classes with higher outcomes to be taught by more experienced teachers. Therefore, it is impossible to rule out that these issues may be affecting the estimates.

4.4 Results

4.4.1 Average SES effect

The non-random distribution of the students across schools is a critical matter in peer effect studies. To address this issue, this paper relies on a school fixed effects approach, assuming that there may be characteristics that are common to all of the students within each school, but

which vary across the schools. As the non-random allocation of the students to schools is the major threat for reliable identification of peer influence, several estimates are presented to analyse how the use of school fixed effects affects the figures[51]. OLS Regression (columns 1-2 in table 4.2), where no attempt is made to control for the self-selection problem, shows that the most important factor affecting students' performance in 10th grade is the student's prior achievement (SIMCE, eighth grade). An increase by one standard deviation of the peers' mean SES leads to growth of .120 and .099 of a standard deviation in Maths and Language scores, respectively. These results suggest that the influence of the average SES of the classmates is greater than the student's own SES in each of the subjects. The second variable of interest, the classroom SES diversity, shows no significant effect in any of the subjects when using OLS. However, these estimates may be affected by non-random distribution of the students across the school taking place at two different times, firstly at primary schools, where the peer influence is observed (in the scope of this study) and secondly at secondary school where the students are tested and a proportion of them are placed in a new educational context. When accounting for potential self-selection at schools solely in primary school enrolment (3-4), some changes are noticed in relation to the variables of interest. First, there a decrease in the magnitude of the effect of the peers' mean SES in Maths (although the impact continues to be positive and significant), while in Language the coefficients remain unaltered. Second, a small negative effect associated with increases in the socioeconomic diversity of the classmates appears in Language. When fixed effects are only included to control for the self-selection problem at the secondary level (5-6), the results show an even greater reduction regarding the classmates' SES. Finally, when fixed effects are used simultaneously at both primary and secondary school (7-8), several changes can be observed. There is a reduction in the influence of the prior attainment variable, but it remains the most influential factor affecting the test scores at secondary school[52]. Regarding the variables of interest, two issues must be taken into account. First, the influence of the heterogeneity of the peer SES is now negative in Language, while no significant impact is noticed for Maths, and second, there is a slight reduction in the coefficient of the average SES of the classmates in Math.

The estimates using fixed effects simultaneously at the primary and secondary level are preferred because they account for omitted variables in the two contexts where the students are observed (the peer characteristics at the primary school and the outcome at the secondary level). Furthermore, the R-square measure shows higher values using school fixed effects in

[51] Tables presented in this section only include the main variables used in the analysis. In the appendix (4A-4D), tables including the full set of covariates are presented.

[52] In the section for Robustness checks, estimates based on an adaptation of the model are presented to highlight the importance of including previous measures of attainment (and peer academic characteristics) when analysing compositional effects. Results varies importantly when the measure of prior achievement is excluded, suggesting potential bias in the estimates.

both years. As the non-random allocation of students occurs at both primary and secondary level, all of the following models include school fixed effects for both years.

There are three main conclusions based on the preferred estimates (Table 4.2, col. 7-8). First, there is an effect associated with the average socioeconomic status of the classmates. The impacts vary across subjects, with values of .070 and.99 of a standard deviation in Maths and Language respectively. Second, the socioeconomic heterogeneity of the classmates has a much more unclear influence, with significant effects only recorded for Language. However, the impacts are very small, considering that a one standard deviation increase in the level of socioeconomic diversity leads to only a reduction in .013 of a standard deviation. Third, there is a negative—although small (.059 of a standard deviation)—impact due to increases in the level of academic performance of the peers in Language[53]. Based on these findings, students would benefit from being exposed to wealthier peers and would not be negatively affected by being placed in socioeconomically heterogeneous settings. However, increases in the mean performance of the classmates do exert a negative influence (at least in Language).

[53] The influence of the peers may operate through multiple mechanisms and it is not always positive. For example, the "Invidious comparison" model states that students would experience detrimental effects deriving from being exposed to high-achieving peers. In this model, the students are negatively affected by both comparing themselves to other more talented students and because the classes are targeted at higher-performing students. Chapter 5 focuses on analysing endogenous peer effects and provides a much more detailed discussion of this topic.

Table 4.2. Ordinary Least Squares and Fixed Effect Estimates of Peer Socioeconomic Effects

VARIABLES	OLS Maths (1)	OLS Lang (2)	FE (2011) Maths (3)	FE (2011) Lang (4)	FE (2013) Maths (5)	FE (2013) Lang (6)	FE (2011-2013) Maths (7)	FE (2011-2013) Lang (8)
Prior Achievement	.645***	.617***	.644***	.617***	.583***	.578***	.589***	.584***
	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)
Student SES	.059***	.044***	.058***	.045***	.026***	.023***	.026***	.024***
	(.003)	(.004)	(.003)	(.004)	(.003)	(.004)	(.003)	(.004)
Peers' Mean Performance	.004	-.055***	-.007	-.058***	-.089***	-.126***	-.007	-.059***
	(.006)	(.005)	(.009)	(.008)	(.004)	(.004)	(.008)	(.008)
Peers' Mean SES	.120***	.099***	.081***	.099***	.077***	.077***	.070***	.099***
	(.006)	(.005)	(.017)	(.021)	(.005)	(.006)	(.016)	(.020)
Peers' SES Heterogeneity	.000	-.000	-.007	-.016***	-.004	-.004	-.005	-.013**
	(.003)	(.003)	(.004)	(.005)	(.002)	(.003)	(.004)	(.005)
Constant	-.366***	-.329***	-.349**	-.300*	-.958***	-.945***	-.828***	-.872***
	(.032)	(.036)	(.133)	(.123)	(.089)	(.105)	(.150)	(.206)
Observations	106,919	106,630	106,919	106,630	106,919	106,630	106,919	106,630
R-squared	.625	.479	.669	.527	.717	.564	.733	.587

Robust standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.05. Standard errors are clustered at the secondary school level.

4.4.2 Peer effects in different socioeconomic groups and school sectors

The general results of previous models using fixed effects (7-8) show that an increase in the classmates' average SES has a positive impact on student attainment, while there are almost no effects associated with increases in the levels of socioeconomic heterogeneity in the classroom. As the literature has suggested, the influence of peer characteristics may vary for students in different parts of the SES distribution. For example, it may be that highly disadvantaged students benefit more from being exposed to wealthy classmates than those in the middle of the SES distribution. Exposure to a more heterogeneous class in terms of SES could also influence poor and wealthy students differently. In Table 4.3, estimates are presented by dividing the students into three equivalent groups according to their SES.

The results in Table 4.3 show that the impact of the classmates' characteristics varies according to the SES of the students. In Maths, a one standard deviation increase in the mean of the classmates' SES leads to positive and significant effects for students from terciles 1 and 2 (.071 and .077 of a standard deviation respectively). No impact is observed for the wealthier students (tercile 3). A dissimilar picture is depicted by the results for Language. In this case, the poorest and the wealthiest students benefit from increases in the mean SES of the peer group (.114 and .098 of a standard deviation respectively), while students in tercile 2 do not experience any effect. Once again no relevant impacts are related to increases in socioeconomic heterogeneity. It is important to note that—in Language—increases in the peer group performance are associated with negative values, which tend to be greater for wealthy pupils. This suggests that the socioeconomic and academic characteristics are—to some extent—exerting opposite effects on the students.

Table 4.3. Fixed Effect by Student SES

	Maths			Language		
	Tercile 1	Tercile 2	Tercile 3	Tercile 1	Tercile 2	Tercile 3
VARIABLES	(1)	(2)	(3)	(1)	(2)	(3)
Prior Achievement	.594***	.600***	.566***	.575***	.597***	.581***
	(.005)	(.005)	(.005)	(.005)	(.005)	(.006)
Student SES	.038***	-.002	.050***	.004	-.005	.067***
	(.009)	(.016)	(.008)	(.010)	(.019)	(.010)
Peers' Mean Performance	-.001	.008	-.026	-.038**	-.068***	-.076***
	(.014)	(.014)	(.015)	(.014)	(.014)	(.014)
Peers' Mean SES	.071*	.077**	.035	.114**	.068	.098**
	(.030)	(.027)	(.030)	(.038)	(.036)	(.037)
Peers' SES Heterogeneity	-.005	-.014*	-.004	-.013	-.006	-.019*
	(.007)	(.007)	(.007)	(.009)	(.009)	(.008)
Constant	-1.137***	-.975***	-1.307***	-.839***	-.591*	-1.446***
	(.199)	(.201)	(.276)	(.251)	(.241)	(.280)
Observations	34,732	36,020	35,161	34,962	36,287	35,381
R-squared	.691	.713	.736	.593	.594	.585

Robust standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.05. Standard errors are clustered at the secondary school level.

As previous literature has highlighted, Chile shows levels of hyper-segregation in regard to SES. More than half of the total enrolment is educated at private subsidised schools. Although this sector has significant levels of SES diversity in enrolment, the composition of the schools within this sector tends to be highly homogenous. Table 4.4 shows the estimates for each educational sector. SES heterogeneity does not have an effect in the municipal sector, while it has a negative and minimal impact on Language in subsidised-private schools. Conversely, there is a positive—although again small—effect for Maths in the non-subsidised private sector. The effects of an increase in the average SES of the classmates leads to gains in the SIMCE scores in both municipal and subsidised private schools, while no effect is recorded for the non-subsidised private schools. Once again, negative effects caused by increases in the average performance of the peers are observed in Language.

Table 4.4. Fixed Effects Estimates by School Sector

	Municipal		Subsidised Private		Non-Subsidised Private	
VARIABLES	Maths	Lang	Maths	Lang	Maths	Lang
	(1)	(2)	(3)	(4)	(5)	(6)
Prior Achievement	.594***	.576***	.595***	.592***	.506***	.566***
	(.004)	(.005)	(.004)	(.004)	(.009)	(.011)
Student SES	.019***	.007	.020***	.025***	.036***	.030**
	(.004)	(.005)	(.003)	(.004)	(.007)	(.009)
Peers' Mean Performance	.005	-.045***	-.015	-.051***	-.025	-.068***
	(.009)	(.010)	(.010)	(.010)	(.016)	(.017)
Peers' Mean SES	.039**	.069***	.051**	.046*	.006	.015
	(.014)	(.017)	(.016)	(.020)	(.024)	(.031)
Peers' SES Heterogeneity	-.008	-.011	-.007	-.013*	.027*	-.021
	(.005)	(.007)	(.005)	(.006)	(.014)	(.018)
Constant	-.954***	-.762***	-.861***	-.925*	-.059	.575*
	(.239)	(.215)	(.232)	(.391)	(.135)	(.228)
Observations	40,590	40,435	57,565	57,426	8,631	8,635
R-squared	.682	.575	.696	.559	.585	.477

Robust standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.05. Standard errors are clustered at the secondary school level.

4.4.3 Socioeconomic peer effects and student selection

One particularity of the Chilean educational system is that schools did not face any restrictions on controlling their intake. As selection was allowed in practice, an important proportion of the schools implemented admission procedures which served to gather information about the students regarding both academic and social matters. As this may be a crucial institutional factor that contributes to shaping the schools' compositions, estimates are presented separately according to the selective status of the schools in accordance with the parents' reports. 'Selectivity' has been classified into two dimensions: social and academic, depending on the type of selection procedures conducted by the school.

The results in Table 4.5 show some differences between the schools implementing selective practices and those without student selection. Regarding social selection, the positive influence of increases in the classmates' SES is much more notable in schools without selective admission (.049 and .089 of a standard deviation in Maths and Language, respectively). The positive effects only hold for Maths in socially selective schools.

Schools without academic selection recorded positive and significant effects (in both subjects) associated with increases in the classmates' SES, while the impact of this factor is limited to Maths in academically selective schools. Surprisingly, the effects in Maths are greater for the students enrolled in selective schools compared to those in non-selective institutions. This draws a peculiar picture, in which the way the effects are displayed varies significantly by subject. The effects of the classmates' socioeconomic diversity appear not to be significant in most of the estimates, regardless of the selectivity status of the school. Finally, and consistent with previous estimates, the effects of increases in the average performance of the peers lead to negative effects. This detrimental impact is observed exclusively in Language, but is manifested independently of the selectivity status of the schools.

Table 4.5. Fixed Effect Estimates by School Selectivity

	Without Social Selection		With Social Selection		Without Academic Selection		With Academic Selection	
	Maths	Lang	Maths	Lang	Maths	Lang	Maths	Lang
VARIABLES	(25)	(27)	(26)	(26)	(29)	(31)	(30)	(32)
Prior Achievement	.599***	.581***	.556***	.594***	.592***	.578***	.586***	.587***
	(.003)	(.003)	(.005)	(.006)	(.004)	(.005)	(.003)	(.004)
Student SES	.020***	.017***	.037***	.037***	.021***	.014**	.025***	.027***
	(.003)	(.004)	-.006	(.008)	(.004)	(.005)	(.004)	(.005)
Peers' Mean Performance	-.002	-.054***	-.032*	-.053***	.005	-.042***	-.019	-.069***
	(.008)	(.008)	(.015)	(.015)	(.010)	(.011)	(.010)	(.010)
Peers' Mean SES	.049***	.089***	.075*	.034	.037*	.093***	.059**	.045
	(.014)	(.018)	(.032)	(.042)	(.016)	(.019)	(.020)	(.026)
Peers' SES Heterogeneity	-.007	-.013**	.006	-.019	.001	-.013	-.009	-.015*
	(.004)	(.005)	(.009)	(.011)	(.006)	(.007)	(.005)	(.006)
Constant	-.860***	-.911***	-.703***	-1.136***	-1.012***	-.825***	-.763***	-.882*
	(.150)	(.211)	(.129)	(.170)	(.253)	(.208)	(.169)	(.356)
Observations	81,555	81,343	25,364	25,084	41,262	41,157	65,657	65,473
R-squared	.704	.572	.695	.548	.688	.580	.726	.574

Robust standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.05. Standard errors are clustered at the secondary school level.

4.4.4 Robustness checks

So far, the estimates suggest there are positive and significant effects associated with increases in the socioeconomic status of the classmates (greater in Language) and virtually no impacts related to greater socioeconomic heterogeneity. However, some sources of bias cannot be ruled out in the estimate using the full sample. This section presents analyses addressing two issues: the within-school, non-random allocation of the students and the presence of former primary school peers at the secondary school level. An analysis of the extent to which the inclusion/exclusion of certain control variables affects the estimates is also presented.

In this paper, estimates using school fixed effects assume that the students are randomly allocated to classrooms within the schools. Although this a reasonable assumption for most of the schools, recent evidence suggests that sorting practices take place in Chilean secondary schools. Although all the estimates include measurements of peer ability at the classroom level, there may be other non-observable factors that are correlated to certain groups within-school. To tackle this issue, estimates are presented based on the group of schools where student sorting was not used. In this scenario it is reasonable to assume that all the non-observable factors will be fairly distributed across classes.

Three main conclusions emerge from Table 4.6. First, the effects of the variables of interest remain significant and positive (or negative with minimal coefficient in the case of the socioeconomic diversity of the peers). This implies that the main findings presented in this study hold up even considering the non-random allocation of students within schools. While in previous estimates, the effects of increases in the peer group's mean SES were .070 and .099 of a standard deviation (Maths and Language, respectively), in the subset of schools without sorting the values change to .081 and .076 of a standard deviation. No changes are observed regarding the role of peers' socioeconomic heterogeneity. Second, although the figures remain positive and significant (regarding peers' mean performance), there is a slight variation in the coefficients in both subjects. This implies that the allocation of the students across classrooms may play a role, introducing bias into the estimates. Although it is not possible to rule that this is due to sample variation, the changes are small and do not change the main findings. Third, there are some changes in the influence of the academic characteristics of the classmates. While in previous estimates no significant effect was recorded in Maths, in the subsample of schools without student sorting there is a significant and negative impact in Maths (.033 of a standard deviation) and a larger and also negative effect in Language (.087 of a standard deviation). As could be expected, within-school sorting seems to be more closely associated with the academic features of the peer group than the socioeconomic characteristics. These figures suggests that the negative impact of increases in

the average peers' performances is attenuated by grouping practices and the (negative) effects of the peers influence diminish where more academically homogenous groups are implemented[54].

Table 4.6. Fixed Effect Estimates for Schools Without Sorting Practices

VARIABLES	Maths (1)	Lang (2)	Maths (Preferred Estimates)	Lang (Preferred Estimates)
Prior Achievement	.581***	.587***	.589***	.584***
	(.004)	(.004)	(.003)	(.003)
Student SES	.025***	.031***	.026***	.024***
	(.004)	(.005)	(.003)	(.004)
Peers' Mean Performance	-.033**	-.087***	-.007	-.059***
	(.010)	(.010)	(.008)	(.008)
Peers' Mean SES	.081***	.076**	.070***	.099***
	(.019)	(.024)	(.016)	(.020)
Peers' SES Heterogeneity	-.000	-.013*	-.005	-.013**
	(.004)	(.005)	(.004)	(.005)
Constant	-.809**	-.941*	-.828***	-.872***
	(.283)	(.399)	(.150)	(.206)
Observations	58,609	58,468	106,919	106,630
R-squared	.739	.588	.733	.587

Robust standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.05. Standard errors are clustered at the secondary school level.

The use of lagged measures of peer characteristics helps separate the mutual influence in the results between the students and their peer group. However, during the transition from primary to secondary school, most of the students are sorted into a classroom with a proportion of their former primary school peers. This lack of variation implies that the current peer group is affected by the former classroom group (including the student's own performance). One option to reveal this relationship is to estimate the effect of the peers only for students with no former primary peers at the secondary school. However, this number is very limited in the Chilean system. Therefore, estimates are presented using the sample of students with less than 10% of former primary school peers in the secondary school classroom. Although this approach does not entirely eliminate the bias, it helps observe whether the main results remain stable or there are changes when there is an important change in the composition of the group.

Table 4.7 shows that the effects of the variables of interest remain significant and positive. However, a reduction in the magnitude of the impacts in both subjects is observed (although it is more marked in Language). While in the preferred estimates (col. 3-4) the effect associated with a one standard deviation increase in the peers' mean SES was .070 and .099

[54] This issue will be discussed in Chapter 5, which focuses on academic peer effects.

of a standard deviation in Maths and Language respectively, after limiting the sample to students with fewer than 10% of former peers in their secondary school classroom, these values decrease to .055 and .065 of a standard deviation for each of the subjects. However, these findings must be observed cautiously. On the one hand, the decrease on the coefficients of the variables of interest (in both subjects) may imply that simultaneity is playing a role and the preferred estimates present an upward bias. On the other hand, the sample of students with a low number of primary school classmates at the secondary level is not equivalent in every aspect to the general sample. In particular, this subgroup presents lower SIMCE scores and SES background. Therefore, it is not possible to reach a strong conclusion about what the factors are that drive the differences between the estimates. However, if the problem of simultaneity is real, the differences are small and do not change the main findings in this work.

Table 4.7. Fixed Effects for Students Changing Schools

VARIABLES	Maths 1	Lang 2	Maths 3	Lang 4
Prior Achievement	.579***	.567***	.589***	.584***
	(.004)	(.004)	(.003)	(.003)
Student SES	.019***	.011*	.026***	.024***
	(.004)	(.004)	(.003)	(.004)
Peers' Mean Performance	-.027**	-.078***	-.007	-.059***
	(.009)	(.009)	(.008)	(.008)
Peers' Mean SES	.055***	.065**	.070***	.099***
	(.016)	(.020)	(.016)	(.020)
Peers' SES Heterogeneity	-.009	-.016**	-.005	-.013**
	(.005)	(.006)	(.004)	(.005)
Constant	-.593	-.978	-.828***	-.872***
	(.349)	(.506)	(.150)	(.206)
Observations	57,821	57,588	106,919	106,630
R-squared	.702	.580	.733	.587

Robust standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.05. Standard errors are clustered at the secondary school level.

It is not only the distribution of the students within the schools and the simultaneity problem that may introduce bias to the estimates, but also whether the students' prior attainment is taken into account. In contrast to the majority of the research on the issue of exogenous effects, this work explicitly includes measures of prior attainment. To investigate how results vary when key control variables are excluded from the model, Table 4.8 shows different specifications for estimating peer influence in Maths and Language. There are two main factors to be considered. First, the inclusion of the peer group characteristics (to estimate the influence of the classmates on the students' academic outcomes). Second, the use of student-

level lagged scores in SIMCE as a measure of prior achievement. For each of the subjects, model 1 is a naïve specification for measuring peer effects. Several control variables have been included, but no attempt is made to control for prior achievement. Only one measurement of peer characteristics has been added (mean SES). The results show that the mean SES of the classmates has a positive and significant impact on the students' scores (up to .158 and .144 of a standard deviation in Maths and Language, respectively). The inclusion of a second measurement expressing the socioeconomic diversity of the classmates does not change those values (Model 2). When a measurement of peer academic performance is added (model 3), significant changes are observed. On the one hand, the coefficients of the peers' mean SES rise significantly. On the other hand, the new control variable shows negative and significant values (.117 and .084 of a standard deviation for Maths and Language).

Table 4.8. Changes in Basic Model Specification

	Maths				Language			
VARIABLES	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Student SIMCE Score (8th Grade)				.589***				.584***
				(.003)				(.003)
Student SES	.061***	.061***	.063***	.026***	.048***	.048***	.050***	.024***
	(.004)	(.004)	(.004)	(.003)	(.005)	(.005)	(.005)	(.004)
Peers' Mean SES Performance	.158***	.159***	.219***	.070***	.144***	.149***	.194***	.099***
	(.021)	(.021)	(.022)	(.016)	(.025)	(.025)	(.026)	(.020)
Peers' SES Heterogeneity		-.003	-.001	-.005		-.012*	-.011	-.013**
		(.005)	(.005)	(.004)		(.006)	(.006)	(.005)
Peers' Mean Performance			-.117***	-.007			-.084***	-.059***
			(.013)	(.008)			(.011)	(.008)
Constant	-1.959***	-1.958***	-2.076***	-.828***	-1.837***	-1.834***	-2.076***	-.872***
	(.189)	(.189)	(.191)	(.150)	(.243)	(.243)	(.243)	(.206)
Observations	107,109	107,109	106,919	106,919	107,167	107,167	106,630	106,630
R-squared	0.538	0.538	.538	.733	.370	.370	.371	.587

Robust standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.05. Standard errors are clustered at the secondary school level. 'Zero books', 'Uncompleted Secondary or less' and 'Non-indigenous background' are the reference categories for 'Numbers of Books at Home', 'Parental Expectations' and 'Indigenous Background'

Finally, the preferred specification (in Model 4, also presented in Table 2, col. 7-8) suggests there are significant changes when a measurement of prior attainment of the students is incorporated. The new variable shows itself as the most influential factor in explaining the students' scores in 10th grade. At the same time, the effect associated with the mean SES of the peers decreases, although it remains significant and positive in both subjects. Consistently though the estimates, the peers' socioeconomic characteristics have a greater influence compared to the students' own SES. Because when the measure of prior attainment is introduced both measures decrease significantly, the students' background may be working through the prior attainment variable. Controlling for this factor not only affects the SES measures, but also produces significant changes in the average performance of the classmates. After the control is added, the academic characteristics show no impact in Maths and a smaller effect in Language (where they remain positive and significant). This suggests that failing to control for students' prior attainment leads to overestimating the impacts of both the socioeconomic and academic characteristics of the peers. It is also important to note that the proportion of the variance explained by the model experiences significant growth after controlling for prior attainment.

4.5 Conclusions

This paper aims to contribute to the corpus of studies focused on determining to what extent the socioeconomic school composition affects students' academic outcomes. Unlike most previous studies examining 'peer effects', this study addresses the issue of potentially omitted variables, includes measurements of the previous attainment of the students, and draws on classroom-level information for observing the peer-group influence. Moreover, this work includes the use of a continuous composite variable to express SES and attempts to control other sources of bias, such as potential sorting of students based on academic ability. The results show a clear—although small—impact of the SES attributes of peers on the students' individual attainment. However, the influence of the two features under analysis—the average socioeconomic status of the classmates and their social heterogeneity—produce dissimilar results. While in both in Maths and Language the interaction with wealthier peers has a positive and significant impact (consistent with 'contagion' models for explaining peer influence), greater SES heterogeneity shows no effects.

The benefit of being exposed to socioeconomically better-off peers is clear for low-SES students in Maths and for both wealthy and poor students in Language. There is no evidence of groups being harmed by increases in the average SES of the classmates. Positive and

significant effects were observed in the municipal and the private-subsidised sectors, but no impact was seen for non-subsidised private schools. Results in terms of the schools' selectiveness are not conclusive. In Language—the subject in which effects are most consistently observed—the figures show a greater impact from increases in the mean peer SES for schools without selection (academic or social). In Maths, the results are less clear. However, as non-selective schools tend to enrol a higher proportion of low-SES pupils, it is possible that these results show that low-SES students benefit more from being exposed to socioeconomically better-off peer groups.

Not only do the socioeconomic characteristics of the peer group influence student outcomes, but the academic composition of the classroom is also relevant. In contrast to the impacts associated with increases in the SES level of the classmates, negative effects are observed with increases in the classmates' mean performance in Language. These impacts tend to be more accentuated for wealthier students. As has been shown in the analysis, the simultaneous inclusion of measurements that capture the characteristics of academic and socioeconomic peers helps to clarify these associations.

The results included in this work are consistent with previous studies in the Chilean context in their main conclusion: the socioeconomic composition of schools is far from trivial regarding student outcomes. However, the magnitude of the impact found in this study is more conservative than that seen in previous studies, particularly in terms of the differences between the municipal and subsidised sectors. The differences regarding previous investigations may be explained by the inclusion of prior attainment information, the type of measurements to express the academic characteristics of peers, and the use of a fixed effects approach to account for unobserved heterogeneity.

The results of this study challenge the Chilean educational system on one of its most critical features. Not only does Chile have remarkably segregated schools—for both poor and wealthy students—but there has also been no reduction in the level of socioeconomic segregation in the last 15 years (as shown in Chapter 2). Even though no reduction of segregation has taken place in Chile since 2000, the implementation of a reform aimed at increasing the social mix—by abolishing the charging of fees to families in the subsidised sector and prohibiting student selection—has recently begun. Given that factors such as urban segregation and parental preferences also shape school composition, the extent to which this reform will change the socioeconomic composition of the schools is unclear. If the new policies successfully increase the socioeconomic mix within schools, new challenges will emerge for them and, in particular, for the teachers. An important body of literature highlights how background characteristics affect not only the teachers' expectations of the students' success, but also their sense of self-

efficacy. Based on the findings in this work, this may be particularly critical because the academic and social characteristics of the students act as opposing forces.

Future research regarding school composition faces multiple challenges at the methodological and conceptual levels. As with most of the previous works on the topic, this study has not attempted to explain the mechanism by which the influence of the peers takes place. Further studies should attempt to reveal to what extent the observed effects are associated with 'peer interaction' or 'institutional' factors related to the composition of the schools.

Although this study provides new information regarding the influence of the socioeconomic characteristics of peers, it still faces some of the limitations of research addressing the issue of compositional effects. Due to constraints in the data, other sources of potential bias cannot be ruled out. In particular, the estimates may be affected by non-random distribution of the teachers within the schools. It is a much more complex challenge to define the group of peers. Even though this work has narrowed the definition of the peer group to the classmates—under the assumption that this is the most relevant group of reference for the students—it is not possible to identify who the relevant peers are within the classroom or to model their interactions.

Chapter 5

Peer Effects in the Long-run: Are the Educational Paths of Students Affected by the Academic characteristics of Primary School Classmates?

5.1 Introduction

The influence of the academic characteristics of school peers on student achievement has been well investigated, especially in the context of industrialised countries. Scholars and policymakers worry that student outcomes may be affected by the peer group's characteristics (academic, race, gender, socioeconomic) with subsequent effects on efficiency and equity in the educational system. If peers do exert influence on the other students' outcomes, the direction of that effect (and the heterogeneity of the impacts through subgroups) is crucial to decide the optimal allocation of students across and within schools. This is especially critical if the concentration of students with similar characteristics acts as an amplifier of their background, exacerbating gaps between groups. Moreover, the existence of peer effects not only challenges system-level policies (student admissions and tracking) and school-based practices (sorting), but also confronts the idea of making schools accountable for their students' performance. However, the implications of peer effects are not restricted to system policies, but can also be an input to organise instruction and are a factor to be considered in teacher training.

Although an increasing large body of research assessing the influence of peers' academic characteristics has been developed in recent decades, only a handful of studies observe the impact of school peers in the long-run. Moreover, most of those studies do not centre their attention on later educational outcomes, but other factors (typically labour market indicators). Analysing the peers' long-term effects is critical to understand whether the influence (if any) endures over time or is merely limited to the duration of the school years (Carrel, Hoekstra, & Kuka, 2018). If the effects do exist and persist over time, it means that the characteristics of early classmates—a factor that is outside the control of students and families—define later outcomes to some extent, even beyond school education. Depending on the magnitude and direction of these effects, this has implications for the equity and efficiency of the educational system.

Regardless of whether educational peer effects are assessed in the short- or long-term, studies in the field face three common challenges. First, the definition of the peer group. Demarking a relevant group of reference, where there is an "intense-enough" relationship, may reasonably be assumed to be critical. Although the criteria may vary according to conceptual and empirical considerations, researchers have privileged the use of classroom-level information for observing peer effects (Yeung & Nguyen-Hoang, 2016). However, in many educational systems the notion of "classroom group of peers" tends to fade away at the secondary level when students start joining subject-based groups where pupils from different classes are mixed, hindering the identification of a reliable peer group. Second, the non-random

distribution of students across schools. In most educational systems, students are not allocated to schools based on random procedures, but following admissions codes or based on catchment areas. As students may be allocated to schools due to admission policies or self-selection, the ascertainment of peer effects is intricate. Failure to consider this factor may introduce bias into the estimates or attribute an influence to the peers that originates in other unobserved factors. Finally, the mutual influence between the student and the peers. The problem of reflection makes it challenging to isolate the influence of the peers on the students, because at the same time the students are affecting the peers. Understanding that relationship has been a long-standing challenge for scholars studying the topic. These problems are aggravated in the absence of longitudinal data and a lack of information about prior attainment.

This work focuses on the long-term effects of the academic ability of primary school classmates[55]. In particular, it observes to what extent the academic ability of primary school peers (measured in fourth grade) impacts later educational outcomes, such as timely completion of secondary school, scores on the national higher education (HE) entrance test, and the type of HE institution in which the student enrols. Unlike an important proportion of previous studies, the administrative datasets allow the exact group of peers in fourth grade at the classroom level to be identified and their educational and social backgrounds to be observed. At this level, practices of mixing students from different classes are unlikely. The features of the datasets enable the methodological obstacles of selection and reflection to be tackled. School fixed effects are used to control the omitted-variable problem derived from the non-random distribution of the students across schools. The data also allow identification of schools that implement academic selection procedures at the primary school level. This information is also used to sophisticate the analysis regarding the influence of the peers. As with some previous studies, this work uses lagged information about the peers' academic characteristics to overcome the reflection problem. Taking advantage of a transition from primary school to secondary school, the simultaneous nature of peer interaction is taken into account and controlled for.

This study makes three main contributions to the strand of the literature focused on academic peer effects. First, it provides information about the impacts in the long-term. Only recently have studies started to analyse whether the effects are long-lasting or tend to disappear after the school years. No studies observe long-term effects in non-industrialised countries, and none of the existing studies link primary school information with higher education entrance

[55] Some scholars have contested the idea of 'ability' (e.g. Taylor et al., 2018) and argue that studies focused on peer effects and within-school sorting do not usually observe 'ability', but performance. Although this is a valid perspective, this work uses the concept of 'ability' interchangeably with performance, as most of the literature on the topic does. The idea of ability should not be understood as fixed.

examinations. Second, this work analyses heterogeneous effects based on the ability level of the students. The estimates are not limited to traditional absolute measurements of ability (relying on standardised test results), but also capture the within-school relative ability of the students. This approach is important in the Chilean context, which presents high values of between-school socioeconomic segregation and segmentation of academic outcomes by the type of provider. To some extent the use of relative measurements of ability is related to new studies using ordinal rank measurements to explore peer effects[56]. Third, this paper links to discussions about student tracking and sorting. Almost all the studies on the issue of peer effects have been conducted in comprehensive systems with moderate levels of socioeconomic segregation (such as the United Kingdom and the United States). Chile is—in formal terms—also a comprehensive system. However, practices of student selection based on ability and family background have operated in an environment of weak regulation for several years, even at early stages of education. Moreover, within-school sorting procedures take place in a portion of primary schools. As the distribution of students is a significant concern when observing the influence of the peers, this study takes advantage of the detailed Chilean data to analyse how the peer influence might vary across selective and non-selective schools. It also searches for differentiated impacts between schools sorting students into different classes based on their academic performance and those where sorting is not used.

Apart from this introduction, this work is developed as follows: Section two provides a brief description of the Chilean educational system and certain institutional features that mediate the allocation of students across schools. Section three briefly reviews the main findings in the literature on academic peer effects and, particularly, regarding the recent contributions addressing the long-term impact of schoolmates' characteristics. The fourth section describes the data and the sources of information. The fifth section explains the empirical approach and highlights how the study deals with the problems of self-selection and reflection. Section six shows the results of the estimates and the last part summarises the conclusions of the study.

5.2 The Chilean Educational System

The allocation of students across schools is critical for identification of peer effects. This is particularly relevant in the Chilean educational system, which has been operating a widespread voucher scheme since 1981. As part of the reform, school choice started to be encouraged through public funding for private institutions that were treated in many regards

[56] The contribution of these studies to the literature on peer effects will be discussed later in this work.

as equivalent to traditional state-managed-schools[57]. The education providers can be classified into three groups based on the ownership of the school. First, municipal schools are publicly funded under the voucher scheme and are administrated by local governments. Second, subsidised-private schools—under the same funding scheme as municipal schools—are owned by both for-profit and non-profit organisations. An important proportion of them are also religious (44% in 2017). Third, non-subsidised private schools do not operate under the voucher-scheme and are fully funded by families. The 1981 reform triggered significant growth in enrolment in the subsidised-private sector (from 15% in 1981 to 54% in 2017) and a decreased enrolment in traditional municipal schools (from 78% to 37% in the same period). Although there is no formal tracking of students before the age of 14, there are some factors that play a role in shaping school composition at early stages. All schools were operated for a long time (1981-2015) under a system with very weak regulations on school admissions (Carrasco, Gutiérrez, & Flores, 2017). As there were no restrictions on or inspection of admissions procedures, schools implemented early selection of students based on ability, religion, and socioeconomic background of the families (Godoy, Salazar, & Treviño, 2014)[58]. A second factor shaping the school intake is co-payment. Subsidised private schools were allowed to charge fees to families on top of the regular public subsidy (Flores & Carrasco, 2013). Finally, the Chilean educational system has intensively used repetition of grades, primarily based on academic reasons (Villalobos & Béjares, 2017)[59]. Students failing grades may be expelled from school and have to find a new institution to continue their education. Recent studies have suggested that attempts by the schools to shape the student body are not limited to the initial selection procedures, but continue over time. Separation of students has not only has taken place between schools but also within them. Recent studies have shown that student academic sorting occurs in Chilean schools, but is more frequently used at the secondary level (Treviño et al., 2016)[60].

[57] Although the basis of the educational system established in 1981 remains unaltered, a recent reform has changed some important features. The "Law for School Inclusion" (2015) regulated and centralised school admission procedures for both municipal and subsidised-private schools and banned profit-making in all schools. It has also started to gradually eliminate co-payment (for a detailed analysis of recent policy changes see Valenzuela & Montecinos, 2017). Due to the gradual implementation of the "Law for School Inclusion", none of these changes have affected the cohort under analysis in this work.

[58] Although new studies have highlighted that schools do use selection procedures, it is still unclear how intense those practices actually are and to what extent they help to shape the school intake (as it is unknown which schools are oversubscribed and how many of the students applying are actually rejected in the selection process).

[59] According to PISA 2015, some 24% of the Chilean students taking part in the examination (at age 15) reported having repeated a grade. This value is far above the OECD average (11%).

[60] In comparative terms, Chile has high levels of within-school student sorting. According to PISA 2009, more than 30% of headteachers stated that ability-sorting was used in all subjects (OECD, 2010). However, there is little information about this at the primary level.

The Chilean educational systems guarantees 12 years of compulsory education for all students (8 years of primary school and 4 years of secondary education). All types of schools can provide primary and secondary education. However, an important proportion provide only the primary levels, and after year eight, students must move to a secondary school or to a school providing both levels. Tracking takes place for the first time in 10th grade, when students have to decide whether to follow vocational studies or a traditional academic path. The track does not formally limit the possibility of following any type of higher education.

5.2.1 Previous Studies

Peer effects are usually classified as exogenous or endogenous, based on the conceptualisation provided by Manski (1993). While the first group refers to the influence of the fixed characteristics of the peers (such as gender, socioeconomic background, or race), the second refers to the peers' academic outcomes and behaviour. Although some studies have assessed both effects simultaneously, most of the studies tend to focus on only one type of effect. Recently, two new meta-analyses have examined the presence of exogenous and endogenous peer effects at the school level. According to Van Ewijk & Sleegers (2010), ethnicity and socioeconomic status do have an impact on student attainment (equivalent to .31 of a standard deviation), but the results vary significantly depending on the variable used for expressing the peer characteristics and the modelling techniques. The study conducted by Yeung & Nguyen-Hoang (2016) concludes that there is a positive—although small—endogenous effect on academic performance (.03 of a standard deviation). Once again, the authors raise alerts on how the results are affected by the definition of the peer group and the measure of educational outcomes, among other factors.

Beyond the differentiation between endogenous and exogenous effects, the literature has theorised and empirically tested the mechanisms by which the influence of the peers may take place[61]. In this approach, the students would gain in achievement by sharing the educational space—the classroom, the grade, the school—with at least one high ability student ("shining light" model). On the contrary, alternative models ("bad apple") suggest that the presence of a single low-ability student may harm the achievement of the remaining students. While the "boutique" model suggests that students perform better when surrounded by peers with the same level of ability, the "rainbow" model argues that heterogeneity may be beneficial for all the students. If the "boutique" model is correct, policies and practices such as tracking and

[61] Sacerdote (2011) provides a clear summary of the models used in the literature to assess peer effects. This classification is based on the work developed by Hoxby & Weingarth (2005). Not all the models in the classification are discussed here.

student sorting should be promoted. Particularly relevant for this work is the "Invidious comparison" model, where the students would experience detrimental effects derivate from being exposed to high-achieving peers. In this model, the students are negatively affected by both comparing themselves to other more talented students and because the classes are targeted at higher-performing students.

Two issues are critical in all studies addressing the influence of the academic characteristics of the peers[62]: The definition of the peer group and the strategy for dealing with the problems of selection and reflection. The definition of the relevant peer group is far from trivial. According to the level or age when the peers' features are captured, the relevant peer group may change. An important proportion of the studies use school-level data. However, it is disputable how the academic characteristics of the students outside the natural learning environment—the classroom—can affect the students' educational outcomes in terms of test scores[63]. A more widely accepted level for the observation of peer academic influence is the classroom. This approach has the advantage of placing the peers in an appropriate educational space, where the main portion of the (at school) learning process takes place and where the academic characteristics of the classmates are more likely to have a direct influence on educational outcomes. However, it may be the case that a much more intense influence is due to a proportion of the classmates. Only a minority of studies have been able to identify the friends of students for measuring peer effects (Cook, Deng & Morgano, 2007; Halliday & Kwak, 2012; Liu, Patacchini, & Zenou, 2013). The definition of the relevant peer group will depend significantly on the observed outcome. In this sense, the use of classroom-level data may offer the advantage of including the group that is assumed to be influencing the students' learning (and not exclusively the friends)[64].

The methods for tackling the issues of reflection and selection have been discussed extensively in the literature. According to Yeung & Nguyen-Hoang (2016), the most common way of dealing with the reflection problem is by using lagged measurements of peer ability. However,

[62] Although these are the two most common sources of upward bias when estimating exogenous peer effects, recent studies have pointed out that 'Exclusion Bias' may lead to downward bias in the estimates, even when the peer group is randomly assigned (Caeyers & Fafchamps, 2016). According to the authors, this source of bias is due to the fact that a "mechanical negative relationship exists between people's ex ante characteristics and those of their peers" (p3). This source of bias is mechanical, as individuals are—by definition—excluded from being their own peers. For example, for a high-ability student, the population from which the peers may be drawn excludes a high ability student. On the contrary, for a low-ability student, the group of potential peers excludes a low-ability student. Therefore, a mechanical and negative relationship exists between the individual and the predetermined characteristics of the peers.

[63] For example, Halliday & Kwak (2012) argue that using the school-grade-cohort level for defining the peer group may lead to underestimation of the effects.

[64] For example, some studies have assessed the presence of "disruptive peers" (Lazear, 2001). The assumption is that the whole peer group can be affected by the behaviour of a disruptive classmate, regardless of a friendship relationship.

as lagged performance does not include the influence of the current peer characteristics, the results may be downwardly biased. More recently, the use of lagged information has been used conjointly with changes in group composition during transition across educational levels (Gibbons & Telhaj, 2016), detaching the student's achievement outcomes from their peers' academic performance. This strategy—a central feature in the estimates presented in this work—has gained popularity in recent years and has been implemented in several studies (Sund, 2009).The second most common approach is to use instrumental variables regression (Kang, 2007; Liu, Patachini, & Zenou, 2013; Boucher et al., 2014). However, a valid instrument is rare and some of the studies on the topics have been consistently criticised for not fulfilling the conditions for a valid instrument.

Only a few studies on peer effects rely on randomised designs (Duflo, Dupas, & Kremer, 2011; Bietenbeck, 2015). In the absence of experimental data, scholars have to deal with the issue of selection in the school using—student, classroom, school, or teacher—fixed effects. This approach allows the non-observable factors that might introduce bias into the estimates to be taken into account. For example, Sund (2009) uses lagged peer achievement and a transition between school levels to eliminate the problems of reflection and selection. He also includes several fixed effects—student, school, and teacher—to estimate the peer influence on student achievement in Swedish schools[65].

As stated by Hoxby & Weingarth (2005), peer effects do not necessarily operate in a homogenous way for all the students in the educational system. Specific group compositions may benefit, harm, or be innocuous for certain students more than for others. To analyse heterogeneous peer effects, the literature has used two main strategies: quantile regressions or interactive variables. Drawing on PISA datasets and administrative data, Schindler-Rangvid (2003), used a quantile regression approach for investigating peer effects in Danish schools. She found that both low- and high-ability students tend to benefit from attending school with 'better-quality' peers. Burke & Sas (2013) relate quintiles of test score performance with the mean performance of the peers to explore differentiated results. Both approaches are based on the complete distribution of results in a test, but do not take into account the rank of the students within their schools (a relative measurement of ability). A more novel group of

[65] As with Sund, an increasing number of scholars use random variation in student composition in adjacent school cohorts. The assumption is that changes in composition between cohorts may be a source of exogenous variation and help avoid identification problems. Although this is an appealing solution, it might not be the right strategy using Chilean data. First, SIMCE was not taken at secondary schools every year. Therefore, there are a limited number of cohorts with information in both primary and secondary schools. This information is critical for solving the reflection problem. Secondly, nationwide policies that could be shaping school composition were introduced in years prior to the cohort used in this work. Therefore, the assumption on random variation between cohorts may not be strong in this case. Third, information for higher education outcomes has only recently been released and there is not enough data for previous cohorts.

studies has started to address related issues using rank ordinal measures (Murphy & Weinhardt, 2014; Elsner & Isphording, 2017). Contrary to the main tendency of using the results in a standardised test as the source to define the student level of ability, these studies have included a relative ability approach. In these cases, it is not the score of the student at the national level that matters, but their academic position within the school setting. Some of these works theorise about how students compare their performance to other students and have adopted the "invidious comparison" model to explain the peer interactions (Murphy & Weinhardt, 2014).

Independent of the period for which the effects are evaluated, most of the studies in this strand of the literature have been carried out in comprehensive systems. Raitano & Vona (2013) analyse the role of peer academic heterogeneity in both comprehensive and early-tracking systems. Using PISA data sets, they conclude that heterogeneity plays a different role in both systems. While in comprehensive systems academic heterogeneity has a negative—although moderate—impact on student performance, the opposite effect is seen in early tracking systems. Schneeweis & Winter-Ebmer (2007), using PISA data for studying endogenous peer effects in Austrian schools, addressed the absence of an exogenous source of variation for observing the school's academic composition by using fixed effects and taking advantage of rich additional PISA information. Schindler-Rangvid (2003) followed a similar strategy—in the different context of the Danish educational system—and merged PISA datasets with local administrative data.

The vast majority of the studies assessing endogenous peer effects in the field of education have focused on school-level short-term results. Only recently, this strand of the literature has been enriched by works observing long-term effects on educational outcomes (higher education). However, the topic remains mostly unexplored and almost none of these studies look at the peer groups at the primary level. Observing the long-term influence of the early-stage peers is essential to understand whether certain conditions—outside the control of the students and families—are shaping their future educational opportunities and achievement. Carrell, Hoekstra & Kuka (2018) analyse how the presence of disruptive peers at primary school impacts college attendance and completion, as well as earnings. Using a school-by-grade fixed effects approach, they exploit the idiosyncratic variation in the population to overcome the selection problem. The authors find that exposure to "a disruptive peer" leads to a decrease in the probability of college enrolment and of obtaining a degree. Bifulco, Fletcher & Ross (2011) argue that a higher proportion of high school classmates with mothers holding college-level education negatively affects the chances of dropping out of college, but is positively associated with college attendance. Later, Bifulco et al. (2014) found no effects of the education level of peers' mothers on labour market outcomes. Drawing on data from

Norway, Black, Devereux & Salvanes (2013), also use the female proportion at school (9th grade) to examine effects on social, educational, and labour outcomes. Some previous studies have suggested that girls tend to show better behaviour (Lavy & Schlosser 2011). The results of this study are diverse, but highlight that differences are expressed by gender. Bietenbeck (2015) takes advantage of the random assignment of teachers and students of the STAR project to observe how the presence of low-achiever repeaters impacts the regular first-time kindergarten students and concludes that positive long-term effects are found in several outcomes (e.g. the likelihood of taking college entrance exams). Mendiola, Paloyo & Walker (2016) draw on British data to estimate how high school peers affect the probabilities of attending university. They innovate by developing a novel identification strategy based on using the characteristics of the primary school peers of the high school peers of the students to tackle issues of reflection and selection. They find that peer ability does not affect the likelihood of attending university.

This work does not attempt to reveal the mechanisms by which the peer influence is exerted, but tries to understand whether the impact of the classmates endures over time and how it affects students in a context of unregulated school admissions and sorting practices. The identification strategy lies in observing how the lagged characteristics of the former primary school classmates affect later post-secondary educational outcomes, controlling unobserved factors using school fixed effects. The analysis is enriched by using different samples according to selectivity and sorting practices and by explaining heterogeneous effects based on the within-school ranking of the students.

5.3 Data

Data from the *Sistema de Medición de la Calidad de la Educación* (SIMCE)[66] provides information on student achievement at several grades during both primary and secondary school. In 2008, some 222,002 students took the examination. However, there are 202,961 students with full information from SIMCE examinations in fourth grade (2008), divided among 4,894 schools and 10,014 classrooms. The remaining cases correspond to duplicate information or invalid scores. As with most datasets, SIMCE information is not flawless. To

[66] The "System for Measuring the Quality of Education", considers the application of a test for all students enrolled in several grades (in both public and private schools). Since 1997, Maths and Language have frequently been assessed. The results of the examination are used for school accountability purposes, the allocation of monetary incentives to schools and teachers, and to provide information for school choice. The test uses Item Respond Theory (IRT) and in the first examination had standardised results with a mean of 250 points and a standard deviation of 50. In later assessments these parameters varied according to the students' performance. However, for this work, the scores for each subject were standardised to a mean of zero and a standard deviation of one.

reduce the number of missing cases, where the mother or father's education level was missing, the value of the partner was imputed[67]. No other changes were made to the original data.

An important proportion of the students that were enrolled in fourth grade in 2008 did not complete compulsory secondary education (year 12) in the expected year (2016). Some 68.6% (n=139,418) of the students who took the SIMCE test in 2008 (fourth grade) graduated on time from secondary schools (2016). As repetition has been a practice widely used in the Chilean educational system, it is not surprising that an important proportion of students do not complete secondary school on time. Not all the students finishing in a timely manner take the higher education entrance exam at the end of their last grade at the secondary education level. In the cohort under analysis, 90% (n=125,497) of the students took both Maths and Language examinations in 2016. Of the 31.4% that did not graduate on time, most graduated one or two years later than their schoolmates. There is also a small fraction of students that finish secondary education after several years without attending schools and another group that does not graduate. Of those graduating on time, 58% (n=82,057) started an HE programme in 2017 (that is, there was no interruption in the education path from secondary school to HE). This number is equivalent to 40% of the original group (SIMCE 2008, fourth grade). Besides SIMCE, which serves for observing test scores and constructing the measurements of peer ability and SES, several other databases are used in this work. The Chilean Ministry of Education has administrative records that allow identification of the grade and course in which each student was enrolled during the 12 years of compulsory education. Therefore, it is possible to find out which students do not have the same peer group in primary and secondary school. This is an advantage in tackling the reflection issue that will be discussed as part of the empirical strategy[68]. Student data can also be merged with information from the *Prueba de Selección Universitaria* (PSU), which is the main admission exam for higher education[69]. This test is administered after the end of compulsory education (12 years). Additional information about enrolment in higher education institutions may be obtained from the Servicio de Información de Educación Superior (SIES), which contains information about the institution and programme where the student was enrolled. Depending on the outcome under analysis, the size of the sample of students varies from 201,238 to 53,009 (although in some

[67] This decision was made based on the importance of controlling for both the student SES and for including measurements of exogenous effects. There were 11,114 observations with imputed values. Some 88% of the imputations correspond to missing information about the father's education level.
[68] In the cohort under analysis, 46.8% (58,273) of the students with PSU scores did not have any former primary school peer when they were at the secondary level.
[69] The *Prueba de Selección Universitaria* (PSU) is a curriculum-based test that has been in place since 2003 and is taken annually after the end of the academic year (December). It has two compulsory tests (Maths and Language) and several optional tests that are required depending on the career that the students want to pursue. The results are normalised to a scale with a mean of 500 and a standard deviation of 110, with minimum and maximum values of 150 and 850.

analyses the students may be distributed in several estimates). Descriptive statistics for the main descriptive variables are shown in Table 5.1.

Table 5.1. Descriptive Statistics of Samples

Variable	4th Grade (n=202,961)	PSU (n=124,497)	Enrolment in HE (n=82,057)
Male	50.1%	45.4%	47.3%
Mothers' Education (complete secondary)	73.2%	74.7%	66.5%
Fathers' Education (complete secondary)	72.5%	73.9%	65.9%
Family Income <£360	44.3%	47.3%	37.1%
Parents' Indigenous Background	11.1%	10.4%	10.4%
Participation in Pre-school	95.4%	95.1%	95.3%
Repeated a Grade before 4th Grade	9.9%	4.3%	4.2%
Average Attendance at School	93.4%	94.3%	94.3%
Students Enrolled in Municipal School	43.5%	37.4%	36.1%
Students Enrolled in Private Subsidised School	49.7%	52.9%	52.0%
SIMCE Score Language (4th grade)	262.4	279.8	283.8
SIMCE Score Maths (4th grade)	262.4	280.0	273.7

Note: All the percentages are based on the students of the cohort that took the SIMCE examination in fourth grade and it does not include students that, due to grade repetition, become part of the cohort. Depending on the estimates, subsamples are used for analysis.

There are three outcomes used for assessing endogenous effects in this work. The first of them—timely graduation from secondary school—is binary and takes a value of one when the student graduated in 2016 (as it would be expected without grade repetition). The second dependent variable corresponds to the result on the higher education admission test. In the context of this study, only the mandatory tests are used. The results of the test have been standardised to a mean of zero and a standard deviation of 1. In practice, there are no economic restrictions for taking the test due to a wide programme of scholarships for socioeconomically disadvantaged students. However, not all the higher education institutions will select the students based on the results of the test. Officially, the PSU is a test for selecting students applying to universities. Hence, students applying to a vocational institution will—in some cases—only need the secondary education certificate to apply. The last dependant variable under analysis is the type of institution where the student was enrolled. This is an ordinal variable. The Chilean higher education system is mainly organised according to the degrees they grant. While technical/vocational degrees are typically obtained in five-semester programmes, professional institutes confer degrees after a 10-semester programme. Universities are the only institutions that provide academic degrees that allow Master's and doctoral programmes to be followed. There are private and public universities. The most prestigious group combine both private and public institutions under the denomination

CRUCH[70]. In the sample under analysis, 12.5% of the students were enrolled in technical institutions, 22.4% in professional institutions, and 65.1% in universities.

The background information from SIMCE and administrative records is also used to construct the socioeconomic status measurement included as covariate. Using polychoric correlation, a composite measurement was derived from three original variables: mother's education, father's education and family income[71]. This information was requested from the parents as part of the questionnaire submitted to them when SIMCE was administrated. The variables of interest are the academic characteristics of the classmates, expressed as their average score on the SIMCE test, and the standard deviation of their scores. While the first measurement captures the level of ability of the peers, the second one indicates how academically diverse the primary school peers were. As controlling for students' previous attainment is a critical issue in peer effect estimates, a full set of entry variables is included. Besides the SIMCE scores for each student (in fourth grade), three other variables were included as proxies of students' academic ability. First, a variable stating whether the child was enrolled in pre-school education. Several recent studies have concluded that attending pre-school education in Chile is associated with better developmental and academic outcomes (Contreras, Herrera, & Leyton, 2007; Cortázar, 2015). Second, a binary variable identifying whether the student repeated a grade one or more times before fourth grade. As the main reason for repetition in Chile is not fulfilling academic requirements, it can be considered a fair proxy of academic performance. Some previous studies using similar datasets have included this as a strategy (Mizala & Torche, 2012)[72]. However, the portion of the students repeating a grade prior to fourth grade or not attending pre-school education is low (see Table 5.1). As the Chilean educational system is highly stratified between school sectors (Elacqua, 2006; McEwan, Urquiola, & Vegas, 2008), a measurement of relative ability was constructed within the classroom using the grade point average (GPA) in first grade. The construction of this variable follows the procedure used by Elsner & Isphording (2015). The ranking variable is distributed between values of 0 (meaning the best student in the class) and 1 (representing the student with the lowest GPA). The calculation of the student's position within the classroom was derived using the following formula:

[70] CRUCH stands for "Consejo de Rectores de Universidades de Chile", meaning "Council of Chancellors of Chilean Universities". This organisation currently includes the traditional universities (those created before 1981) and it controls the university admissions systems (PSU). However, recently the most prestigious private institutions created after 1981 have been incorporated into their system for university admission.

[71] The new variable expressing SES was generated with an Eigenvalue of 2.21 and it explains 73.7% of the variance in the data.

[72] Descriptions of the variables used in the estimates are included in the appendix (5A).

$$\text{Within-classroom Ranking} = \left(\frac{Absolute\ Ranking-1}{N\ students\ in\ the\ Classroom-1}\right)$$

SIMCE not only provides information about parental social and economic backgrounds, but also sheds light on the use of selective practices at early stages. The questionnaire submitted to the parents of the students taking the test in fourth grade gathers information on the use of selective admission procedures, such as entrance exams, play sessions, and the request of pre-school reports. Based on this data, schools were classified as selective when at least 70% of the parents responded that these procedures/requisites were used during the admission process. Previous studies have used this source of information to identify selective schools, but using less demanding parameters (Contreras, Sepúlveda & Bustos, 2010; González, 2018).

5.4 Empirical Strategy

The central assumption is that the current performance of students is affected not only by their academic ability and socioeconomic and cultural background, but also by the characteristics of the school and their peers. Moreover, it is not just the current context that plays a role in mediating the results of the students, but the previous background (particularly the peers) may also influence the students' results in the present. Although the primary concern of this work is to assess endogenous effects, the estimates also include a measurement of exogenous effects based on the average socioeconomic level of the peers.

There are three dependent variables with which to analyse the higher education paths of the students. First is timely graduation from secondary school. As completing 12 years of compulsory education is a requisite for taking the PSU exam and for applying to any higher education institution, this can be considered an initial indicator about the future educational paths of the students. The second is the score on the higher education entrance exam. Although this test is not a requisite to apply to all the institutions, it is an extended examination and a vast majority of the students graduating from secondary school take this assessment. Third is the type of institution in which they enrol. The type of Higher Education Institution (HEI) in which the student enrols may be determined not only by academic factors of each student but also the characteristics of the peers (e.g. in classrooms with more high-performing students, the idea of attending university may be more widespread). As the dependent variables have different characteristics, the models used are not the same.

As most of the analysis will focus on PSU scores, the basic model used in this work is described based on the outcome of this exam. Specifications for timely graduation and type of HE institution are explained later in the text following the same basic structure:

$$A_{icst} = \alpha + \beta_1 A_{icst-1} + \beta_2 F_{icst-1} + \beta_3 S_{icst-1} + \beta_4 \overline{SIMCE}_{-icst-1} + \beta_5 SDSIMCE_{-icst-1} + \beta_6 \overline{SES}_{-icst-1} + \gamma_{st-1} + \mu_{icst}$$

A_{icst}: Expresses the PSU score of the student *i* in class *c*, in school *s* (at time *t*).

A_{icst-1}: Vector of academic ability of the students. Includes the student scores on SIMCE (fourth grade), a dichotomic measure of repeating before fourth grade (0=non-repeater; 1=repeater); Years of pre-school education and a GPA-based within-school ranking at year 1.

F_{icst-1}: Is a vector of family socioeconomic background in fourth grade, the parental expectations of the level of education that the student will pursue, and the number of books at home (a proxy of cultural capital).

S_{icst-1}: Is a vector of student-level controls such as gender, indigenous background, and attendance in fourth grade.

$\overline{SIMCE}_{-icst-1}$: Is the first variable of interest for measuring endogenous effects. It is a measurement of the average ability of the students in classroom *c*, in school *s*, excluding student *i*.

$SDSIMCE_{-icst-1}$: Is the second variable of interest for measuring endogenous effects. It expresses the academic diversity of the students in classroom *c*, in school *s*, excluding student *i*. It is constructed based on the standard deviation of the SIMCE scores of the classmates.

$\overline{SES}_{-icst-1}$: Is a measurement for assessing exogenous effects. It expresses the average socioeconomic status of the students in classroom *c*, in school *s*, excluding student *i*.

γ_{t-1}: Expresses the school fixed effects (fourth grade).

μ_{icst}: Error term

The model will be estimated separately for Maths and Language. School fixed effects have been used in the fourth grade as the peer characteristics are been observed at that time. Although an important proportion of the students move to a different school during their educational trajectory (especially due to the transition from primary to secondary school), this

chapter does not use fixed effects at any later stage (as was done in Chapter 4). Unlike the analysis included in Chapter 4, 12th grade students in a school might be following different types of education (vocational/academic). Therefore, the assumption of shared unobservable characteristics for the students within a school does not hold. In the Appendix, specifications controlling for the type of educational plan and including SIMCE scores in 10th grade are presented.

Following the same structure, a logit model for timely graduation is estimated. In this case, the dependant variable expresses whether the student graduated from secondary school in 2016 (as would be expected if they were enrolled in fourth grade in 2008). In this model, the dependent variable takes a value of one when the student has completed the secondary level in time and a value of zero when he/she has not. The model for the type of HE institution of enrolment is an ordered logit. It is assumed that there is a hierarchical structure in the educational system, where universities are considered to be more complex institutions, awarding degrees after more years of study and with alumni earning higher salaries[73]. In this model, the dependent variable 'Type of HEI' takes a value of one for Technical/Vocational institutions, a value of two for Professional Institutes and a value of three for Universities.

In order to tackle the reflection problem, a restricted sample is used for estimating models on peer impact on HE entrance exams and type of HE institution of enrolment. The restricted sample only includes the students who did not have any primary school peers in secondary education[74]. In those cases, the problem of reflection between the peers' academic performance and the student performance is eliminated, because that influence has already occurred when starting secondary school (therefore, there is no simultaneous impacts). Although the basic estimates use the restricted sample, new estimates with the complete sample are used to relate the results (albeit disregarding the potential bias induced by the reflection problem). There is no attempt to control for the problem of simultaneity of the models estimating the impact on timely secondary school completion. Given that the dependent variable implies that students have repeated or abandoned school after fourth grade, it does not make sense to use the transition to secondary school, as the student may have dropped out prior to that year.

[73] The hierarchical nature of the HE system is a contested topic. Some may argue that certain technical or professional institutions are better quality than some universities or that some technical degrees have better economic returns than other university degrees. Acknowledging this criticism, the models are also estimated under a multinomial logit model, where no hierarchy across the institutions is assumed. The results are available upon request.

[74] However, this group shows some differences compared to the groups of students with former primary school peers in the secondary school of enrolment. In particular, it has lower academic outcomes in both Maths and Language (equivalent to .1 of a standard deviation). Hence, it is necessary to be cautious when interpreting those results. A comparison between estimates based on the restricted and full sample is presented in the results section (robustness analyses).

As the effects of the peers could be dissimilar for students in different parts of the academic distribution, models using interactions between the student performance and the peer characteristics are presented. Based on the students' test results in SIMCE (fourth grade), two different measurements capturing the students' ability are compared with the peer characteristics. First, the SIMCE score of the student (expressing their ability in absolute terms), and second, the within-school student ranking (expressing a relative measurement of ability). This strategy not only allows the way in which the characteristics of the classmates operate for students in different parts of the ability distribution to be understood, but it also allows comparison of how the results may vary according to the selected measurement.

In addition to the analysis for selective and non-selective schools, differentiated estimates are carried out for those using within-school sorting based on ability. As with some other studies focused on within-school non-random distribution of the students, this work uses the approach proposed by Clotfeltter, Ladd & Vigdor (2006). The distribution of the students across groups was tested in every school with two or more classes based on quantiles of achievement (based on the grade point average in first grade for 2005) and the percentage of grade repeaters. Analysis of schools without sorting include both schools with only one class per grade (as sorting is not possible) and all those schools were the null hypotheses of a similar academic distribution of the students was rejected. According to this classification, 22% (n=45,064) of the students were considered to be enrolled in school that sort students among classes.

The features of the data and the empirical strategy address the main issues discussed in the literature on peer effects (Thrupp, Lauder, & Robinson, 2002; Yeung & Nguyen-Hoang, 2013), namely, the inclusion of prior attainment measurements, identification of peers at the classroom level, the inclusion of relevant entry-level covariates, use of continuous measurements for expressing academic ability, and solutions for selection and reflection problems.

5.5 Results

To understand the effects of the peers' academic characteristics on post-secondary paths, three main outcomes are considered: timely completion of the secondary level, the scores on the PSU exam and the type of HE institution of enrolment. Although each of them represents a specific dimension of the post-secondary academic outcomes of the students, this work focuses on analysing the effects on the scores on the higher education entrance exam. Due to the sample size and data limitations, the estimates on timely graduation and the type of higher institution of enrolment are mostly used to contrast the main results.

5.5.1 Higher education entrance exam

The estimates in Table 5.2 show the effects of the variables of interest on the students' scores on the PSU. Columns 1 and 2 show the preferred specification in Language and Mathematics, respectively[75]. Using the subsample of students with no former primary school peers at the secondary level and implementing school fixed effects, these estimates simultaneously address the issues of selection and reflection discussed above. This specification not only includes measurements of the academic attributes of the primary school peers, but also a variable expressing the classmates' average socioeconomic status in fourth grade (exogenous effects). There are three main factors to be observed from these estimates. First, increases in the level of academic heterogeneity have a negative—although very small—effect in both Language and Maths (equivalent to .024 and .012 of a standard deviation, respectively). In other words, a major change in class composition (such as one standard deviation increase of academic heterogeneity) would produce a very limited negative effect on the students' performance. This finding suggests that a more diverse academic setting is not a key factor to explain negative effects on the higher education examination. Second, the effect of the average ability of the classmates is more pronounced than the effects of the peers' academic heterogeneity. This is especially noticeable in Maths. The data suggest that a one standard deviation increase in the average peer ability results in a decrease of .031 of a standard deviation in Language and .097 of a standard deviation in Maths. Even though they are much greater than the effects associated with the academic diversity of the classroom, the results are still of a small magnitude. Third, the average socioeconomic status of the peers (exogenous effects) has a positive and significant impact (in Maths). As can be observed, while increases in the academic attributes of the peers negatively affect the outcomes, there is a positive effect associated with being exposed to wealthier classmates.

The results from previous estimates suggest a negative average effect of the classmates' academic attributes. However, they do not shed light on how those effects are displayed for students with different levels of achievement. Heterogeneous effects are explored by comparing the students' academic performance with the peers' average ability. To do so, two indicators are used for the pupils' performance. The first measurement follows the traditional methodology employed in several previous studies in the field and compares the score of the student on a standardised test (in this case, the SIMCE in fourth grade). This approach considerers the ability of the student in absolute terms. The second approach uses the student's

[75] For simplicity, only a subset of variables is presented in this section. Estimates including all covariates are presented in the appendix (5F-5K).

ranking within their school based on the results on the SIMCE test. Figure 5.1 shows the effects of increases in the peers' average ability on PSU scores for students in different parts of the ability distribution. When observing the "absolute measurement" (A-B) based on SIMCE scores, the data indicate certain differentiated effects across subjects. In Language, students show a very small negative effect on PSU scores associated with increases in the peers' average academic ability, with the exception of those with better SIMCE scores (percentile 90), which show gains in scores derived from being exposed to high-ability peers. Although the positive effect for the top performers is greater than the negative effects for the rest of the students, the group positively affected is small and does not entirely offset the negative effects for the rest of the students. By contrast, in Maths the data suggest that the negative effects are displayed similarly across the achievement distribution. This is consistent with the greater average negative effect observed in the subject. Exploring heterogeneous effects (Language) by using the relative measurements of ability (C-D) shows that the better performers are not negatively affected by increases in the average peer ability. On the contrary, the low achievers show a greater detrimental effect on the PSU when exposed to higher-ability peers. Results in Maths graphically demonstrate that increases in peer ability lead to worse results on the PSU. In contrast to the estimates based on absolute measurements of ability, the

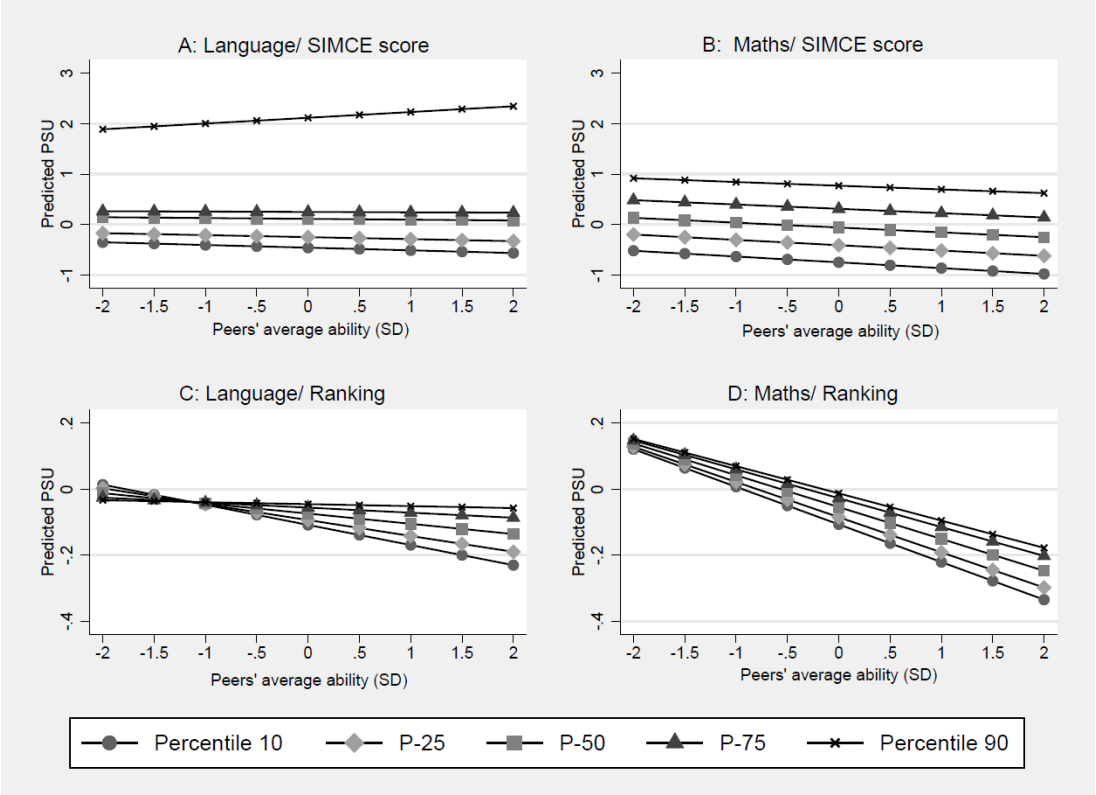
Table 5.2. The Effect of Peer characteristics on Higher Education Entrance Exams

	All schools		Non-selective		Selective		Without sorting		With sorting	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VARIABLES	Lang	Maths	Lang	Maths	Lang	Maths	Lang	Maths	Lang	Maths
Student SES	.132***	.130***	.109***	.110***	.161***	.149***	.137***	.129***	.124***	.124***
	(.006)	(.005)	(.006)	(.006)	(.013)	(.012)	(.007)	(.007)	(.013)	(.011)
Average Peer SES	.012	.057*	.015	.074***	.045	-.095	.009	.041	.022	.098*
	(.026)	(.024)	(.023)	(.021)	(.066)	(.068)	(.032)	(.029)	(.044)	(.042)
Peer Heterogeneity	-.024***	-.012*	-.035***	-.014*	-.005	-.023*	-.030***	-.015*	-.013	-.001
	(.005)	(.005)	(.006)	(.006)	(.012)	(.011)	(.006)	(.006)	(.011)	(.009)
Peer Ability	-.031***	-.097***	-.026**	-.088***	-.018	-.104***	-.025*	-.095***	-.048**	-.112***
	(.009)	(.009)	(.009)	(.009)	(.019)	(.022)	(.011)	(.010)	(.018)	(.016)
Constant	-.857***	.010	-1.399*	-.625	-.621***	.223	-1.054***	.158**	-.790***	-.229
	(.061)	(.050)	(.562)	(.346)	(.162)	(.155)	(.073)	(.060)	(.156)	(.124)
Observations	53,009	53,314	39,271	39,532	13,738	13,782	40,378	40,597	12,631	12,717
R-squared	.407	.539	.364	.515	.423	.527	.432	.558	.437	.563
Selection Solution	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Reflection Solution	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Robust standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.05. Standard errors are clustered at fourth grade.

results clearly show that the worse the student performance is, the greater the negative influence of being exposed to high-achieving peers will be.

Figure 5.1. Heterogeneous Effects According to Students' Ability



The two measures used to compare the effect of variations in the average ability of the classmates on the students' PSU scores express certain differences. First, when using the absolute values in the SIMCE scores as a proxy for ability, little variation is observed for almost all the groups in both subjects (with the expectation of the top performers in Language). The differentiated results for the top performers in Language may explain why the average result is lower in this subject than in Maths (as observed in Table 5.2, col. 1-2)[76]. Second, the results using the relative measurement of ability vary by subject. In Language the results suggest that increases in the classmates' average ability have no effect on the top performers and a gradually more negative impact for the other groups. In Maths, all the students across the academic distribution experience negative effects, but they appear to be more marked for the low achievers.

[76] The results from the model using interactions are presented in the appendix (5I).

Although the graphic representation shows some differentiated effects using the relative measurement of ability, the effects are very small. Therefore, the traditional measurement seems a better approach to highlight the heterogeneous effects through subgroups.

As previous studies have suggested, the schools might be using both admission procedures and "sorting" as ways of managing the academic level or diversity of the school intake. Chilean datasets allow the identification of which schools implement selection based on academic considerations and which distribute the students between classes based on their academic ability. Non-selective schools (Table 5.2, col. 3-4) show very similar results to those obtained in previous estimates. Once again, the average ability of the peers (particularly in Maths) shows greater influence than peer heterogeneity. The magnitude of the effects is slightly greater compared to the estimates using the full sample. Students in academically selective schools (Table 5.2, col. 5-6) do not show impacts of the peers' attributes in Language, suggesting that academic selectivity helps to reduce the negative impact of the peers' academic characteristics. While in the full sample (Table 5.2, col. 1-2) small negative effects were recorded for both variables of interest, in the subgroup of schools with academic selection those impacts are not present in this domain. However, the opposite happens in Maths where the selective schools show greater negative effects associated with increases in the peers' academic heterogeneity or the classmates' academic diversity. Although these changes are interesting, they must be carefully interpreted as they may be associated with sampling variation.

A somewhat similar pattern is observed depending on the tracking status of the school. Schools without sorting practices (Table 5.2, col. 7-8) record negative effects associated with both peers' heterogeneity and classmates' average ability. The magnitude of the coefficients are similar to those obtained when using the full sample (Table 5.2, col 1-2) for each of the domains. This means that the main negative effect regarding the influence of the peers is observed in Mathematics and it is associated with increases in the average ability of the classmates. In the case of schools in which sorting is implemented, the results show some striking differences and similarities. First, the impact of peers' academic ability remains negative and significant in both Maths and Language. However, in both subjects the size of the effect is greater than that observed in schools without sorting. Second, the negative impact of increases in academic heterogeneity fade out in both domains. On the one hand, these results suggest that sorting practices—implying more academically homogenous classrooms—may be helping to reduce the negative effect of academic diversity. On the other hand, the negative effects of increases in the classmates' average ability are even stronger in these settings.

5.5.2 Timely graduation and type of higher education institution

To define to what extent the peers' academic attributes impact long-term educational outcomes, two other factors are observed. First, the timely completion of compulsory secondary education, which represents the first academic outcome in the transition from school to higher education. Although informative, these estimates are limited in the resolution of the reflection problem. The main problem with observing this result while restricting the analysis to the group of students without primary school students is the loss of information. In this group, any student who repeats a grade or temporarily leaves the school before 10th grade will be excluded from the analysis (as they were not in 10th grade in 2014). However, these students are very important for the scope of the analysis, since they will be part of the group that has not completed the secondary level on time. The results (Table 5.3, col. 1-2) show that greater academic heterogeneity leads to an increase in the probability of timely completion of secondary school (in Language). In particular, one unit increase (e.g. one sd) in the level of academic diversity of the students is associated with a 10% increase in the odds of graduating from secondary school on time. Although it acts in the same direction, the effect of the academic diversity of the classmates is not significant in the estimates based on Maths. On the contrary, increases in the average ability of the peers reduces the likelihood of timely secondary education graduation (only significant in Maths). The socioeconomic factor seems to be more consistently associated with greater chances of timely completion of secondary education. In both Maths and Language, a one-unit increase in the students' SES increases the odds of timely graduation by nearly 12%. Similarly, an increase in the average SES of the peers leads to an equivalent increase in the odds of completing the secondary level in the expected year. These findings suggest that the socioeconomic factor—both at the student and classroom level—play a much more decisive role in the odds of graduating on time compared to the academic factor (which seems to be restricted to the academic heterogeneity of the peers in only one of the subjects).

The type of higher education institution of enrolment expresses very different paths for the students. While university degrees are usually associated with greater earnings and economic returns, technical and professional institutions are often less prestigious and selective and lead to lower future gains. Although this is a gross generalisation, it is still reasonable to assume that universities are the leading institutions in many regards. Estimates for this outcome overcome the problems of reflection and selection, but are affected by collinearity. The results suggest (Table 5.3, col. 3-4) that that socioeconomic and academic factors produce opposite

effects on the chances of attending university compared to the other two other types of institutions combined. In particular, for a one-unit increase in the student SES, the odds of attending university versus attending a vocational or professional institution are 1.542 and 1.524 times greater (in Language and Maths, respectively). Interestingly, no significant effects are observed from increases in the average peer SES. Moreover, both greater academic heterogeneity of the classmates and higher average ability of the peers reduce the chances of being enrolled in a university compared to other types of higher education institutions.

The ordered logit analysis for Type of Higher Education must be carefully considered as it has an exploratory nature. It is important to take into account that only students who finish secondary education on time and started university immediately after graduating from secondary school are included in this estimate. This implies that students with lower achievement are not in the sample and may be affecting the estimates regarding the influence of both the socioeconomic and academic factors. Therefore, these results cannot be generalised to the national level.

Table 5.3. The Effect of Peer Characteristics on Timely Graduation and Type of HE Institution of Enrolment (Odds Ratio)

	Timely graduation (Logit)		Type of HEI (Ordered Logit)	
	(1)	(2)	(3)	(4)
VARIABLES	Lang	Maths	Lang	Maths
Student SES	1.183***	1.170***	1.542***	1.524***
	(.012)	(.012)	(.041)	(.040)
Average Peer SES	1.188***	1.206***	1.121	1.062
	(.055)	(.056)	(.118)	(.111)
Peer Heterogeneity	1.025**	1.011	.940**	.935**
	(.009)	(.009)	(.021)	(.020)
Peer Ability	.999	.936***	.925*	.896**
	(.015)	(.016)	(.031)	(.034)
Observations	201,238	201,238	32,149	32,232
Selection Solution	Yes	Yes	Yes	Yes
Reflection Solution	No	No	Yes	Yes

Note: Robust standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.05. Standard errors are clustered at fourth grade.
In the estimates for "Timely Graduation", "Not graduating on time" is used as the category of reference. In the Ordered Logit estimates, the dependent variable "Type of HEI" is coded as Technical/Vocational (1), Professional Institutes (2) and Universities (3).

5.5.3 Robustness analysis

As has been mentioned previously, this work addresses two of the major methodological challenges faced by studies on endogenous peer affects (reflection and selection). In order to disentangle the simultaneous nature of peer effects, this study has exploited a change in group composition from primary to secondary school, assuring that the peer attributes were not measured at the same time as the outcomes. In order to address the issue of selection, fixed effects were used to control the non-observable factors associated with the non-random distribution of the students across schools. This strategy was also reinforced by separately analysing students from selective and non-selective schools. Several analyses were carried out to verify whether the results of this paper were robust in terms of changes in samples and specification. First, the results were compared to the full sample in the cohort and second, several specifications were tested.

An initial model using the full sample of students was estimated using OLS, without any attempt to control for the selection and reflection problems. The results (Table 5.4, col. 1-2) show that increases in academic ability lead to a positive and significant effect (.041 of a standard deviation) in Language and a negative and significant effect (.076 of a standard deviation) in Maths. An extremely low magnitude negative effect (.009 of a standard deviation) arises from a one standard deviation increase in the classmates' academic heterogeneity in Language and no effect is observed in Maths. Exogenous effects are greater in magnitude, positive, and significant (.261 and .205 of a standard deviation in Language and Maths, respectively). However, those estimates do not address any of the problems that could introduce bias into the estimates. Using the same sample, new estimates introduce school fixed effects (Table 5.4, Col. 3-4). All the effects of the variables of interest are now negative and significant. The results are similar in magnitude to those obtained in the core sample used in the previous analysis (Table 5.4, col. 7-8). On the contrary, the exogenous effects do undergo an important variation, with significant reductions in the sizes of the effect.

Table 5.4. The Effect of Peer Characteristics on Higher Education Entrance Exam Scores (Robustness Analysis)

	OLS (All schools)		FE (All schools)		OLS (Restricted sample)		Preferred Specification	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Lang	Maths	Lang	Maths	Lang	Maths	Lang	Maths
Student SES	.137***	.122***	.127***	.121***	.146***	.135***	.132***	.130***
	(.004)	(.004)	(.004)	(.004)	(.006)	(.005)	(.006)	(.005)
Average Peer SES	.261***	.205***	.045*	.073***	.169***	.154***	.012	.057*
	(.006)	(.005)	(.019)	(.018)	(.006)	(.006)	(.026)	(.024)
Peer Heterogeneity	-.009**	-.000	-.012**	-.011***	-.007	.004	-.024***	-.012*
	(.003)	(.003)	(.004)	(.003)	(.004)	(.003)	(.005)	(.005)
Peer Ability	.041***	-.076***	-.027***	-.095***	.011*	-.099***	-.031***	-.097***
	(.005)	(.004)	(.006)	(.006)	(.005)	(.005)	(.009)	(.009)
Constant	-.771***	-.173***	-1.107***	-.024	-.776***	-.208***	-.857***	.010
	(.040)	(.032)	(.043)	(.035)	(.050)	(.042)	(.061)	(.050)
Observations	116,725	117,324	116,725	117,324	53,009	53,314	53,009	53,314
R-squared	.412	.518	.461	.558	.335	.478	.407	.539
Selection Solution	No	No	Yes	Yes	No	No	Yes	Yes
Reflection Solution	No	No	No	No	Yes	Yes	Yes	Yes

Note: Robust standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.05. Standard errors are clustered at fourth grade.

Accounting for the between-schools heterogeneity of the students' characteristics produces important changes in the estimates. Not only does the magnitude of the coefficients change, but also the direction of the effects. A naïve estimate (col 1-2) suggests positive effects in Language, while under the fixed effects approach those values are clearly negative. This reinforces the importance of tackling selection issues. As mentioned before, the use of fixed effects also significantly affects the control variable for the average peers' SES. The coefficients for this variable shrinks significantly, suggesting that failing to control for the between-schools heterogeneity of the students characteristics may lead to overestimating the exogenous effects.

Finally, new estimates were carried out using the restricted sample, but ignoring the school fixed effects (Table 5.4, col. 5-6). This approach serves to distinguish whether the reflection problem is affecting the estimates— and into what extent. In this case, the results show that coefficients of average peer ability (in Maths) and classroom heterogeneity (in Language) remain similar in terms of the direction of the effect and significance (compared to the naïve model in col 1-2). However, differences emerge regarding other variables, such as peer heterogeneity (with no significant effects) and average peer ability (with an important reduction in size compared to the full-sample OLS estimates. These results also show that controlling for the reflection problem does play a role in the estimates, but it is much more limited compared to accounting for selection.

In general terms, the findings in this section suggest that controlling for fixed effects are relevant for both the direction of the endogenous effects and for the magnitude of the exogenous effects. As findings using the full sample (and controlling for selection) are substantially similar to those obtained when using the preferred specification and sample (col 7-8), the main results of this works can reasonably be extrapolated to the general Chilean system. Changes in the specification of the model were introduced to test how stable the outcomes were. The results suggest that the findings are strong for several specifications, including the exclusion of the measurement of the exogenous effect and the previous attainment on SIMCE[77].

[77] Additional controls for the type of secondary school (academic or vocational) and SIMCE in 10th grade scores have been considered in additional models in the Appendix (5H). Although some small differences of magnitude are observed, the main findings remain the same regarding the direction of the endogenous and exogenous effects. However, some low magnitude effects are not significant in those estimates. In Appendix 5K, the specifications excluding the average peer SES measurement or previous SIMCE score also show stability in the direction of the effects, but with some changes in their magnitude. While in the case of peers' academic heterogeneity the estimates remain negative but

5.6 Conclusions

Long-term peer effects are rarely observed in the educational arena. This study advances on previous literature by providing new information about how the academic attributes of early peers affect the students' performance on higher education entrance exams. Observing the long-term effects of the classmates is critical to assess the efficiency and equity of educational systems.

The results show that the academic characteristics of the peers do play a role in the students' outcomes. This implies that the attributes of the primary school classmates is not trivial for a student's later educational path. The effects, which are much more clearly observable in Maths, draw an unusual picture: negative effects of increases in the average performance of the peers are manifested for the students, regardless of their own level of achievement. In Language, where the average effect is smaller than in Maths, the negative effects do not operate for high achievers. These conclusions are, to some extent, in contrast to the usual findings in the literature on peer effects (although most of the studies only observe short-term impacts within the school setting). Typically, evidence from studies addressing the issues of reflection and endogeneity suggests average positive effects of low-magnitude (or no impacts) associated with increases in average peer performance. There are two main factors that could drive the average negative effect observed in this work. First, instruction may be tailored to high-achieving students, leaving low performers in a detrimental position for learning. This problem might be related to failures in teacher training regarding working with diverse sets of students or weaknesses in the procedures for monitoring learning, among other factors. Second, students may de "demoralised" by the presence of higher achievers and their results tend to be negative. Both factors have been discussed in the literature as part of the "invidious comparison" model for explaining the peer influence (Biu, Craig, & Imberman, 2014; Murphy & Weinhardt, 2014; Antecol, Eren, & Ozbeklik, 2016). Moreover, a recent study taking advantage of the 2010 earthquake in Chile (as a natural experiment), concluded that Chilean students present rank concerns and those may generate peer effects (Tincani, 2017). The estimates for schools where selective or sorting practices take place are consistent with this interpretation. As is expected, in these schools the effect of the average ability of the peers is

increase in size, the average ability of the peers shows differentiated effects. While in Maths, the values remain negative but shrink in size, in Language the coefficient is still negative and similar in magnitude.

even greater than in those schools without student selection or where there is within-school segregation based on performance.

The negative results also present a particular feature: they are much more noticeable in Mathematics than they are in Language. Although it is not the purpose of this work to disentangle the mechanisms by which the peer influence takes place, the differences across the domains may be caused by several factors. First, as previous works have stated (Lavy, Silva & Weinhardt, 2012), the subjects may rely on divergent sets of skills. If peers exert influence in skills that are more closely related to a specific subject, differentiated effects are expected. Second, the effects in Maths may have a cumulative nature, widening the differences over time compared to Language (this is consistent with the findings in Chapter 4, where short-run effects are less marked in Maths). Finally, the rank concerns of the students may be stronger in Maths as suggested by Tincani (2017), allowing a greater impact of the peers than would be expected in an 'invidious comparison' framework. However, the differences between subjects in the literature on peer effects are not something new. Several recent works separately analysing the effect of peers across subjects find differentiated effects (Arcidiacono et al., 2012; Carman & Zhang, 2012).

The results in this study contradict not only the predominant discourse about peer effects at international level, but also the very limited local research on the topic. A plausible explanation is that the identification strategy in this work solves issues that previous works have ignored. The literature on the topic has consistently highlighted that the exclusion of measurements of previous attainment or overlooking the problems of self-selection and reflection may lead to upward bias in the estimates.

The figures not only suggest that there are negative effects associated with increases in the average peer performance, but that there are virtually no effects associated with increases in peer heterogeneity. Therefore, it is not the diversity of ability that has the greatest influence, but the average level of ability. Moreover, sorting students within schools tends to eliminate the very small negative effects of academic diversity, but increases the effects associated with greater peer average ability.

Although this work focuses on estimating long-term endogenous effects, there are interesting findings regarding the exogenous effects. Only effects of a small size are recorded in Mathematics, while no significant impacts are observed in Language. These effects are much more limited in magnitude compared to the observed effects of the individual socioeconomic status. This is a striking picture, as in Chapter 4 the figures showed the opposite (with a much

more important influence of the peers' characteristics than the students' SES. These changes suggest that while the academic attributes of the classmates exert an impact that lasts over time (although with variations across subjects), the endogenous effects fade out over time. Although this work is unable to identify the specific mechanisms in which peer effects operate, these findings suggest that endogenous and exogenous peer effects function in dissimilar ways.

The estimates included in this work suggest that factors out of the control of students and families affect the students' performance in the long term. As higher education entrance exams play a decisive role in shaping future opportunities, it is not trivial that compositional effects are taking place.

Chapter 6

Conclusions and discussion

Conclusions

The wide gap in achievement between poor and affluent students has been a long-standing phenomenon in Chile. Critics of the market-oriented educational system implemented in Chile since 1981 have argued that differences in achievement are closely associated with the socioeconomically stratified nature of the educational system. Despite the intense public and political debate on the matter, the causes of socioeconomic segregation remain a contested topic in the academic arena. While some pieces of research have underlined the role of parental preferences, other works have highlighted the extent to which specific features of the system explain the extreme level of separation of rich and poor students. Furthermore, only a pair of studies have observed the effects of school composition on students' academic outcomes. Notwithstanding the lack of a consensus diagnosis on the causes of segregation and the uncertainties about the effects of separation of the students, several policies tackling—either directly or indirectly—the issue of student composition have been put into effect in recent years. Moreover, a new and more radical reform aimed at reducing segregation has started to be implemented (2015).

In the international literature—where the topic of peer effects has been investigated much more extensively—there is also controversy about the direction and size of the potential academic effects. Concerns about the methods to estimate the impacts of the schools' composition have eroded the formerly prevalent notion of positive gains derived from interaction with better-off peers. In this scenario, this work aims to contribute to the literature in two ways. First, by analysing the trends of segregation (both nationally and internationally) in a period when numerous initiatives intended to tackle segregation and inequalities have been implemented worldwide (and in Chile) and second by estimating the effects of the socioeconomic and academic composition on student outcomes in the short- and long-run (and considering the main methodological challenges in these types of estimates).

Previous studies have called attention to the risks associated with the high degree of stratification of educational systems. Not only may the concentration of students with similar social backgrounds have detrimental effects on pupils' achievement, but it could also undermine social cohesion and contribute to the weakening of democratic coexistence. The first two chapters of this work are not intended to provide causal explanations regarding the volume of segregation, but rather to observe the evolutions of a phenomenon in a period in which concerns about inequalities in education have gained visibility in many educational

systems. Both internationally and in Chile, no significant reduction in the degree of separation of rich and poor students is observed. Despite the efforts to reduce inequalities, none of the OECD nations have shown significant reductions in levels of socioeconomic segregation in the last 15 years. In the case of Chile, policies put into effect during the last decade are not correlated with reductions in the magnitude of socioeconomic segregation. Moreover, since 2000 Chile has remained one of the most segregated OECD countries. As parental school preferences are not included in national records, this work cannot determine to what extent the allocation of the students in different schools is driven by families' choices or is due to geographic factors (such as territorial segregation of students). When observing the supply-side characteristics, the data suggest that both co-payment and student selection are associated with greater segregation.

However, as an important proportion of the segregation is attributable to the distribution of the students within each sector (municipal and subsidised-private) it is plausible that parental preferences are also playing an essential role in defining the student allocation. Regardless of the causes, segregation remains high even when limitations on selection and co-payment have been implemented. Three main reasons may explain this scenario. First, the new regulations are weak and have not been radical enough to effectively reduce co-payment and student selection or to incentivise schools to enrol socioeconomically disadvantaged students. While selection is formally forbidden but is still used in practice by more than half of schools, co-payment has only been reduced for a particular group of students in schools that voluntarily adhere to the 'Preferential School Subsidy Law'. Second, although segregation is high in all social groups, it is remarkably elevated for wealthy students, who appear to be almost entirely isolated from the rest of the students. As all recent policies do not affect the non-subsidised sector—where most wealthy students are enrolled—the effects could be less marked in a scenario where all sectors are subject to the policy regulations. Third, it is plausible that—as some of the school choice literature suggests—parents prefer to cluster themselves with other families with similar beliefs, expectations, and backgrounds, which leads to stratification. As in Chile the diversity of providers and educational projects is promoted and there are no geographical restrictions on choosing a school, this process may be driving segregation beyond the regulations.

The academic effects of the socioeconomic characteristics of classmates also provide relevant conclusions. Data show a positive average effect associated with being exposed to wealthy peers during primary school. Probably, the more significant cultural and educational capital

of wealthy students benefits students from more disadvantaged backgrounds. Although it is not the purpose of this research to disentangle the specific factors by which the peer effects operate, based on previous literature, several mechanisms may be mentioned. For example, communities with higher average socioeconomic status may demand improvements in the quality of education provided by the school and demand greater accountability from the schools' leaders. Is also likely that teachers have greater expectations of the students in settings with a higher socioeconomic level. The benefits from increases in the SES of the classmates could also be driven by peer interaction, with wealthy students sharing cultural capital and helping to set higher education expectations for the other students. Importantly for the context in which there is a greater school mix, there are no adverse effects associated with greater socioeconomic heterogeneity. This suggests that policies oriented towards a greater school mix would be beneficial in academic terms. Future works should address the thresholds of "integration" ensuring the positive effects and the best ways to incentivise socioeconomic mix in a scenario encouraging parental school choice.

In contrast, the academic characteristics of the peers show a negative effect on student performance in the long term. Notably, being exposed to peers with greater ability leads to reductions in the students' scores on higher education entrance exams. There are two perspectives to explain this effect. On the one hand, teachers may customise the instruction to higher achievers. In that scenario, teachers would teach according to the needs of the ablest students, leaving behind the less talented students. This is a plausible explanation in the Chilean system, where schools do not need to work on specific learning targets for students in different parts of the academic distribution. On the other hand, students may be observing each other. Students that are not at the top of the distribution may be demoralised and invest less effort in achieving (‘invidious comparisons’ or the related topic of ‘Big fish, little pond’). Both of these hypotheses require additional research. In particular, observing the effects of the relative position of the students—using ordinal rank measures— may be appropriate for the Chilean case given these findings. The detrimental effects of being exposed to more talented classmates are also challenging for the Chilean educational system. If greater school mix is stimulated, higher academic heterogeneity can be expected. Therefore, the factors causing these negative effects should be clarified and intervened.

As the impacts of the classmates' characteristics on academic outcomes have been observed both in the short and long run, original insights may be drawn. Data not only confirm the existence of impacts associated with the peers' socioeconomic characteristics, but suggest that

they endure over time until the end of the schooling period (at least in Maths). Similarly, the average performance of the peers also exerts an effect (this time negative) that continues to exist in the long run (in Language). In both cases, and as could be expected, the effects are smaller in the long-run estimates. This work does not attempt to untangle the mechanisms by which peer influence operates. However, the findings suggest that while the effects of academic characteristics of the peers endure over time, the impact of the socioeconomic attributes of the classmates declines strongly. Some differences also appear in the effects observed between Mathematics and Language, evincing that the classmates' attributes may work on skills that might be more relevant to succeed in some domains rather than in others. However, these conclusions must be considered carefully for several reasons. For example, the higher education exam results may be affected by private tutoring for the exam. In that sense, SIMCE and PSU represent very different stakes for the students. Second, the measured outcome is different. Although both tests are curriculum based, they are not strictly comparable. Finally, issues such as student dropout may affect the estimates and hinder the comparisons. This implies that models of long-term effects in this work are inevitably restricted to the group of more academically successful students, as grade repeaters and students with intermittent educational trajectories are not part of the sample.

The findings regarding peer influence in this work raise new challenges for research, but also for the operation of school systems pursuing increased efficiency and equity. On the contrary to most of the previous studies, this work simultaneously assesses the effects of the socioeconomic and academic attributes of the peers. This forces us to consider how peer influence works in each of these dimensions. Moreover, as how peer effect works continues to be a ‘black box’, it is relevant to consider that particular features of the educational system may be shaping the ways in which the peers’ influence is displayed. For example, new research has suggested that academic peer effects may be catalysed by students' ‘rank concerns’. For the Chilean system, in which grades are used to qualify student school performance from very early stages and in which academic selection and sorting practices are extended across the schools, the ‘rank concerns’ may be operating with greater intensity compared to more comprehensive systems where students have much less information to compare themselves to the other students. However, this mechanism may explain the academic influence of the peers, but not necessarily the socioeconomic effects derived from the peers’ attributes. In this work, while academic factors exert a negative impact, the socioeconomic features lead to positive gains. This means that the classmates' influence may be operating through two alternative—

and possibly unrelated or opposing—forces. Studies focusing exclusively on one of the factors have the risk of confounding the way in which the peer characteristics are displayed.

In this analysis, peer effects do exist and shape students' academic outcomes. This implies that factors that are beyond the control of the student and families—such as the socioeconomic and academic composition of the schools—play a role in the students' final test results. Based on this, educational policies should carefully consider to what extent these factors affect pupils' academic outcomes and the direction of the effects. In particular, policies increasing school accountability over academic outcomes should be carefully examined, as a compositional factor may distort the schools' assessment.

In the Chilean context, the new reform (2015) has assumed a much more radical approach regarding the institutional factors mentioned as drivers of socioeconomic segregation. The new scheme takes the school admission process entirely out of schools' control, with a centralised system attempting to allocate the students based on parental preferences. Regarding co-payment, important changes will be developed. Schools will not be allowed to charge fees to families. The state will significantly increase expenditure in education, replacing the contributions of families in the schools using co-payment and levelling up the voucher amount in those without fees. The findings in this work challenge the new model in several ways. First, the new scheme does not affect the sector with the greatest levels of segregation. Although it is true that all social groups appear to be highly segregated, the exclusion of wealthy students strongly limits the possibility of integration and its expected positive effects. In this sense, the most likely changes associated with the new regulations are related to decreases in the 'within' segregation in the Municipal and Subsidised private sector (as access barriers will be eliminated). Second, the new scheme also considers that each subsidised private school can decide whether it will continue operating as a subsidised-private institution or be transformed into a non-subsidised school. If schools enrolling the 'relatively rich' students in the subsidised sector become private, the potential of integration will again be reduced. Third, based on the findings of this work, greater integration poses an important challenge. While being exposed to more affluent students has positive effects, sharing the classroom with more talented students has a negative impact. This implies that schools will have to adjust to a new scenario, where the teaching process will be challenged.

This work has emphasised the academic consequences of school composition. As the effects are small (and there are risks associated with changes in academic composition), this could be

assumed to be an argument to relativise the importance of addressing social segregation. This should be analysed cautiously, considering that the expected effects of limiting segregation are not only confined to academic outcomes, but the development of democratic values and social cohesion.

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8 Appendix

Appendix 2A. Estimates of between-school segregation (H) across countries (2000-2015)

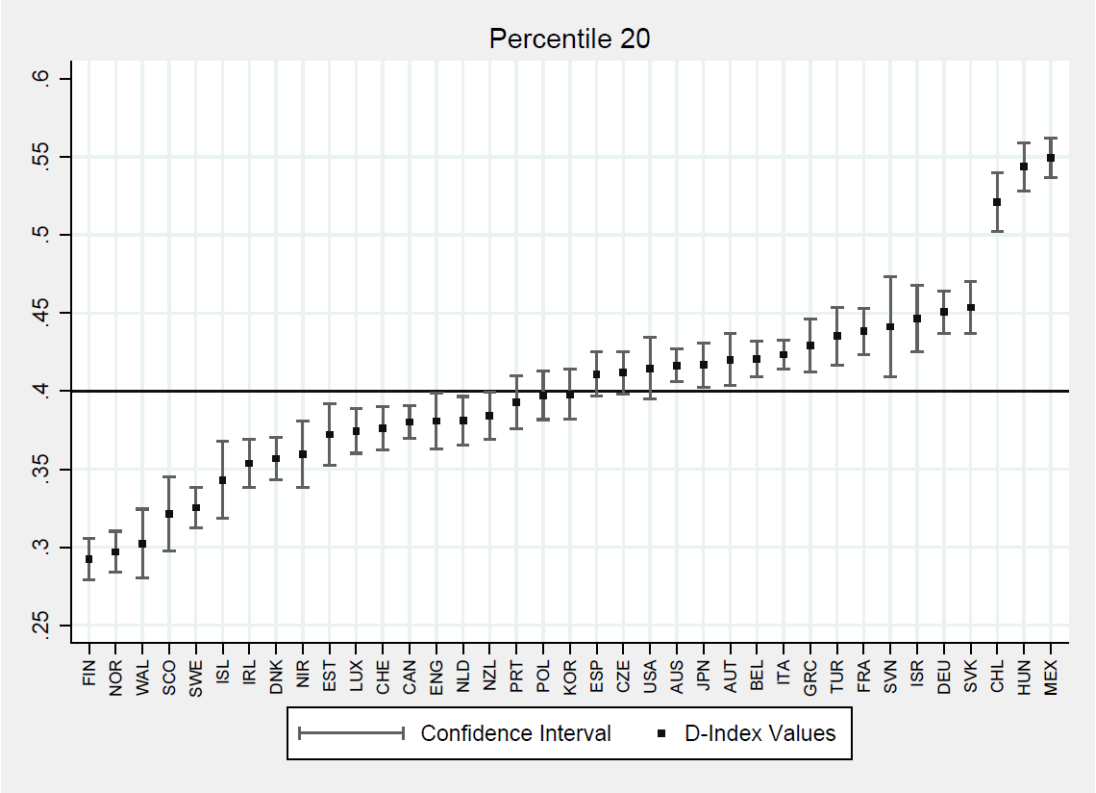
	Percentile 20						Percentile 50						Percentile 80					
Country	2000	2003	2006	2009	2012	2015	2000	2003	2006	2009	2012	2015	2000	2003	2006	2009	2012	2015
Australia	.18	.14	.14	.14	.18	.21	.14	.12	.11	.11	.14	.14	.20	.15	.14	.15	.19	.20
Austria	.17	.18	.17	.17		.17	.12	.17	.15	.13		.12	.20	.23	.23	.23		.20
Belgium	.14	.19	.16	.16	.15	.15	.12	.15	.13	.16	.14	.14	.18	.19	.16	.21	.18	.16
Canada	.12	.14	.15	.14	.14	.13	.09	.11	.11	.10	.09	.09	.13	.13	.16	.14	.13	.12
Chile	.26		.30	.27	.29	.26	.25		.27	.24	.26	.22	.34		.37	.34	.37	.33
Czech Republic	.17	.18	.17	.14	.18	.20	.14	.14	.12	.11	.15	.16	.19	.21	.17	.15	.22	.22
Denmark	.13	.12	.11	.12	.14	.14	.08	.09	.08	.10	.10	.09	.14	.16	.10	.14	.15	.14
Germany	.19	.21	.20	.19	.20	.16	.13	.16	.13	.14	.16	.12	.21	.23	.19	.22	.21	.17
England			.13	.14	.14	.13			.11	.11	.12	.13			.16	.16	.16	.16
Estonia				.11	.16	.17				.10	.12	.12				.12	.14	.16
Finland	.09	.07	.07	.07	.08	.09	.06	.06	.05	.06	.06	.07	.10	.08	.07	.08	.09	.09
France	.15	.17	.19	.18	.18	.16	.13	.16	.17	.15	.15	.15	.19	.21	.24	.24	.22	.20
Greece	.15	.17	.19	.18	.20	.16	.13	.13	.15	.15	.14	.12	.18	.19	.20	.19	.18	.18
Hungary	.27	.30	.25	.29	.27	.28	.23	.21	.20	.20	.19	.20	.30	.29	.26	.27	.27	.26
Iceland	.10	.10	.10	.11	.10	.08	.08	.10	.08	.08	.07	.07	.12	.12	.12	.10	.11	.11
Ireland	.09	.13	.12	.13	.15	.11	.09	.10	.11	.11	.10	.09	.12	.15	.15	.16	.14	.11
Israel	.20			.18	.18	.17	.16			.12	.13	.10	.20			.15	.17	.11
Italy	.16	.19	.15	.17	.15	.17	.13	.15	.12	.14	.13	.12	.18	.22	.16	.19	.19	.18
Japan		.17	.18	.14	.15	.15		.13	.12	.12	.11	.10		.16	.14	.11	.16	.12
Korea	.13	.17	.14	.14	.13	.12	.10	.13	.11	.11	.11	.10	.16	.16	.12	.15	.13	.15
Luxembourg	.10	.11	.10	.12	.14	.14	.08	.12	.11	.12	.14	.13	.11	.14	.13	.13	.14	.16
Mexico	.25	.27	.35	.29	.32	.29	.25	.24	.27	.24	.24	.21	.31	.26	.29	.28	.27	.25
Netherlands	.11	.14	.14	.14	.12	.12	.08	.12	.12	.10	.10	.10	.13	.20	.18	.19	.14	.16
New Zealand	.12	.13	.13	.14	.17	.14	.09	.08	.08	.10	.12	.10	.13	.12	.13	.15	.16	.12
Northern Ireland			.11	.12	.14	.11			.10	.11	.12	.10			.15	.13	.17	.13
Norway	.10	.09	.09	.08	.08	.09	.07	.07	.07	.06	.06	.06	.09	.11	.13	.08	.12	.10
Poland	.18	.15	.16	.13	.14	.13	.16	.10	.10	.10	.13	.11	.24	.13	.13	.16	.16	.14

Portugal	.13	.12	.17	.14	.16	.15	.11	.12	.16	.14	.15	.12	.16	.18	.21	.22	.24	.20
Scotland			.12	.12	.09	.09			.09	.08	.08	.08			.10	.14	.14	.12
Slovakia		.22	.19	.16	.24	.20		.15	.15	.11	.17	.13		.21	.19	.17	.23	.19
Slovenia				.20	.20	.18				.16	.16	.15				.22	.24	.19
Spain	.16	.16	.16	.16	.15	.18	.14	.15	.14	.13	.12	.15	.21	.18	.20	.19	.17	.20
Sweden	.09	.10	.09	.10	.12	.10	.07	.07	.08	.08	.09	.09	.08	.10	.12	.11	.11	.11
Switzerland	.17	.16	.14	.11	.11	.11	.12	.12	.10	.10	.10	.10	.17	.19	.18	.16	.16	.15
Turkey		.19	.18	.19	.16	.16		.17	.12	.13	.12	.12		.27	.19	.21	.18	.18
United States	.21	.18	.14	.18	.17	.16	.12	.13	.12	.15	.13	.13	.19	.21	.18	.22	.17	.17
Wales			.10	.08	.09	.09			.07	.07	.06	.06			.11	.12	.12	.10

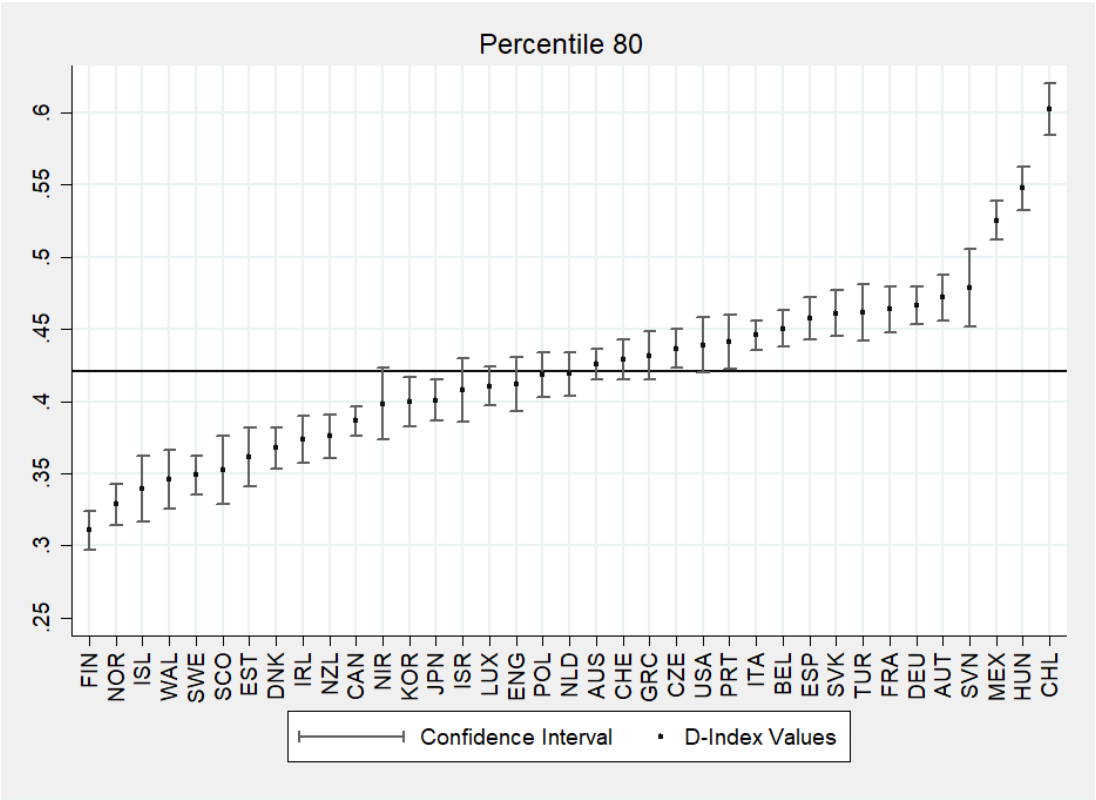
Appendix 2B. Correlation in Between-School Segregation Measures Across Countries. Dissimilarity Index vs. Hutchens Index (2000-2015)

Deciles	Year	Correlation	Year	Correlation	Year	Correlation	Year	Correlation	Year	Correlation	Year	Correlation
10	2000	.977	2003	.966	2006	.980	2009	.988	2012	.991	2015	.989
20	2000	.965	2003	.966	2006	.969	2009	.972	2012	.974	2015	.983
30	2000	.966	2003	.959	2006	.968	2009	.978	2012	.958	2015	.976
40	2000	.954	2003	.951	2006	.963	2009	.965	2012	.958	2015	.964
50	2000	.958	2003	.943	2006	.956	2009	.958	2012	.956	2015	.944
60	2000	.966	2003	.943	2006	.960	2009	.961	2012	.952	2015	.947
70	2000	.973	2003	.939	2006	.966	2009	.962	2012	.960	2015	.937
80	2000	.979	2003	.938	2006	.975	2009	.967	2012	.959	2015	.955
90	2000	.970	2003	.958	2006	.975	2009	.971	2012	.975	2015	.964

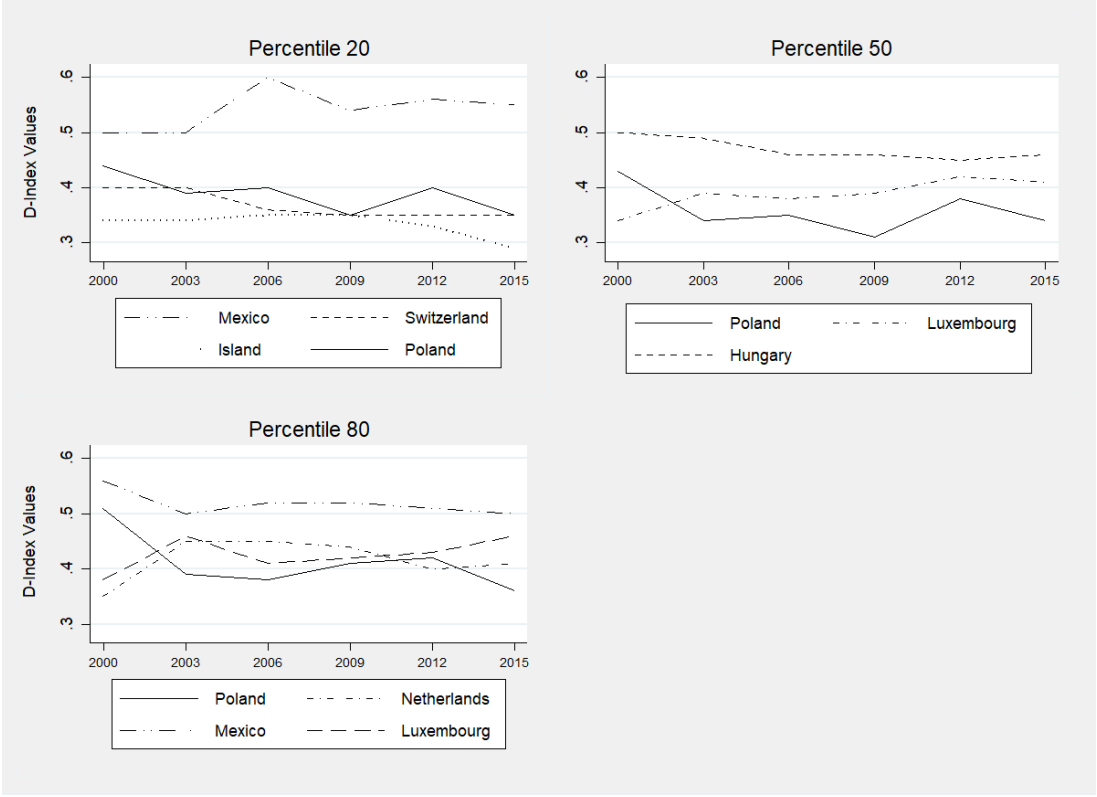
Appendix 2C. Estimates of Between-School Segregation (D) Across OECD Countries (Percentile 20)



Appendix 2D. Estimates of Between-School Segregation (D) Across OECD Countries (Percentile 80)



Appendix 2E. Greatest Variations in D-Index Values over Time.



Appendix 2F. D-Index Country-Level Correlation Matrix by PISA Wave. OECD Countries

Percentile 50

	2000	2003	2006	2009	2012	2015
2000	1					
2003	.841	1				
2006	.880	.880	1.			
2009	.816	.860	.903	1		
2012	.891	.846	.908	.909	1	
2015	.851	.833	.872	.877	.923	1

Percentile 20

	2000	2003	2006	2009	2012	2015
2000	1					
2003	.871	1				
2006	.872	.875	1			
2009	.886	.908	.915	1		
2012	.853	.869	.901	.894	1	
2015	.857	.830	.869	.855	.923	1

Percentile 80

	2000	2003	2006	2009	2012	2015
2000	1					
2003	.756	1				
2006	.811	.804	1			
2009	.823	.820	.907	1		
2012	.887	.822	.907	.880	1	
2015	.788	.847	.894	.864	.908	1

Appendix 3A. Parents' Response Rate in 4th and 10th Grade (SIMCE Questionnaire)

Year	Grade	Number of Students	Number of Parents	Parents' Response Rate
2016	4th	247,526	184,962	74%
2015	4th	243,987	188,642	77%
2014	4th	241,392	194,418	80%
2013	4th	246,055	202,586	82%
2012	4th	220,896	203,156	92%
2011	4th	225,586	213,166	94%
2010	4th	237,569	222,187	94%
2009	4th	254,823	202,626	80%
2008	4th	264,120	226,831	86%
2007	4th	267,451	229,558	86%
2006	4th	274,348	239,263	87%
2005	4th	277,804	242,088	87%
2002	4th	289,760	256,626	89%
1999	4th	296,299	249,951	84%

Year	Grade	Number of Students	Number of Parents	Parents' Response Rate
2016	10th	248,158	154,549	62%
2015	10th	245,160	156,358	64%
2014	10th	241,730	145,611	60%
2013	10th	254,580	157,929	62%
2012	10th	244,826	160,281	65%
2010	10th	258,172	203,826	79%
2008	10th	270,897	202,250	75%
2006	10th	280,753	231,320	82%
2003	10th	259,580	222,949	86%
2001	10th	206,226	176,288	85%

Appendix 3B. Correlation Hutchens and Duncan (primary level)

Year	Pearson's Correlation Coefficient
1999	.9967
2002	.9916
2005	.9968
2006	.9979
2007	.9981
2008	.9981
2009	.9987
2010	.9981
2011	.9981
2012	.9986
2013	.9985
2014	.9988
2015	.9985
2016	.9987

Appendix 3C. General Values of Segregation at Primary level.

Primary (4th Grade)

	Percentile 10			Percentile 20			Percentile 30			Percentile 40			Percentile 50			Percentile 60			Percentile 70			Percentile 80			Percentile 90		
	H	B	D	H	B	D	H	B	D	H	B	D	H	B	D	H	B	D	H	B	D	H	B	D	H	B	D
1999	.24	.25	.49	.23	.30	.50	.23	.33	.50	.25	.36	.52	.26	.38	.52	.28	.41	.55	.30	.42	.56	.38	.49	.62	.53	.56	.73
2002	.21	.26	.45	.21	.31	.46	.21	.33	.47	.21	.35	.51	.24	.39	.50	.31	.41	.56	.32	.43	.57	.38	.48	.63	.46	.52	.69
2005	.30	.22	.53	.26	.29	.51	.27	.32	.52	.27	.35	.53	.28	.38	.55	.32	.41	.58	.34	.43	.59	.41	.47	.64	.57	.54	.76
2006	.29	.24	.53	.28	.30	.53	.26	.34	.52	.26	.37	.52	.27	.40	.53	.32	.44	.57	.33	.45	.58	.40	.49	.64	.57	.55	.76
2007	.30	.26	.54	.28	.29	.54	.27	.33	.52	.27	.36	.53	.28	.38	.54	.32	.42	.57	.34	.44	.59	.41	.47	.65	.58	.55	.77
2008	.29	.25	.54	.28	.30	.54	.28	.34	.53	.27	.35	.53	.31	.39	.57	.33	.42	.58	.34	.43	.59	.43	.47	.66	.59	.55	.78
2009	.32	.25	.56	.28	.31	.53	.28	.34	.53	.28	.36	.54	.28	.38	.53	.32	.42	.57	.36	.44	.60	.44	.48	.67	.59	.55	.78
2010	.31	.25	.55	.27	.31	.53	.27	.33	.52	.28	.36	.54	.30	.39	.56	.32	.41	.57	.36	.44	.61	.44	.47	.67	.61	.56	.79
2011	.31	.26	.55	.27	.32	.52	.27	.35	.53	.27	.37	.53	.30	.39	.55	.32	.42	.57	.35	.44	.60	.44	.47	.67	.60	.55	.79
2012	.31	.26	.55	.28	.32	.53	.28	.34	.53	.27	.37	.53	.29	.39	.54	.32	.41	.57	.36	.44	.60	.44	.48	.67	.61	.56	.79
2013	.31	.26	.54	.28	.31	.53	.26	.35	.52	.26	.38	.52	.31	.41	.56	.32	.41	.56	.36	.44	.60	.45	.48	.68	.60	.55	.79
2014	.30	.27	.54	.27	.32	.52	.27	.35	.52	.27	.38	.52	.31	.40	.55	.31	.41	.56	.37	.44	.61	.45	.48	.67	.60	.56	.79
2015	.30	.29	.54	.27	.33	.51	.26	.37	.51	.37	.38	.51	.27	.39	.52	.31	.43	.56	.35	.45	.60	.45	.49	.67	.60	.57	.79
2016	.29	.28	.53	.26	.33	.51	.25	.37	.50	.27	.41	.52	.27	.41	.52	.30	.43	.54	.34	.45	.58	.42	.49	.65	.57	.55	.77

Note: ‘H’ refers to the national level of segregation estimated using the Square Root Index (Hutchens); ‘B’ refers to the percentage of the national level of segregation attributable to differences between types of schools (‘Municipal’, ‘Subsidised private’ and ‘Non-subsidised private’); ‘D’ refers to the national level of segregation estimated using the dissimilarity Index (Duncan)

Appendix 3D. General Values of Segregation at Secondary level.

	Percentile 10			Percentile 20			Percentile 30			Percentile 40			Percentile 50			Percentile 60			Percentile 70			Percentile 80			Percentile 90		
	H	B	D	H	B	D	H	B	D	H	B	D	H	B	D	H	B	D	H	B	D	H	B	D	H	B	D
2001	.16	.28	.39	.16	.32	.39	.17	.35	.42	.18	.37	.44	.18	.38	.44	.22	.42	.50	.26	.46	.54	.32	.50	.60	.43	.56	.68
2003	.20	.26	.45	.19	.30	.44	.18	.33	.44	.19	.36	.45	.21	.39	.48	.23	.43	.51	.24	.50	.52	.33	.50	.61	.48	.57	.73
2006	.23	.27	.49	.23	.29	.49	.22	.32	.49	.24	.35	.51	.25	.38	.53	.28	.41	.57	.31	.44	.59	.37	.50	.65	.53	.57	.76
2008	.23	.26	.48	.23	.30	.49	.23	.33	.50	.24	.35	.51	.25	.38	.53	.30	.43	.57	.32	.45	.59	.37	.49	.64	.48	.55	.72
2010	.23	.27	.48	.22	.30	.47	.21	.32	.48	.23	.36	.50	.23	.38	.50	.25	.40	.53	.30	.46	.58	.38	.50	.65	.54	.57	.76
2012	.27	.28	.52	.25	.31	.51	.25	.34	.52	.25	.36	.52	.27	.39	.54	.30	.43	.57	.33	.45	.60	.41	.49	.66	.56	.57	.77
2013	.25	.27	.50	.23	.30	.49	.23	.34	.50	.24	.37	.51	.25	.39	.52	.29	.43	.56	.32	.45	.59	.38	.49	.64	.55	.56	.76
2014	.24	.27	.49	.23	.30	.49	.23	.33	.49	.23	.36	.50	.27	.39	.54	.28	.42	.55	.32	.43	.59	.40	.47	.65	.54	.54	.75
2015	.23	.28	.47	.22	.32	.48	.22	.34	.48	.22	.37	.49	.23	.39	.50	.26	.41	.53	.30	.45	.57	.38	.49	.64	.54	.55	.75
2016	.22	.29	.47	.20	.34	.46	.20	.35	.46	.21	.38	.48	.21	.39	.48	.24	.42	.52	.30	.46	.57	.36	.49	.63	.52	.54	.74

Note: ‘H’ refers to the national level of segregation estimated using the Square Root Index (Hutchens); ‘B’ refers to the percentage of the national level of segregation attributable to differences between types of schools (‘Municipal’, ‘Subsidised private’ and ‘Non-subsidised private’); ‘D’ refers to the national level of segregation estimated using the dissimilarity Index (Duncan)

Appendix 3E. Percentage of Total Segregation Attributable to 'Between' Sector Segregation (Primary).

	Co-payment (Primary Level)									Selectivity Status (Primary Level)									
	Percentile of SES										Percentile of SES								
	10	20	30	40	50	60	70	80	90		10	20	30	40	50	60	70	80	90
1999	35.2	40.9	41.2	40.7	39.5	39.1	38.3	34.0	26.4	1999	17.1	22.2	23.3	24.6	24.4	24.4	24.1	21.7	18.6
2002	37.1	42.9	44.3	44.9	46.0	45.8	44.9	42.5	34.3	2002	16.4	21.6	23.2	24.7	25.8	25.4	25.3	24.2	20.8
2005	36.1	43.5	45.8	46.8	48.5	49.7	48.3	46.8	41.8	2005	14.1	20.4	23.4	24.6	25.6	26.3	25.5	25.2	23.1
2006	39.4	44.1	45.7	47.8	48.7	50.1	49.9	48.6	42.6	2006	17.5	22.5	24.9	26.7	27.0	26.8	26.6	26.0	24.1
2007	36.7	39.7	41.3	43.7	45.5	47.3	47.2	46.3	42.2	2007	18.5	21.8	23.3	24.9	25.6	25.9	26.2	24.9	23.1
2008	38.6	44.4	47.2	48.0	51.1	51.6	51.1	49.6	43.5	2008	17.1	21.7	23.8	24.3	25.1	24.9	25.3	24.7	23.6
2009	39.3	43.2	46.9	49.8	50.0	52.7	52.0	49.5	44.5	2009	16.7	21.5	23.5	24.4	24.6	25.0	24.8	24.1	21.4
2010	40.2	43.6	46.1	49.7	51.6	53.0	52.8	51.8	46.3	2010	18.7	22.1	23.9	25.4	26.2	25.6	25.6	25.2	23.9
2011	38.3	44.3	47.8	50.3	52.8	53.2	53.4	51.6	45.2	2011	17.9	22.3	24.5	25.6	25.8	25.4	25.4	24.3	23.1
2012	39.3	46.1	48.9	51.0	53.2	55.2	54.7	53.6	46.9	2012	17.9	22.5	24.0	25.7	26.0	25.2	25.5	25.3	23.9
2013	38.3	45.3	48.7	51.6	54.9	55.0	55.6	54.1	48.0	2013	18.6	22.3	24.5	25.3	25.0	25.2	25.0	24.2	23.2
2014	40.2	47.1	50.5	52.9	55.8	55.9	56.6	54.7	48.4	2014	18.5	22.7	24.2	24.7	24.5	24.7	24.5	23.8	22.4
2015	40.9	46.0	50.4	52.6	53.7	56.7	56.5	54.2	47.9	2015	19.1	22.1	24.0	24.0	24.4	23.6	23.4	22.9	20.9
2016	31.2	38.6	42.3	48.6	48.6	50.2	50.4	47.7	39.8	2016	18.5	22.0	24.1	24.5	24.5	24.6	23.8	23.1	20.8

Note: Numbers in left side of the table shows the values of 'between segregation' for the private subsidised schools according to their co-payment level ('Without co-payment', 'Low-Fees', 'Medium-Fees' and 'High-Fees'). At the right side of the table the values of between segregation are displayed for the schools according to their selectivity status ('Selective' and 'Non-Selective')

Appendix 3F. Percentage of Total Segregation Attributable to 'Between' Sector Segregation (Secondary).

	Co-payment (Secondary Level)								
	Percentile of SES								
	10	20	30	40	50	60	70	80	90
2001	24.6	27.4	28.9	29.2	29.0	27.7	27.9	25.2	19.3
2003	33.0	36.7	37.1	37.9	38.4	39.1	39.2	37.5	33.8
2006	36.6	39.6	40.0	40.8	41.3	41.4	41.5	39.9	36.4
2008	33.4	36.9	38.5	39.2	40.4	41.5	41.4	39.8	35.3
2010	34.1	36.6	37.9	40.4	40.5	41.4	40.6	41.3	37.2
2012	35.3	38.0	39.7	40.6	42.5	43.8	43.7	42.8	38.8
2013	36.3	38.7	41.3	43.1	44.0	44.8	44.8	44.2	39.7
2014	36.1	39.4	42.5	45.2	48.0	48.1	48.4	46.3	41.0
2015	35.2	40.4	43.4	45.5	46.8	47.3	48.4	46.3	40.0
2016	31.3	36.4	39.6	44.3	45.8	48.0	49.7	48.5	43.4

	Selectivity Status (Secondary Level)								
	Percentile of SES								
	10	20	30	40	50	60	70	80	90
2001	11.5	13.5	15.4	16.0	16.0	17.1	17.5	16.5	12.6
2003	9.8	13.4	16.0	17.4	18.5	19.3	20.5	21.1	20.1
2006	15.2	16.1	17.4	18.6	19.6	20.8	21.8	22.0	21.2
2008	13.6	15.5	17.0	17.9	19.0	19.9	20.5	21.1	18.9
2010	13.2	15.2	15.9	17.6	18.2	19.0	20.3	20.6	18.5
2012	17.7	18.6	19.3	20.0	19.9	20.1	19.5	19.2	17.2
2013	17.5	18.7	20.7	21.9	22.1	22.3	22.6	21.4	19.9
2014	16.1	16.7	16.7	16.9	17.0	16.6	15.8	14.6	12.8
2015	18.0	19.3	19.2	19.2	19.5	19.2	19.4	17.5	15.3
2016	20.6	24.0	26.9	29.0	30.9	31.9	33.9	35.0	32.3

Note: Numbers in left side of the table shows the values of 'between segregation' for the private subsidised schools according to their co-payment level ('Without co-payment', 'Low-Fees', 'Medium-Fees' and 'High-Fees'). At the right side of the table the values of between segregation are displayed for the schools according to their selectivity status ('Selective' and 'Non-Selective')

Appendix 4A. Ordinary Least Squares and Fixed Effect Estimates of Peers' Socioeconomic Effects

VARIABLES	OLS Maths (1)	OLS Lang (2)	FE (2011) Maths (3)	FE (2011) Lang (4)	FE (2013) Maths (5)	FE (2013) Lang (6)	FE (2011-2013) Maths (7)	FE (2011-2013) Lang (8)
Prior Achievement	.645***	.617***	.644***	.617***	.583***	0.578***	0.589***	.584***
	(.003)	(.003)	(.003)	(.003)	(.003)	(0.003)	(0.003)	(.003)
Students' SES	.059***	.044***	.058***	.045***	.026***	.023***	.026***	.024***
	(.003)	(.004)	(.003)	(.004)	(.003)	(.004)	(.003)	(.004)
Books at Home = (1 to 9)	.015	.045**	.010	.042**	.007	.035*	.007	.038*
	(.015)	(.016)	(.014)	(.016)	(.013)	(.015)	(.013)	(.015)
Books at Home = (10 to 50)	.044**	.075***	.038**	.072***	.027*	.062***	.023	.060***
	(.015)	(.016)	(.014)	(.016)	(.013)	(.015)	(.013)	(.015)
Books at Home = (51 to 100)	.068***	.109***	.056***	.101***	.047***	.092***	.041**	.090***
	(.015)	(.017)	(.015)	(.017)	(.013)	(.016)	(.013)	(.016)
Books at Home = (More than 100)	.055***	.147***	.056***	.139***	.049***	.128***	.044**	.126***
	(.015)	(.017)	(.015)	(.017)	(.013)	(.016)	(.014)	(.016)
Years of Pre-school Education	-.009***	-.011***	-.004**	-.008***	-.003**	-.006***	-.002	-.006***
	(.002)	(.002)	(.001)	(.002)	(.001)	(.002)	(.001)	(.002)
Parental Expectations = Secondary	.089**	.028	.090**	.049	.082**	.037	.081**	.044
	(.028)	(.031)	(.028)	(.031)	(.026)	(.030)	(.027)	(.030)
Parental Expectations = Undergraduate HE	.117***	.057	.119***	.083**	.089***	.052	.087***	.061*
	(.028)	(.031)	(.028)	(.031)	(.026)	(.030)	(.026)	(.030)
Parental Expectations = Post-graduate HE	.274***	.188***	.257***	.195***	.163***	.121***	.161***	.126***
	(.028)	(.031)	(.028)	(.031)	(.026)	(.029)	(.026)	(.030)
Indigenous Background	.002	.022**	.011	.015*	.012*	.013	.012*	.012
	(.007)	(.008)	(.006)	(.007)	(.006)	(.007)	(.006)	(.007)
Class Size	.006***	.006***	.002	.002*	.002***	.003***	.000	.001
	(.000)	(.001)	(.001)	(.001)	(.000)	(.000)	(.001)	(.001)
Peers' Mean Performance	.004	-.055***	-.007	-.058***	-.089***	-.126***	-.007	-.059***

	(.006)	(.005)	(.009)	(.008)	(.004)	(.004)	(.008)	(.008)
Peers' Mean SES	.120***	.099***	.081***	.099***	.077***	.077***	.070***	.099***
	(.006)	(.005)	(.017)	(.021)	(.005)	(.006)	(.016)	(.020)
Peers' SES Heterogeneity	.000	-.000	-.007	-.016***	-.004	-.004	-.005	-.013**
	(.003)	(.003)	(.004)	(.005)	(.002)	(.003)	(.004)	(.005)
Constant	-.366***	-.329***	-.349**	-.300*	-.958***	-.945***	-.828***	-.872***
	(.032)	(.036)	(.133)	(.123)	(.089)	(.105)	(.150)	(.206)
Observations	106,919	106,630	106,919	106,630	106,919	106,630	106,919	106,630
R-squared	.625	.479	.669	.527	.717	.564	.733	.587

Robust standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.05. Standard errors are clustered at the secondary school level. 'Zero books', 'Uncompleted Secondary or less' and 'Non-indigenous background' are the reference categories for 'Numbers of Books at Home', 'Parental Expectations' and 'Indigenous Background'

Appendix 4B. Fixed Effect Estimates by Students' Socioeconomic Status

	Maths			Language		
	Tercile 1	Tercile 2	Tercile 3	Tercile 1	Tercile 2	Tercile 3
VARIABLES	(1)	(2)	(3)	(1)	(2)	(3)
Prior Achievement	.594***	.600***	.566***	.575***	.597***	.581***
	(.005)	(.005)	(.005)	(.005)	(.005)	(.006)
Student SES	.038***	-.002	.050***	.004	-.005	.067***
	(.009)	(.016)	(.008)	(.010)	(.019)	(.010)
Books at Home = (1 to 9)	.019	.008	.008	.041*	.047	.016
	(.017)	(.029)	(.051)	(.019)	(.035)	(.070)
Books at Home = (10 to 50)	.030	.024	.039	.068***	.056	.058
	(.017)	(.029)	(.050)	(.019)	(.034)	(.068)
Books at Home = (51 to 100)	.040*	.031	.063	.081***	.091*	.097
	(.020)	(.030)	(.050)	(.023)	(.035)	(.069)
Books at Home = (More than 100)	.060*	.050	.057	.150***	.108**	.133
	(.024)	(.030)	(.050)	(.029)	(.037)	(.069)
Years of Pre-school Education	-.003	-.001	.000	-.006	-.010**	-.003
	(.003)	(.003)	(.002)	(.003)	(.003)	(.003)
Parents Expectations=Secondary	.075*	.079	-.116	.059	.006	-.052
	(.033)	(.070)	(.098)	(.034)	(.096)	(.156)
Parents Expectations=Undergraduate (HE)	.097**	.078	-.162	.081*	.017	-.054
	(.033)	(.069)	(.093)	(.035)	(.095)	(.151)
Parents Expectations=Post-graduate (HE)	.145***	.158*	-.034	.149***	.073	.041
	(.033)	(.069)	(.092)	(.035)	(.095)	(.150)
Indigenous Background	.003	.007	.024	.008	.009	.014
	(.009)	(.010)	(.014)	(.011)	(.013)	(.018)
Class Size	.001	-.000	-.001	.001	.003	.001
	(.002)	(.001)	(.001)	(.002)	(.002)	(.002)
Peers' Mean Performance	-.001	.008	-.026	-.038**	-.068***	-.076***

	(.014)	(.014)	(.015)	(.014)	(.014)	(.014)
Peers' Mean SES	.071*	.077**	.035	.114**	.068	.098**
	(.030)	(.027)	(.030)	(.038)	(.036)	(.037)
Peers' SES Heterogeneity	-.005	-.014*	-.004	-.013	-.006	-.019*
	(.007)	(.007)	(.007)	(.009)	(.009)	(.008)
Constant	-1.137***	-.975***	-1.307***	-0.839***	-.591*	-1.446***
	(.199)	(.201)	(.276)	(.251)	(.241)	(.280)
Observations	34,732	36,020	35,161	34,962	36,287	35,381
R-squared	.691	.713	.736	.593	.594	.585

Robust standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.05. Standard errors are clustered at the secondary school level. 'Zero books', 'Uncompleted Secondary or less' and 'Non-indigenous background' are the reference categories for 'Numbers of Books at Home', 'Parental Expectations' and 'Indigenous Background'

Appendix 4C. Fixed Effect Estimates by School Sector

	Public		Subsidised Private		Non-subsidised Private	
VARIABLES	Maths	Lang	Maths	Lang	Maths	Lang
	(1)	(2)	(3)	(4)	(5)	(6)
Prior Achievement	.594***	.576***	.595***	.592***	.506***	.566***
	(.004)	(.005)	(.004)	(.004)	(.009)	(.011)
Student SES	.019***	.007	.020***	.025***	.036***	.030**
	(.004)	(.005)	(.003)	(.004)	(.007)	(.009)
Books at Home = (1 to 9)	.005	.039	.009	.041	.019	-.363
	(.017)	(.020)	(.022)	(.026)	(.111)	(.188)
Books at Home = (10 to 50)	.025	.057**	.017	.065**	.066	-.341
	(.017)	(.020)	(.021)	(.025)	(.104)	(.183)
Books at Home = (51 to 100)	.046*	.087***	.036	.087***	.087	-.278
	(.019)	(.022)	(.022)	(.026)	(.105)	(.184)
Books at Home = (More than 100)	.047*	.101***	.042	.133***	.088	-.255
	(.020)	(.025)	(.022)	(.026)	(.105)	(.184)
Years of Pre-school Education	-.005*	-.010***	-.001	-.005*	-.000	.008
	(.002)	(.003)	(.002)	(.002)	(.005)	(.007)
Parents Expectations=Secondary	.083*	.060	.071	.017	-.060	.007
	(.034)	(.038)	(.048)	(.054)	(.187)	(.205)
Parents Expectations=Undergraduate (HE)	.098**	.083*	.064	.032	-.081	.030
	(.034)	(.038)	(.048)	(.054)	(.102)	(.164)
Parents Expectations=Post-graduate (HE)	.159***	.148***	.148**	.097	.041	.119
	(.034)	(.038)	(.048)	(.053)	(.078)	(.127)
Indigenous Background	.008	.021*	.015	.004	.073*	.026
	(.009)	(.010)	(.008)	(.010)	(.035)	(.051)
Class Size	.001	.003	-.000	.000	-.002	-.001
	(.001)	(.002)	(.001)	(.001)	(.003)	(.003)
Peers' Mean Performance	.005	-.045***	-.015	-.051***	-.025	-.068***

	(.009)	(.010)	(.010)	(.010)	(.016)	(.017)
Peers' Mean SES	.039**	.069***	.051**	.046*	.006	.015
	(.014)	(.017)	(.016)	(.020)	(.024)	(.031)
Peers' SES Heterogeneity	-.008	-.011	-.007	-.013*	.027*	-.021
	(.005)	(.007)	(.005)	(.006)	(.014)	(.018)
Constant	-.954***	-.762***	-.861***	-.925*	-.059	.575*
	(.239)	(.215)	(.232)	(.391)	(.135)	(.228)
Observations	40,590	40,435	57,565	57,426	8,631	8,635
R-squared	.682	.575	.696	.559	.585	.477

Robust standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.05. Standard errors are clustered at the secondary school level. 'Zero books', 'Uncompleted Secondary or less' and 'Non-indigenous background' are the reference categories for 'Numbers of Books at Home', 'Parental Expectations' and 'Indigenous Background'

Appendix 4D. Fixed Effect Estimates by School Selectivity

	Without Social Selection		With Social Selection		Without Academic Selection		With Academic Selection	
VARIABLES	Maths	Lang	Maths	Lang	Maths	Lang	Maths	Lang
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Prior Achievement	.599***	.581***	0.556***	.594***	.592***	.578***	.586***	.587***
	(.003)	(0.003)	(0.005)	(.006)	(.004)	(.005)	(.003)	(.004)
Student SES	.020***	.017***	.037***	.037***	.021***	.014**	.025***	.027***
	(.003)	(.004)	(.006)	(.008)	(.004)	(.005)	(.004)	(.005)
Books at Home = (1 to 9)	.006	.032*	.020	.114	.007	.035	.009	.041
	(.014)	(.016)	(.048)	(.059)	(.017)	(.020)	(.021)	(.026)
Books at Home = (10 to 50)	.021	.056***	.036	.126*	.026	.063**	.021	.057*
	(.013)	(.016)	(.046)	(.058)	(.017)	(.019)	(.021)	(.025)
Books at Home = (51 to 100)	.039**	.082***	.053	.162**	.044*	.090***	.040	.087***
	(.014)	(.017)	(.047)	(.059)	(.019)	(.022)	(.022)	(.026)
Books at Home = (More than 100)	.048**	.121***	.050	.192***	.048*	.088***	.043*	.135***
	(.015)	(.018)	(.047)	(.058)	(.020)	(.025)	(.022)	(.026)
Years of Pre-school Education	-.002	-.008***	-.001	-.000	-.005*	-.009**	-.001	-.004
	(.002)	(.002)	(.003)	(.004)	(.002)	(.003)	(.002)	(.002)
Parents Expectations=Secondary	.079**	.052	.032	-.042	.060	.053	.122*	.035
	(.028)	(.031)	(.117)	(.153)	(.032)	(.036)	(.051)	(.055)
Parents Expectations=Undergraduate (HE)	.091**	.073*	-.016	-.071	.074*	.078*	.119*	.041
	(.028)	(.031)	(.116)	(.149)	(.032)	(.037)	(.050)	(.054)
Parents Expectations=Post-graduate (HE)	.157***	.138***	.100	.009	.136***	.141***	.201***	.110*
	(.027)	(.031)	(.115)	(.148)	(.032)	(.037)	(.050)	(.054)
Indigenous Background	.010	.012	.030*	.006	.008	.018	.013	.009
	(.006)	(.007)	(.015)	(.019)	(.009)	(.010)	(.008)	(.010)
Class Size	.001	.002*	-.003*	-.002	.001	.002	-.000	.001
	(.001)	(.001)	(.002)	(.002)	(.001)	(.002)	(.001)	(.001)
Peers' Mean Performance	-.002	-.054***	-.032*	-.053***	.005	-.042***	-.019	-.069***

	(.008)	(.008)	(.015)	(.015)	(.010)	(.011)	(.010)	(.010)
Peers' Mean SES	.049***	.089***	.075*	.034	.037*	.093***	.059**	.045
	(.014)	(.018)	(.032)	(.042)	(.016)	(.019)	(.020)	(.026)
Peers' SES Heterogeneity	-.007	-.013**	.006	-.019	.001	-.013	-.009	-.015*
	(.004)	(.005)	(.009)	(.011)	(.006)	(.007)	(.005)	(.006)
Constant	-.860***	-.911***	-.703***	-1.136***	-1.012***	-0.825***	-.763***	-.882*
	(.150)	(.211)	(.129)	(.170)	(.253)	(.208)	(.169)	(.356)
Observations	81,555	81,343	25,364	25,084	41,262	41,157	65,657	65,473
R-squared	.704	.572	.695	.548	.688	.580	.726	.574

Robust standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.05. Standard errors are clustered at the secondary school level. 'Zero books', 'Uncompleted Secondary or less' and 'Non-indigenous background' are the reference categories for 'Numbers of Books at Home', 'Parental Expectations' and 'Indigenous Background.

Appendix 4E: Summary statistics of main variables for the full sample and types of schools / Math

	Full sample				Municipal				Private Subsidised				Non-Subsidised private			
	Mean	Sd	Min. Value	Max. Value	Mean	Sd	Min. Value	Max. Value	Mean	Sd	Min. Value	Max. Value	Mean	Sd	Min. Value	Max. Value
Student achievement (10th grade)	0	1	-2.94	2.29	-0.42	0.93	-2.94	2.29	0.15	0.93	-2.94	2.29	1.09	0.67	-2.92	2.29
Prior Achievement (8th grade)	0	1	-2.80	2.63	-0.35	0.92	-2.77	2.63	0.10	0.95	-2.79	2.63	1.04	0.83	-2.80	2.63
Student SES	0	1	-2.49	2.55	-0.53	0.75	-2.49	2.55	0.13	0.85	-2.49	2.55	1.82	0.50	-1.72	2.55
Books at home	3.16		1	5	2.88		1	5	3.23		1	5	4.16		1	5
Years of Pre-school Education	2.47	1.37	0	5	2.19	1.34	0	5	2.52	1.35	0	5	3.51	1.09	0	5
Parents' Expectations	3.55		1	4	3.30		1	4	3.66		1	4	3.98		1	4
Indigenous Background	0.12		0	1	0.15		0	1	0.11		0	1	0.02		0	1
Class size	21.03	6.82	10	49	18.52	5.92	10	43	23.18	6.89	10	49	18.62	5.37	10	38
Peers' mean performance	0	1	-2.68	3.54	-0.59	0.72	-2.68	2.75	0.17	0.84	-2.36	2.90	1.77	0.64	-1.42	3.54
Peers' mean SES	0	1	-2.25	2.94	-0.69	0.52	-2.14	1.75	0.17	0.72	-2.25	2.52	2.31	0.32	0.83	2.94
Peers' SES heterogeneity	0	1	-3.69	4.39	0.08	0.93	-3.18	4.39	0.16	0.87	-2.92	3.82	-1.48	0.99	-3.79	2.44

Note: Mean and Standard deviation only reported for continuous variables.

Appendix 4F: Summary statistics of main variables by Socioeconomic group / Math

	Tercile 1				Tercile 2				Tercile 3			
	Mean	Sd	Min. Value	Max. Value	Mean	Sd	Min. Value	Max. Value	Mean	Sd	Min. Value	Max. Value
Student achievement (10th grade)	-0.46	0.91	-2.94	2.29	-0.07	0.93	-2.94	2.29	0.55	0.90	-2.94	2.29
Prior Achievement (8th grade)	-0.39	0.90	-2.79	2.63	-0.07	0.93	-2.76	2.63	0.49	0.97	-2.80	2.63
Student SES	-1.02	0.42	-2.49	-0.51	-0.11	0.22	-0.51	0.31	1.19	0.60	0.32	2.55
Books at home	2.74		1	5	3.09		1	5	3.69		1	5
Years of Pre-school Education	2.09	1.32	0	5	2.36	1.30	0	5	2.99	1.33	0	5
Parents' Expectations	3.14		1	4	3.60		1	4	3.91		1	4
Indigenous Background	0.18		0	1	0.12		0	1	0.06		0	1
Class size	19.20	6.31	10	49	21.75	6.84	10	49	22.18	6.93	10	49
Peers' mean performance	-0.51	0.73	-2.68	3.51	-0.16	0.82	-2.55	2.90	0.70	1.02	-2.60	3.54
Peers' mean SES	-0.70	0.52	-2.25	2.15	-0.19	0.61	-2.12	2.76	0.93	1.01	-1.90	2.94
Peers' SES heterogeneity	0.02	0.92	-3.18	4.39	0.13	0.88	-3.41	3.82	-0.16	1.17	-3.69	3.79

Note: Mean and Standard deviation only reported for continuous variables.

Appendix 4G: Summary statistics of main variables by social and academic selectivity/ Math

	Without Social Selection				With Social Selection				Without Academic Selection				With Academic Selection			
	Mean	Sd	Min. Value	Max. Value	Mean	Sd	Min. Value	Max. Value	Mean	Sd	Min. Value	Max. Value	Mean	Sd	Min. Value	Max. Value
Student achievement (10th grade)	-0.19	0.96	-2.94	2.29	0.62	0.85	-2.94	2.29	-0.37	0.93	-2.94	2.29	0.24	0.97	-2.94	2.29
Prior Achievement (8th grade)	-0.16	0.96	-2.79	2.63	0.55	0.95	-2.80	2.63	-0.31	0.93	-2.80	2.63	0.20	0.99	-2.79	2.63
Student SES	-0.25	0.86	-2.49	2.55	0.83	0.99	-2.49	2.55	-0.52	0.78	-2.49	2.55	0.34	0.98	-2.49	2.55
Books at home	3.03		1	5	3.60		1	5	2.89		1	5	3.34		1	5
Years of Pre-school Education	2.33	1.35	0	5	2.94	1.3	0	5	2.17	1.32	0	5	2.66	1.37	0	5
Parents' Expectations	3.45		1	4	3.87		1	4	3.31		1	4	3.70		1	4
Indigenous Background	0.14		0	1	0.06		0	1	0.16		0	1	0.10		0	1
Class size	20.08	6.36	10	49	24.2	7.3	10	44	18.95	6.12	10	49	22.38	6.91	10	44
Peers' mean performance	-0.28	0.85	-2.68	2.962	0.92	0.90	-1.54	3.54	-0.51	0.77	-2.68	2.96	0.33	0.99	-2.36	3.54
Peers' mean SES	-0.32	0.76	-2.25	2.781	1.06	0.99	-1.44	2.94	-0.67	0.60	-2.25	2.77	0.44	0.97	-1.76	2.94
Peers' SES heterogeneity	0.06	0.92	-3.38	4.386	-0.21	1.20	-3.69	3.45	0.05	0.95	-3.26	4.39	-0.03	1.03	-3.69	3.78

Note: Mean and Standard deviation only reported for continuous variables.

Appendix 4H: Summary statistics of main variables for the full sample and types of schools / Lang

	Full sample				Municipal				Private Subsidised				Non-Subsidised private			
	Mean	Sd	Min. Value	Max. Value	Mean	Sd	Min. Value	Max. Value	Mean	Sd	Min. Value	Max. Value	Mean	Sd	Min. Value	Max. Value
Student achievement (10th grade)	0	1	-2.49	2.39	-0.30	0.97	-2.49	2.39	0.10	0.97	-2.49	2.39	0.77	0.84	-2.46	2.39
Prior Achievement (8th grade)	0	1	-3.38	2.32	-0.27	0.97	-3.34	2.32	0.09	0.96	-3.38	2.32	0.77	0.86	-3.38	2.32
Student SES	0	1	-2.49	2.55	-0.53	0.75	-2.49	2.55	0.13	0.85	-2.49	2.55	1.82	0.50	-1.72	2.55
Books at home	3.16		1	5	2.88		1	5	3.23		1	5	4.16		1	5
Years of Pre-school Education	2.47	1.37	0	5	2.19	1.335	0	5	2.52	1.35	0	5	3.51	1.09	0	5
Parents' Expectations	3.55		1	4	3.30		1	4	3.66		1	4	3.98		1	4
Indigenous Background	0.12		0	1	0.15		0	1	0.11		0	1	0.02		0	1
Class size	21.03	6.82	10	49	18.52	5.919	10	43	23.18	6.89	10	49	18.62	5.37	10	38
Peers' mean performance	0	1	-3.73	2.92	-0.53	0.85	-3.73	2.52	0.17	0.87	-3.29	2.88	1.46	0.65	-2.28	2.92
Peers' mean SES	0	1	-2.25	2.94	-0.69	0.52	-2.14	1.75	0.17	0.72	-2.25	2.52	2.31	0.32	0.83	2.94
Peers' SES heterogeneity	0	1	-3.69	4.39	0.08	0.93	-3.18	4.39	0.16	0.87	-2.92	3.82	-1.48	0.99	-3.69	2.44

Note: Mean and Standard deviation only reported for continuous variables.

Appendix 4I: Summary statistics of main variables by Socioeconomic group / Lang

	Tercile 1				Tercile 2				Tercile 3			
	Mean	Sd	Min. Value	Max. Value	Mean	Sd	Min. Value	Max. Value	Mean	Sd	Min. Value	Max. Value
Student achievement (10th grade)	-0.34	0.94	-2.49	2.39	-0.05	0.97	-2.49	2.39	0.41	0.94	-2.48	2.39
Prior Achievement (8th grade)	-0.33	0.95	-3.34	2.32	-0.04	0.96	-3.33	2.32	0.39	0.95	-3.38	2.32
Student SES	-1.02	0.42	-2.49	-0.51	-0.11	0.22	-0.51	0.31	1.19	0.60	0.32	2.55
Books at home	2.74		1	5	3.09		1	5	3.69		1	5
Years of Pre-school Education	2.09	1.315	0	5	2.36	1.30	0	5	2.99	1.33	0	5
Parents' Expectations	3.14		1	4	3.60		1	4	3.91		1	4
Indigenous Background	0.18		0	1	0.12		0	1	0.06		0	1
Class size	19.20	6.31	10.00	49.00	21.75	6.84	10.00	49.00	22.18	6.93	10.00	49.00
Peers' mean performance	-0.46	0.84	-3.69	2.88	-0.13	0.89	-3.73	2.87	0.62	0.95	-3.59	2.92
Peers' mean SES	-0.70	0.52	-2.25	2.15	-0.19	0.61	-2.12	2.76	0.93	1.01	-1.90	2.94
Peers' SES heterogeneity	0.02	0.92	-3.18	4.39	0.13	0.88	-3.41	3.82	-0.16	1.17	-3.69	3.79

Note: Mean and Standard deviation only reported for continuous variables.

Appendix 4J: Summary statistics of main variables by social and academic selectivity/ Lang

	Without Social Selection				With Social Selection				Without Academic Selection				With Academic Selection			
	Mean	Sd	Min. Value	Max. Value	Mean	Sd	Min. Value	Max. Value	Mean	Sd	Min. Value	Max. Value	Mean	Sd	Min. Value	Max. Value
Student achievement (10th grade)	-0.14	0.98	-2.49	2.39	0.45	0.92	-2.48	2.39	-0.26	0.96	-2.49	2.39	0.17	0.99	-2.49	2.39
Prior Achievement (8th grade)	-0.13	0.98	-3.34	2.32	0.43	0.93	-3.38	2.32	-0.23	0.98	-3.36	2.32	0.15	0.99	-3.38	2.32
Student SES	-0.25	0.86	-2.49	2.55	0.83	0.99	-2.49	2.55	-0.52	0.78	-2.49	2.55	0.34	0.98	-2.49	2.55
Books at home	3.03		1	5	3.60		1	5	2.89		1	5	3.34		1	5
Years of Pre-school Education	2.33	1.35	0	5	2.94	1.32	0	5	2.17	1.32	0	5	2.66	1.37	0	5
Parents' Expectations	3.45		1	4	3.87		1	4	3.31		1	4	3.70		1	4
Indigenous Background	0.14		0	1	0.06		0	1	0.16		0	1	0.10		0	1
Class size	20.08	6.36	10.00	49.00	24.19	7.35	10.00	44.00	18.95	6.12	10.00	49.00	22.38	6.91	10.00	44.00
Peers' mean performance	-0.24	0.91	-3.73	2.88	0.81	0.83	-2.87	2.92	-0.44	0.87	-3.73	2.88	0.29	0.97	-3.73	2.92
Peers' mean SES	-0.32	0.76	-2.25	2.78	1.06	0.99	-1.44	2.94	-0.67	0.60	-2.25	2.77	0.44	0.97	-1.76	2.94
Peers' SES heterogeneity	0.06	0.92	-3.38	4.39	-0.21	1.20	-3.69	3.45	0.05	0.95	-3.26	4.39	-0.03	1.03	-3.69	3.78

Note: Mean and Standard deviation only reported for continuous variables.

Appendix 4K. Fixed Effect Estimates by School Sorting

VARIABLES	Maths (37)	Lang (38)
Prior Achievement	.581***	.587***
	(.004)	(.004)
Student SES	.025***	.031***
	(.004)	(.005)
Books at Home = (1 to 9)	-.030	.016
	(.018)	(.023)
Books at Home = (10 to 50)	-.011	.041
	(.018)	(.022)
Books at Home = (51 to 100)	.006	.083***
	(.019)	(.023)
Books at Home = (More than 100)	.010	.112***
	(.019)	(.024)
Years of Pre-school Education	-.003	-.006**
	(.002)	(.002)
Parents Expectations=Secondary	.050	-.008
	(.045)	(.049)
Parents Expectations=Undergraduate (HE)	.051	.002
	(.044)	(.049)
Parents Expectations=Post-graduate (HE)	.120**	.061
	(.044)	(.048)
Indigenous Background	.012	.013
	(.008)	(.010)
Class Size	-.003**	-.001
	(.001)	(.001)
Peers' Mean Performance	-.033**	-.087***
	(.010)	(.010)
Peers' Mean SES	.081***	.076**
	(.019)	(.024)
Peers' SES Heterogeneity	-.000	-.013*
	(.004)	(.005)
Constant	-.809**	-.941*
	(.283)	(.399)
Observations	58,609	58,468
R-squared	.739	.588

Robust standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.05. Standard errors are clustered at the secondary school level. 'Zero books', 'Uncompleted Secondary or less' and 'Non-indigenous background' are the reference categories for 'Numbers of Books at Home', 'Parental Expectations' and 'Indigenous Background.'

Appendix 4L. Fixed Effects for Students Changing Schools

VARIABLES	Maths 1	Lang 2	Maths 3	Lang 4
Prior Achievement	.579***	.567***	.582***	.569***
	(.004)	(.004)	(.004)	(.004)
Student SES	.019***	.011*	.019***	.010*
	(.004)	(.004)	(.003)	(.004)
Books at Home = (1 to 9)	-.018	.041*	-.003	.044*
	(.016)	(.019)	(.015)	(.018)
Books at Home = (10 to 50)	.004	.069***	.015	.070***
	(.015)	(.019)	(.015)	(.018)
Books at Home = (51 to 100)	.020	.096***	.033*	.095***
	(.017)	(.020)	(.016)	(.019)
Books at Home = (More than 100)	.027	.111***	.043*	.116***
	(.018)	(.022)	(.017)	(.021)
Years of Pre-school Education	-.003	-.005*	-.003	-.005*
	(.002)	(.002)	(.002)	(.002)
Parents Expectations=Secondary	.064*	.001	.060*	.020
	(.032)	(.037)	(.030)	(.035)
Parents Expectations=Undergraduate (HE)	.084**	.031	.076*	.046
	(.032)	(.037)	(.031)	(.035)
Parents Expectations=Post-graduate (HE)	.136***	.076*	.132***	.097**
	(.032)	(.037)	(.030)	(.035)
Indigenous Background	.012	.015	.009	.011
	(.008)	(.009)	(.007)	(.009)
Class Size	-.000	.001	.000	.001
	(.001)	(.001)	(.001)	(.001)
Peers' Mean Performance	-.027**	-.078***	-.023**	-.074***
	(.009)	(.009)	(.009)	(.009)
Peers' Mean SES	.055***	.065**	.049**	.070***
	(.016)	(.020)	(.015)	(.019)
Peers' SES Heterogeneity	-.009	-.016**	-.011*	-.017**
	(.005)	(.006)	(.005)	(.006)
Constant	-.593	-.978	-.606	-1.010
	(.349)	(.506)	(.349)	(.517)
Observations	57,821	57,588	62,349	62,123
R-squared	.702	.580	.700	.577

Robust standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.05. Standard errors are clustered at the secondary school level. 'Zero books', 'Uncompleted Secondary or less' and 'Non-indigenous background' are the reference categories for 'Numbers of Books at Home', 'Parental Expectations' and 'Indigenous Background'

Appendix 5A. Summary of Variables

Variable	Description	Min.	Max.	Mean	Std. Dev.
Timely Graduation	Dependent Variable. Binary. Expresses whether the student graduated from secondary school on time (2016). Takes the value of 1 for those who graduated on time.	0	1	---	---
Score on Higher Education Entrance Exam (PSU) – Language	Dependent variable. Continuous. It expresses the score on the higher education entrance examination. Standardised to a mean of 0 and a standard deviation of 1.	-3.20	3.21	0	1
Score on Higher Education Entrance Exam (PSU) – Maths	Dependent variable. Continuous. It expresses the score on the higher education entrance examination. Standardised to a mean of 0 and a standard deviation of 1.	-3.25	3.15	0	1
Type of Higher Education Institution	Dependent Variable. Ordinal. Expresses the type of higher education institution in which the student was enrolled: a) Technical/Vocational; b) Professional Institution; c) University	1	3	---	---
Grade Repetition	Binary. Proxy for prior attainment. It expresses whether the student repeated one or more times from first to fourth grade. Takes the value of 1 for those who repeated.	0	1	---	---
Years of Pre-school Education	Continuous. Proxy for prior attainment. It expresses the number of years of pre-school education.	0	5	---	---
School GPA Ranking (1st Grade)	Continuous. It expresses the relative position of the student based on their academic achievement in first grade. Value of zero represents the students with lowest GPA in the school, while value of one represents the highest GPA score.	0	1	.46	.28
Score in SIMCE (4th Grade) – Language	Continuous. It expresses the score of the student on the SIMCE examination. Standardised to a mean of 0 and a standard deviation of 1.	-3.18	2.10	0	1
Score in SIMCE (4th Grade) – Maths	Continuous. It expresses the score of the student on the SIMCE examination. Standardised to a mean of 0 and a standard deviation of 1.	-3.19	2.15	0	1
Parents' Indigenous Background	Binary. It takes value of 1 when at least one of the parents has an indigenous background.	0	1	---	---
Parental Expectations of Education	Ordinal. It summarises the level of education that the parents' believe the student will achieve. Takes 4 values: a) Incomplete secondary	0	4	---	---

	education ; b) Complete secondary education; c) Undergraduate higher education; d) Master's or PhD.				
Number of Books at Home	Ordinal. Takes 4 values: a) Five or less; b) From 6 to 10; c) From 11 to 30; d) More than 30.	1	4	---	---
Average Attendance at School	Continuous. It expresses the average percentage of attendance of the student during fourth grade.	0	100	93.42	8.42
Gender	Binary. It takes the value of 1 for males.	0	1	---	---
Student SES	Continuous. Derived from polychoric correlation. It expresses the socioeconomic status of the student based on the father's education, mother's education, and family income. Standardised to a mean of zero and a standard deviation of 1.	-2.33	2.72	0	1
Average Peer SES	Continuous. It expresses the average SES of the classmates of each student.	-2.26	3.10	0	1
Average Peer Ability – Language	Continuous. This is one of the variables of interest. It expresses the average of the peer performance on SIMCE.	-3.80	2.85	0	1
Average Peer Ability – Maths	Continuous. This is one of the variables of interest. It expresses the average of the peer performance on SIMCE.	-3.42	3.02	0	1
Peer Academic Heterogeneity - Language	Continuous. This is one of the variables of interest. It expresses the standard deviation of the peer performance on SIMCE.	-4.24	4.52	0	1
Peer Academic Heterogeneity - Maths	Continuous. This is one of the variables of interest. It expresses the standard deviation of the peer performance on SIMCE.	-4.06	5.52	0	1

Note: Mean and Standard deviation only reported for continuous variables.

Appendix 5B: Summary statistics of main variables for the full sample selective / non-selective schools / Lang

	All schools				Non-selective				Selective			
	Mean	Sd	Min. Value	Max. Value	Mean	Sd	Min. Value	Max. Value	Mean	Sd	Min. Value	Max. Value
PSU score (dependent variable)	-0.1	1.0	-3.27	3.07	-0.23	0.92	-3.27	3.07	0.26	0.99	-3.19	3.07
Years of Pre-school Education	1.9	1.3	0	5	1.78	1.26	0	5	2.27	1.42	0	5
Grade Repetition	0.07		0	1	0.08		0	1	0.05		0	1
GPA Ranking (1st Grade)	0.53	0.29	0	1	0.53	0.29	0	1	0.49	0.28	0	1
Student SIMCE score (4th Grade)	-0	1	-3.09	2.16	-0.09	0.99	-3.09	2.16	0.26	0.96	-3.03	2.16
Parental Expectations	2.84		1	4	2.76		1	4	3.113		1	4
Indigenous Background	0.13		0	1	0.14		0	1	0.08		0	1
Number of Books at home	2.68		1	4	2.55		1	4	3.1		1	4
Attendance at School	93.59	9.11	0	100	93.57	8.99	0	100	93.63	9.51	0	100
Gender	0.48		0	1	0.48		0	1	0.47		0	1
Student SES	0	1	-2.45	3.19	-0.22	0.86	-2.45	3.19	0.67	1.08	-2.45	3.19
Average Peer SES	0	1	-2.40	3.97	-0.28	0.75	-2.40	3.71	0.85	1.17	-1.72	3.97
Peer Heterogeneity	0	1	-4.40	4.53	0.07	0.97	-4.21	4.53	-0.20	1.04	-4.40	3.79
Peer Ability	0	1	-3.75	3.11	-0.23	0.92	-3.75	2.91	0.66	0.93	-3.52	3.11

Note: Mean and Standard deviation only reported for continuous variables.

Appendix 5C: Summary statistics of main variables for schools with and without sorting /Lang

	Without sorting				With sorting			
	Mean	Sd	Min. Value	Max. Value	Mean	Sd	Min. Value	Max. Value
PSU score (dependent variable)	-0.12	0.96	-3.27	3.07	-0.05	0.95	-3.13	3.07
Years of Pre-school Education	1.87	1.31	0	5	1.96	1.30	0	5
Grade Repetition	0.09		0	1	0.02		0	1
GPA Ranking (1st Grade)	0.52	0.29	0	1	0.53	0.27	0	1
Student SIMCE score (4th Grade)	0	1	-3.07	2.16	0	1	-3.06	2.15
Parental Expectations	2.82		1	4	2.91		1	4
Indigenous Background	0.13		0	1	0.12		0	1
Number of Books at home	2.65		1	4	2.77		1	4
Attendance at School	93.65	9.17	0	100	93.35	8.91	0	100
Gender	0.48		0	1	0.48		0	1
Student SES	-0.25	0.86	-2.36	3.11	0.83	0.99	-2.81	3.55
Average Peer SES	-0.32	0.76	-2.29	3.83	1.06	0.99	-2.82	4.54
Peer Heterogeneity	0.06	0.92	-4.36	4.48	-0.21	1.20	-4.42	3.91
Peer Ability	-0.24	0.91	-3.71	3.10	0.81	0.83	-3.47	3.16

Note: Mean and Standard deviation only reported for continuous variables.

Appendix 5D: Summary statistics of main variables for the full sample selective / non-selective schools / Math

	All schools				Non-selective				Selective			
	Mean	Sd	Min. Value	Max. Value	Mean	Sd	Min. Value	Max. Value	Mean	Sd	Min. Value	Max. Value
PSU score (dependent variable)	-0.09	1	-3.25	3.15	-0.22	0.94	-3.25	3.15	0.28	0.97	-3.25	3.03
Years of Pre-school Education	1.89	1.31	0	5	1.77	1.25	0	5	2.27	1.41	0	5
Grade Repetition	0.07		0	1	0.08	0	0	1	0.04	0.21	0	1
GPA Ranking (1st Grade)	0.53	0.29	0	1	0.53	0.28	0	1	0.49	0.28	0	1
Student SIMCE score (4th Grade)	0	1	-3.15	2.25	-0.12	0.98	-3.15	2.25	0.33	0.95	-3.05	2.25
Parental Expectations	2.84		1	4	2.75		1	4	3.11		1	4
Indigenous Background	0.13		0	1	0.14		0	1	0.07		0	1
Number of Books at home	2.68		1	4	2.55		1	4	3.1		1	4
Attendance at School	93.59	9.11	0	100	93.57	8.99	0	100	93.63	9.50	0	100
Gender	0.48		0	1	0.48		0	1	0.47		0	1
Student SES	0	1	-2.44	3.20	-0.22	0.86	-2.44	3.19	0.67	1.08	-2.44	3.19
Average Peer SES	0	1	-2.4	3.97	-0.28	0.74	-2.4	3.72	0.84	1.17	-1.72	3.97
Peer Heterogeneity	0	1	-4.17	5.49	0.067	0.98	-4.17	4.89	-0.19	1.01	-3.87	5.49
Peer Ability	0	1	-3.38	3.37	-0.24	0.89	-3.38	3.05	0.69	0.95	-2.82	3.37

Note: Mean and Standard deviation only reported for continuous variables.

Appendix 5E: Summary statistics of main variables for schools with and without sorting

	Without sorting				With sorting			
	Mean	Sd	Min. Value	Max. Value	Mean	Sd	Min. Value	Max. Value
PSU score (dependent variable)	-0.11	0.98	-3.25	3.03	-0.03	0.96	-3.25	3.15
Years of Pre-school Education	1.86	1.31	0	5	1.96	1.30	0	5.00
Grade Repetition	0.08	0.28	0	1	0.02	0.13	0	1.00
GPA Ranking (1st Grade)	0.52	0.29	0	1	0.53	0.27	0	1.00
Student SIMCE score (4th Grade)	-0	1	-3.12	2.25	0.00	1.00	-3.13	2.25
Parental Expectations	2.81	0.68	1	4	2.91	0.62	1	4.00
Indigenous Background	0.13	0.33	0	1	0.12	0.32	0	1.00
Number of Books at home	2.65	1.12	1	4	2.77	1.10	1	4.00
Attendance at School	93.65	9.16	0	100	93.35	8.90	0	100
Gender	0.48	0.5	0	1	0.48	0.50	0	1.0
Student SES	-0.25	0.86	-2.36	3.11	0.8	0.99	-2.81	3.56
Average Peer SES	-0.32	0.76	-2.29	3.83	1.1	0.99	-2.82	4.54
Peer Heterogeneity	0.06	0.92	-4.12	5.44	-0.2	1.20	-3.33	3.89
Peer Ability	-0.24	0.91	-3.32	3.35	0.8	0.83	-3.11	3.12

Note: Mean and Standard deviation only reported for continuous variables.

Appendix 5F. The Effect of Peer Characteristics on Higher Education Entrance Exams

	All schools		Non-selective		Selective		Without sorting		With sorting	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VARIABLES	Lang	Maths	Lang	Maths	Lang	Maths	Lang	Maths	Lang	Maths
Years of Pre-school Education	.004	-.007**	.005	-.009**	.003	-.004	.007*	-.006	-.002	-.009
	(.003)	(.003)	(.004)	(.003)	(.005)	(.005)	(.003)	(.003)	(.007)	(.006)
Grade Repetition	-.188***	-.239***	-.167***	-.215***	-.289***	-.340***	-.175***	-.237***	-.344***	-.153*
	(.019)	(.018)	(.021)	(.019)	(.044)	(.043)	(.021)	(.019)	(.081)	(.072)
GPA Ranking (1st Grade)	.594***	.336***	.574***	.312***	.668***	.408***	.593***	.347***	.649***	.356***
	(.015)	(.014)	(.018)	(.017)	(.031)	(.028)	(.018)	(.017)	(.036)	(.032)
Student's SIMCE Score (4th Grade)	.273***	.514***	.268***	.508***	.272***	.490***	.269***	.508***	.276***	.520***
	(.004)	(.005)	(.005)	(.005)	(.009)	(.009)	(.005)	(.005)	(.010)	(.010)
Parental Expectations = Secondary	-.062	-.042	-.046	-.032	-.170	-.096	-.062	-.030	-.082	-.093
	(.036)	(.031)	(.038)	(.032)	(.121)	(.137)	(.042)	(.036)	(.086)	(.073)
Parental Expectations = HE Undergraduate	.041	.075*	.059	.085**	-.062	.038	.039	.091*	.021	.022
	(.036)	(.031)	(.038)	(.032)	(.120)	(.135)	(.042)	(.036)	(.085)	(.073)
Parental Expectations = HE Post-Graduate	.134***	.174***	.158***	.186***	.015	.129	.140**	.200***	.089	.095
	(.038)	(.033)	(.040)	(.034)	(.121)	(.136)	(.044)	(.038)	(.089)	(.076)
Indigenous Background	.020	.001	.023	-.002	.014	.017	.018	.005	.021	-.023
	(.012)	(.011)	(.014)	(.012)	(.030)	(.027)	(.015)	(.013)	(.026)	(.024)
Number of Books at Home = (6 to 10)	.010	.012	.007	.006	.022	.045	.008	.012	.019	.028
	(.012)	(.011)	(.014)	(.012)	(.032)	(.027)	(.014)	(.013)	(.029)	(.024)
Number of Books at Home = (11 to 30)	.011	.028**	.013	.030**	.004	.026	.015	.035**	-.004	.014
	(.012)	(.010)	(.013)	(.012)	(.028)	(.025)	(.014)	(.012)	(.027)	(.023)
Number of Books at Home = (More than 30)	.051***	.061***	.053***	.060***	.039	.068**	.052***	.061***	.052	.067**
	(.012)	(.011)	(.014)	(.012)	(.028)	(.025)	(.014)	(.013)	(.027)	(.023)
Attendance at School	.003***	-.001*	.002***	-.000	.003**	-.002**	.003***	-.001*	.004***	.000

	(.000)	(.000)	(.001)	(.000)	(.001)	(.001)	(.001)	(.000)	(.001)	(.001)
Gender	.225***	-.131***	.222***	-.137***	.233***	-.112***	.210***	-.136***	.265***	-.109***
	(.008)	(.007)	(.009)	(.008)	(.015)	(.015)	(.009)	(.008)	(.017)	(.016)
Student SES	.132***	.130***	.109***	.110***	.161***	.149***	.137***	.129***	.124***	.124***
	(.006)	(.005)	(.006)	(.006)	(.013)	(.012)	(.007)	(.007)	(.013)	(.011)
Average Peer SES	.012	.057*	.015	.074***	.045	-.095	.009	.041	.022	.098*
	(.026)	(.024)	(.023)	(.021)	(.066)	(.068)	(.032)	(.029)	(.044)	(.042)
Peer Heterogeneity	-.024***	-.012*	-.035***	-.014*	-.005	-.023*	-.030***	-.015*	-.013	-.001
	(.005)	(.005)	(.006)	(.006)	(.012)	(.011)	(.006)	(.006)	(.011)	(.009)
Peer Ability	-.031***	-.097***	-.026**	-.088***	-.018	-.104***	-.025*	-.095***	-.048**	-.112***
	(.009)	(.009)	(.009)	(.009)	(.019)	(.022)	(.011)	(.010)	(.018)	(.016)
Constant	-.857***	.010	-1.399*	-.625	-.621***	.223	-1.054***	.158**	-.790***	-.229
	(.061)	(.050)	(.562)	(.346)	(.162)	(.155)	(.073)	(.060)	(.156)	(.124)
Observations	53,009	53,314	39,271	39,532	13,738	13,782	40,378	40,597	12,631	12,717
R-squared	.407	.539	.364	.515	.423	.527	.432	.558	.437	.563
Selection Solution	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Reflection Solution	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Robust standard errors in parentheses

*** p<0.001, ** p<0.01, * p<0.05

Standard errors are clustered at fourth grade. '1 to 5', ‘Female’, 'Incomplete Secondary', and 'Non-indigenous' are the reference categories for 'Numbers of Books at Home', ‘Gender’ 'Parental Expectations' and 'Indigenous Background', respectively.

Appendix 5G. The Effect of Peer Characteristics on Timely Graduation and Type of HE Institution of Enrolment

	Timely Graduation		Type of HEI	
	(1)	(2)	(3)	(4)
VARIABLES	Lang	Maths	Lang	Maths
Years of Pre-school Education	.976***	.969***	.991	.982
	(.004)	(.004)	(.012)	(.013)
Grade Repetition	.437***	.441***	0.802**	.845*
	(.009)	(.009)	(.063)	(.067)
GPA Ranking (1st Grade)	5.528***	4.375***	2.952***	2.156***
	(.130)	(.105)	(.186)	(.141)
Student SIMCE Score (4th Grade)	1.634***	1.891***	1.973***	2.358***
	(.012)	(.016)	(.037)	(.051)
Parental Expectations = Secondary	1.424***	1.399***	.862	.868
	(.052)	(.051)	(.116)	(.117)
Parental Expectations = HE Undergraduate	1.605***	1.560***	1.257	1.255
	(.060)	(.058)	(.168)	(.168)
Parental Expectations = HE Post-Graduate	1.703***	1.621***	1.824***	1.801***
	(.070)	(.067)	(.258)	(.256)
Indigenous Background	1.043*	1.041*	1.063	1.058
	(.019)	(.019)	(.056)	(.056)
Number of Books at Home = (6 to 10)	1.022	1.028	.916	.932
	(.017)	(.017)	(.045)	(.046)
Number of Books at Home = (11 to 30)	1.049**	1.048**	.948	.948
	(.018)	(.018)	(.045)	(.045)
Number of Books at Home = (More than 30)	1.047*	1.032	1.067	1.047
	(.019)	(.018)	(.053)	(.052)
Attendance at School	1.026***	1.025***	1.002	1.001
	(.001)	(.001)	(.002)	(.002)
Gender	.766***	0.630***	.733***	.555***
	(.009)	(.008)	(.024)	(.019)
Student SES	1.183***	1.170***	1.542***	1.524***
	(.012)	(.012)	(.041)	(.040)
Average Peer SES	1.188***	1.206***	1.121	1.062
	(.055)	(.056)	(.118)	(.111)
Peer Heterogeneity	1.025**	1.011	.940**	.935**
	(.009)	(.009)	(.021)	(.020)
Peer Ability	.999	0.936***	.925*	.896**
	(.015)	(.016)	(.031)	(.034)
Constant	.042***	.053***		
	(.005)	(.006)		
Observations	201,238	201,238	32,149	32,232

Note: Robust standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.05. Standard errors are clustered at fourth grade. '1 to 5', 'Female', 'Incomplete Secondary' and 'Non-Indigenous' are the reference categories for 'Numbers of Books at Home', 'Gender' 'Parental Expectations', and 'Indigenous Background', respectively. Estimates for Timely Graduation only control for the selection problem. Estimates for type of HEI control for both selection and reflection.

Appendix 5H. The Effect of Peer Characteristics on Higher Education Entrance Exam Scores (Robustness Analysis)

	Full sample		Full sample		Restricted sample	
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Lang	Maths	Lang	Maths	Lang	Maths
Years of Pre-school Education	.004*	-.007***	.004*	-.007***	.003	-.008***
	(.002)	(.002)	(.002)	(.002)	(.003)	(.002)
Grade Repetition	-.242***	-.303***	-.242***	-.303***	-.212***	-.270***
	(.012)	(.011)	(.012)	(.011)	(.017)	(.016)
GPA Ranking (1st Grade)	.554***	.315***	.554***	.315***	.556***	.308***
	(.010)	(.009)	(.010)	(.009)	(.014)	(.013)
Student SIMCE Score (4th Grade)	.268***	.508***	.268***	.508***	.279***	.515***
	(.003)	(.003)	(.003)	(.003)	(.004)	(.004)
Parental Expectations = Secondary	-.094***	-.047*	-.094***	-.047*	-.077*	-.044
	(.021)	(.020)	(.021)	(.020)	(.032)	(.028)
Parental Expectations = HE Undergraduate	-.007	.094***	-.007	.094***	.025	.093***
	(.021)	(.020)	(.021)	(.020)	(.032)	(.028)
Parental Expectations = HE Post-Graduate	.089***	.184***	.089***	.184***	.127***	.203***
	(.022)	(.020)	(.022)	(.020)	(.033)	(.029)
Indigenous Background	.012	.006	.012	.006	.013	.011
	(.008)	(.007)	(.008)	(.007)	(.011)	(.010)
Number of Books at Home = (6 to 10)	-.005	.010	-.005	.010	.005	.009
	(.008)	(.007)	(.008)	(.007)	(.011)	(.010)
Number of Books at Home = (11 to 30)	-.000	.028***	-.000	.028***	.002	.024*
	(.007)	(.007)	(.007)	(.007)	(.011)	(.010)
Number of Books at Home = (More than 30)	.031***	.065***	.031***	.065***	.043***	.060***
	(.008)	(.007)	(.008)	(.007)	(.011)	(.010)
Attendance at School	.004***	-.000	.004***	-.000	.003***	-.001*
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)

Gender	.218***	-.127***	.218***	-.127***	.220***	-.131***
	(.005)	(.004)	(.005)	(.004)	(.007)	(.006)
Student's SES	.137***	.122***	.137***	.122***	.146***	.135***
	(.004)	(.004)	(.004)	(.004)	(.006)	(.005)
Average Peer SES	.261***	.205***	.261***	.205***	.169***	.154***
	(.006)	(.005)	(.006)	(.005)	(.006)	(.006)
Peer Heterogeneity	-.009**	-.000	-.009**	-.000	-.007	.004
	(.003)	(.003)	(.003)	(.003)	(.004)	(.003)
Peer Ability	.041***	-.076***	.041***	-.076***	.011*	-.099***
	(.005)	(.004)	(.005)	(.004)	(.005)	(.005)
Constant	-.771***	-.173***	-.771***	-.173***	-.776***	-.208***
	(.040)	(.032)	(.040)	(.032)	(.050)	(.042)
Observations	116,725	117,324	116,725	117,324	53,009	53,314
R-squared	.412	.518	.412	.518	.335	.478
Selection Solution	No	No	Yes	Yes	No	No
Reflection Solution	No	No	No	No	Yes	Yes

Note: Robust standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.05. Standard errors are clustered at fourth grade. '1 to 5', 'Female', 'Incomplete Secondary', and 'Non-Indigenous' are the reference categories for 'Numbers of Books at Home', 'Gender' 'Parental Expectations', and 'Indigenous Background', respectively.

Appendix 5I. Heterogeneous Effects Based on Relative and Absolute Measurements of Ability

	Relative Measurement		Absolute Measurement	
	(1)	(3)	(2)	(4)
VARIABLES	Maths	Language	Maths	Language
Years of Pre-school Education	-.007**	.004	-.007**	.004
	(.003)	(.003)	(.003)	(.003)
Grade Repetition	-.241***	-.191***	-.241***	-.190***
	(.018)	(.019)	(.017)	(.019)
GPA Ranking (1st Grade)	.332***	.590***	.334***	.592***
	(.014)	(.016)	(.014)	(.016)
Student SIMCE Score 4th Grade (Absolute Measurement)	.478***	.250***	.515***	.275***
	(.014)	(.015)	(.005)	(.004)
Parental Expectations = Secondary	-.039	-.059	-.040	-.060
	(.031)	(.036)	(.031)	(.036)
Parental Expectations = HE Undergraduate	.080*	.047	.079*	.045
	(.031)	(.036)	(.031)	(.036)
Parental Expectations = HE Post-Graduate	.176***	.137***	.176***	.136***
	(.033)	(.038)	(.033)	(.038)
Indigenous Background	.001	.021	.001	.020
	(.011)	(.012)	(.011)	(.012)
Number of Books at Home = (6 to 10)	.012	.011	.012	.011
	(.011)	(.012)	(.011)	(.012)
Number of Books at Home = (11 to 30)	.029**	.012	.029**	.012
	(.010)	(.012)	(.010)	(.012)
Number of Books at Home = (More than 30)	.061***	.051***	.062***	.051***

	(.011)	(.012)	(.011)	(.012)
Attendance at School	-.001*	.003***	-.001*	.003***
	(.000)	(.000)	(.000)	(.000)
Gender	-.132***	.225***	-.131***	.225***
	(.007)	(.008)	(.007)	(.008)
Student SES	.130***	.132***	.130***	.132***
	(.005)	(.006)	(.005)	(.006)
Average Peer SES (4th Grade)	.058*	.013	.058*	.013
	(.024)	(.025)	(.024)	(.026)
Peer Academic Heterogeneity	-.013**	-.025***	-.011*	-.024***
	(.005)	(.005)	(.005)	(.005)
Subject Rank (Relative measure)	.122**	.082		
	(.044)	(.051)		
Peer Average Ability	-.119***	-.070***	-.096***	-.029***
	(.011)	(.011)	(.009)	(.009)
Subject Rank*Peer Average Ability	.041**	.071***	.014***	.018***
	(.013)	(.014)	(.004)	(.004)
Constant	-.071	-.925***	.005	-.875***
	(.057)	(.072)	(.050)	(.061)
Observations	53,311	53,006	53,314	53,009
R-squared	.539	.407	.539	.407

Note: Robust standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.05'1 to 5', ‘Female’, 'Incomplete Secondary' and 'Non-indigenous' are the reference categories for 'Numbers of Books at Home', ‘Gender’ 'Parental Expectations', and 'Indigenous Background' respectively. All estimates control for both reflection and selection problems.

Appendix 5J. Estimates Adding Covariates From Secondary School Level

VARIABLES	(1) Lang	(2) Maths	(3) Lang	(4) Maths
Years of Pre-school Education	.007**	-.004	.008**	-.005
	(.003)	(.003)	(.003)	(.003)
Grade Repetition	-.194***	-.245***	-.153***	-.178***
	(.019)	(.017)	(.022)	(.019)
GPA Ranking (1st Grade)	.551***	.295***	.488***	.186***
	(.015)	(.014)	(.016)	(.014)
Student SIMCE Score (4th Grade)	.249***	.487***	.114***	.323***
	(.004)	(.004)	(.005)	(.005)
Parental Expectations = Secondary	-.030	-.008	-.015	-.023
	(.035)	(.030)	(.039)	(.033)
Parental Expectations = HE Undergraduate	.010	.044	.006	.017
	(.035)	(.030)	(.039)	(.033)
Parental Expectations = HE Post-Graduate	.089*	.128***	.074	.092**
	(.037)	(.032)	(.041)	(.034)
Indigenous Background	.023	.006	.018	.009
	(.012)	(.011)	(.013)	(.011)
Number of Books at Home = (6 to 10)	.007	.008	-.003	.008
	(.012)	(.011)	(.013)	(.011)
Number of Books at Home = (11 to 30)	.004	.020*	-.008	.013
	(.011)	(.010)	(.012)	(.010)
Number of Books at Home = (More than 30)	.038**	.047***	.016	.033**
	(.012)	(.010)	(.013)	(.011)
Attendance at School	.003***	-.001	.003***	-.001**
	(.000)	(.000)	(.001)	(.000)
Gender	.243***	-.103***	.268***	-.137***
	(.007)	(.007)	(.008)	(.007)

Student SES	.092***	.088***	.074***	.064***
	(.006)	(.005)	(.006)	(.005)
Average Peer SES (4th Grade)	.003	.049*	.005	.054*
	(.025)	(.023)	(.025)	(.023)
Peers Academic Heterogeneity	-.023***	-.008	-.021***	-.003
	(.005)	(.005)	(.005)	(.005)
Average Peer Ability	-.028***	-.092***	-.014	-.063***
	(.008)	(.008)	(.009)	(.009)
School Type 2nd Grade of Secondary	.413***	.431***	.363***	.370***
	(.009)	(.008)	(.010)	(.008)
Student SIMCE Score (10th Grade)			.277***	.316***
			(.005)	(.005)
Constant	-1.300***	-0.454***	-1.457***	-.157**
	(.061)	(.049)	(.359)	(.055)
Observations	52,896	53,199	43,478	44,609
R-squared	.436	.570	.501	.629

Robust standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.05

Note: Standard errors are clustered at fourth grade. '1 to 5', ‘Female’, 'Incomplete Secondary' and 'Non-Indigenous' are the reference categories for 'Numbers of Books at Home', ‘Gender’ 'Parental Expectations', and 'Indigenous Background', respectively. All estimates control for both reflection and selection problems.

Appendix 5K. Estimates Without Using 4th-Grade SIMCE Score as a Control for Prior Attainment.

	Alternative Specification		Preferred specification	
VARIABLES	Lang	Math	Lang	Math
Years of Pre-school Education	.007*	.002	.004	-.007**
	(.003)	(.003)	-.003	-.003
Grade Repetition	-.227***	-.316***	-.188***	-.239***
	(.020)	(.020)	-.019	-.018
GPA Ranking (1st Grade)	.971***	1.100***	.594***	.336***
	(.015)	(.014)	-.015	-0.014
Student's SIMCE Score (4th Grade)			.273***	.514***
			-.004	-.005
Parental Expectations = Secondary	-.054	-.021	-.062	-.042
	(.037)	(.036)	-.036	-.031
Parental Expectations = HE Undergraduate	.078*	.153***	.041	.075*
	(.037)	(.036)	-.036	-.031
Parental Expectations = HE Post-Graduate	.214***	.329***	.134***	.174***
	(.039)	(.037)	-.038	-.033
Indigenous Background	.027*	.023	.02	.001
	(.013)	(.013)	-.012	-.011
Number of Books at Home = (6 to 10)	.014	.018	.01	.012
	(.013)	(.013)	-.012	-.011
Number of Books at Home = (11 to 30)	.023	.053***	.011	.028**
	(.012)	(.012)	-.012	-0.01
Number of Books at Home = (More than 30)	.079***	.119***	.51***	.61***
	(.013)	(.012)	-.012	-.011
Attendance at School	.002***	-.000	.003***	-.001*
	(.000)	(.000)	(.000)	(.000)
Gender	.202***	.002	.225***	-.131***

	(.008)	(.008)	-.008	-.007
Student SES	.148***	.161***	.132***	.130***
	(.006)	(.006)	-.006	-.005
Average Peer SES	.056*	.122***	.012	.057*
	(.028)	(.029)	-.026	-.024
Peer Heterogeneity	-.051***	-.069***	-.024***	-.012*
	(.006)	(.006)	-.005	-.005
Peer Ability	-.038***	-.051***	-.031***	-.097***
	(.010)	(.011)	-.009	-.009
Constant	-1.329***	-.843***	-.857***	.01
	(.063)	(.057)	-.061	-.05
Observations	53,009	53,314	53,009	53,314
R-squared	.356	.390	0.407	0.539

Robust standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.05

Note: Standard errors are clustered at fourth grade. '1 to 5', ‘Female’, 'Incomplete Secondary' and 'Non-Indigenous' are the reference categories for 'Numbers of Books at Home', ‘Gender’ 'Parental Expectations', and 'Indigenous Background', respectively. All estimates control for both reflection and selection problems.