University College London

Institutional Policies, Secondary School Quality and Teacher Effects: Three Studies on Inequality of Educational Opportunity in Chile

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Declaration

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Abstract

Inequality of educational opportunity is a crucial topic in education policy, and a matter of strong debate in the Chilean context. In this thesis, I aim to identify and analyse likely drivers of educational inequality in Chile, by looking at three relevant dimensions: Teacher effectiveness, Secondary School Quality and School Systems' Institutional Characteristics.

First, in Chapter 2, I analyse how differentials on teacher effectiveness across Chilean schools from different socioeconomic status explain differentials in learning achievement in secondary education. Second, in Chapter 3, I assess how school level characteristics and other institutional features of the Chilean school system could be explaining students' access to higher education. Third, in Chapter 4, and through an international comparison using PISA data, I study the effect of school accountability practices on educational outcomes, gathering lessons for the Chilean case.

My results in Chapter 2 show that teacher effectiveness plays a relevant role in explaining educational inequality in Chile, with students from lower and middle SES schools accessing much more variable quality of teaching than better-off schools, and teachers in middle SES schools showing lower average teacher effectiveness.

In Chapter 3, I find that high performing schools can make a big difference for low SES students, increasing their chances of accessing tertiary studies importantly. Nonetheless, low SES students taking the vocational education track, or with no access to public funding, are much less likely to access higher education in Chile.

Finally, in Chapter 4, I find mixed results on the impact of school accountability practices in educational outcomes. While those school practices designed to inform parental decisions do not impact average educational achievement and increase inequality of outcomes at schools, other school practices related to the internal use of assessments results for benchmarking purposes lower inequality in academic outcomes and increase average student performance.

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Chapter 1

Inequality of Educational Opportunity in Chile: A General Introduction

1.1 Introduction

Education is seen as one of the primary means by which societies can develop their citizens' wellbeing and increase their opportunities in life. Access to quality education remains one of the main aspirations for most Chilean citizens. Hence, a crucial question must be addressed: are educational opportunities equally distributed amongst the Chilean population? For those knowledgeable about the Chilean education system, the answer to this question is quite straightforward: there are important differences in access to quality education amongst students from different socioeconomic and geographical backgrounds, and these inequalities still persist, even after decades of school reforms. The question of what aspects of the Chilean education system, its actors and institutions negatively affect students' opportunities in life is the main focus of this thesis. In this initial chapter, I aim to describe the current state of the Chilean education system in terms of access to quality education for all students. I perform this analysis by revising the education system achievements in equity in education, as well as its current challenges. In this chapter, I briefly revise the existing evidence about inequality in access to education in different educational levels, moving towards an analysis of aspects associated to access to quality education in the Chilean context. Finally, I systematize critical issues which could be affecting equity in education in Chile and outline the research questions for the next three empirical chapters.

1.2 Universal access and completion of pre-primary and school education: the starting point.

The Chilean educational system experienced a spectacular increase in enrolment for all educational levels during the last three decades and has been regarded as a pioneer in that endeavour within the Latin American context. Today's net enrolment rates are as high as 92% in primary education (CASEN, 2013) with a fair distribution across different regions. In the same period, private subsidized education has increased its participation up to 52% in 2013 in that level, with 42% of students attending public schools (administrated by municipalities) and the remaining 5% of students attending private unsubsidized schools. By 2011, drop-out incidence rates in this educational level were below 2% for each year. In 2013, less than 4% of the population of students between 6 and 13 years old did not attend primary school (CASEN, 2013).

In secondary education, figures are less encouraging but still positive. Net enrolment rates for secondary education increased from 60% in 1990 to 73% in 2013, with relevant variation across regions (CASEN, 2013). The main incidence in drop-outs occurs in the transition from primary education to lower secondary (8^{th} to 9^{th} grade), and the transition from lower to upper secondary education (10^{th} to 11^{th} grade) (MINEDUC, 2013). Although drop-out levels in secondary education have decreased significantly in the last 10 years, they still remain important (prevalence of around 10% in 2011 for the population aged 15 to 19). The determinants of drop-outs in secondary education and their distributions among the Chilean population have been the subject of previous studies. Román (2009), for instance, systematizes the literature pointing to two different types of determinants: first, factors which are exogenous to the education system, mainly explained by economic difficulties, low parental expectations, work alternatives, teenage pregnancy and geographical conditions (rural schools); and second, factors endogenous to the education system: performance issues at schools, lack of interest in studies and lack of policies to retain students and prevent drop-outs. In this regard, the availability of free, accessible educational services does not seem to be a relevant factor explaining drop-outs.

In pre-primary education, enrolment levels are still well below national targets. Although net enrolment levels in the population with age from 0 to 5 years has increased from 16% in 1990 to 49% in 2013 (CASEN 2013), an important socioeconomic gap still exists, especially for younger children. Figure 1.1 shows that the coverage for the 20% with the highest income in the population is well above that in the lowest 20% income. This gap is much more pronounced for children in early stages of cognitive development (0 to 3 years old. It is a common belief in part of the Chilean population that children under 4 years old receive better care at home rather than at any educational institution. However, this perception seems to change according to parental socioeconomic status, where better off families acknowledge in a bigger proportion the importance of early childhood education (Centro Microdatos, 2010). At the same time, and unlike other educational levels, in pre-primary education there is still a lack of public supply of educational services in certain geographical areas, which is being partially addressed via a national presidential program to build 4,500 additional nursery establishments and 34,000 additional places for pre-school education students (4 to 5 years old) by 2018 (MINEDUC, 2013).

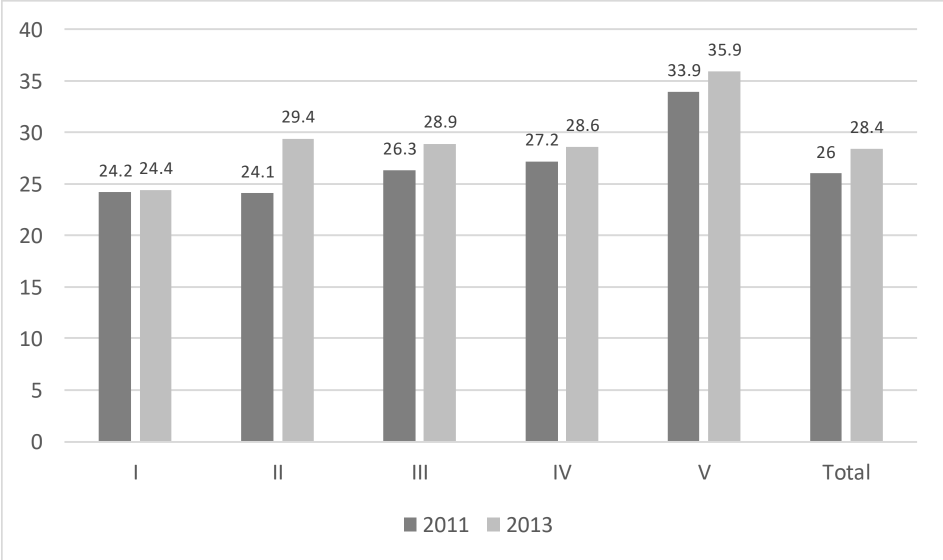
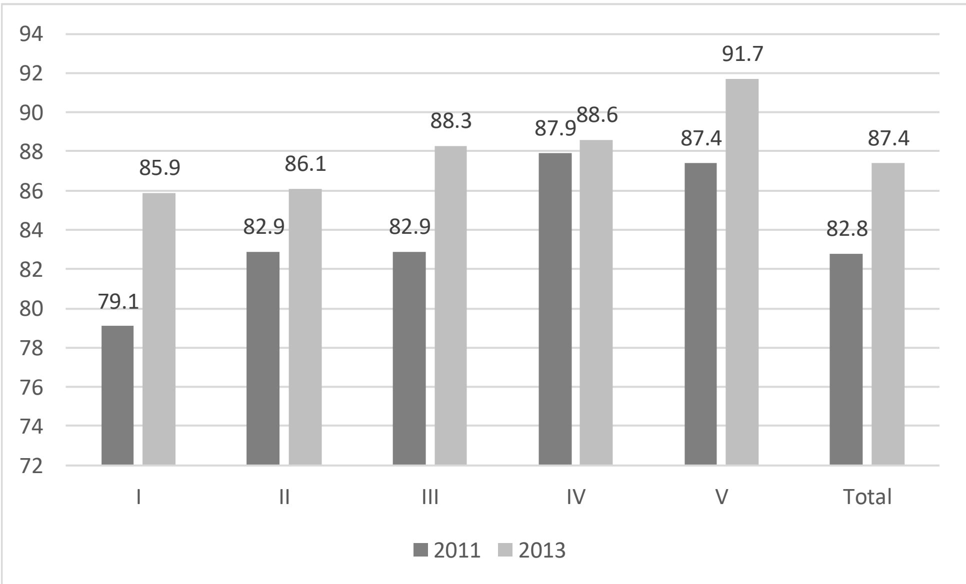


Figure 1.1 Net enrolment rate in pre-primary education. Population aged 0 to 3. *Source: CASEN Survey, 2011-2013. Ministry of Social Development, Chilean Government.*



Figures 1.2 Net enrolment rate in pre-primary education. Population aged 4 to 5. *Source: CASEN Survey. 2011-2013. Ministry of Social Development, Chilean Government.*

1.3 Access to higher education

The questions of whether access to higher education should be universal and free at the point of access for all students, as well as the type of qualifications that should be encouraged by policy makers, are still a matter of important debate in the Chilean context. The Chilean higher education system has increased its participation levels importantly, in different types of academic and vocational degrees, with technical tertiary education being the one with the biggest expansion in the last 10 years (see Figure 1.3; CNED, 2016). The net enrolment rate reached 36.7% in 2013 (see Figure 1.4). In three decades, the expansion of this type of education was around 300% (CASEN, 2013). This systematic increase in admission has been explained by a big expansion in the number of private institutions offering tertiary education (especially technical institutions), and by the extended access to grants and loans for students from more deprived backgrounds. Despite this accomplishment, important differences still exist across socioeconomic levels and geographical locations. Enrolment levels vary from 27% to 43% according to the administrative region. At the same time, coverage is almost universal for those from the top income quintile (60%), whereas it only achieves 27% for the first income quintile (see Figure 1.4). Also, the types of institutions that are attended by students in tertiary education vary by socioeconomic status. Vocational education institutions offer short-length courses leading to technical qualifications, or professional qualifications not leading to Bachelor degrees. These programmes are massively attended by low and middle income families, whereas university studies leading to Bachelor degrees or above are concentrated in the better off population (see Figure 1.5). Moreover, the articulation between academic and technical degrees is almost non-existent.

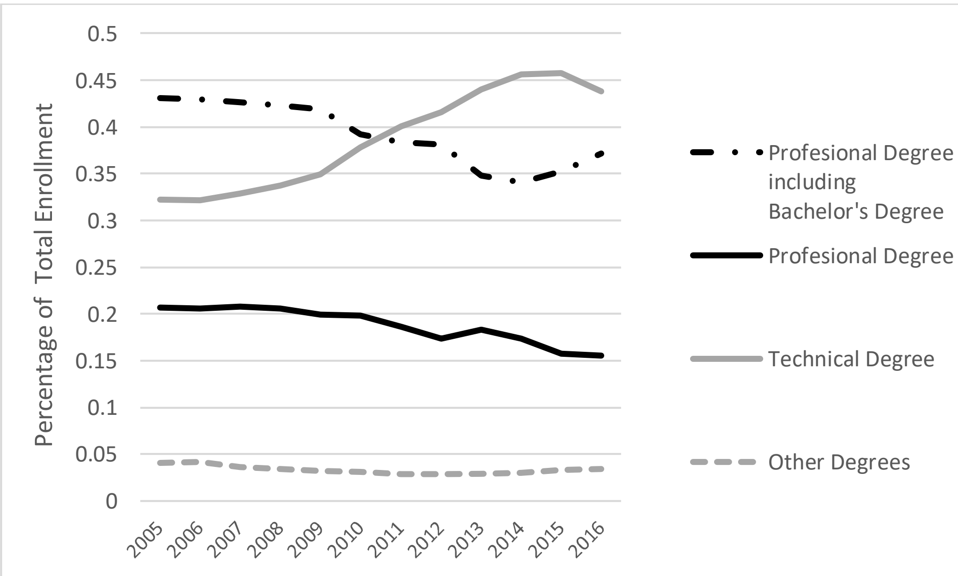


Figure 1.3. Enrolment levels in higher education by type of qualification 2005-2016. *Source: Author's elaboration from CNED (2016). National Council for Education, Chilean State.*

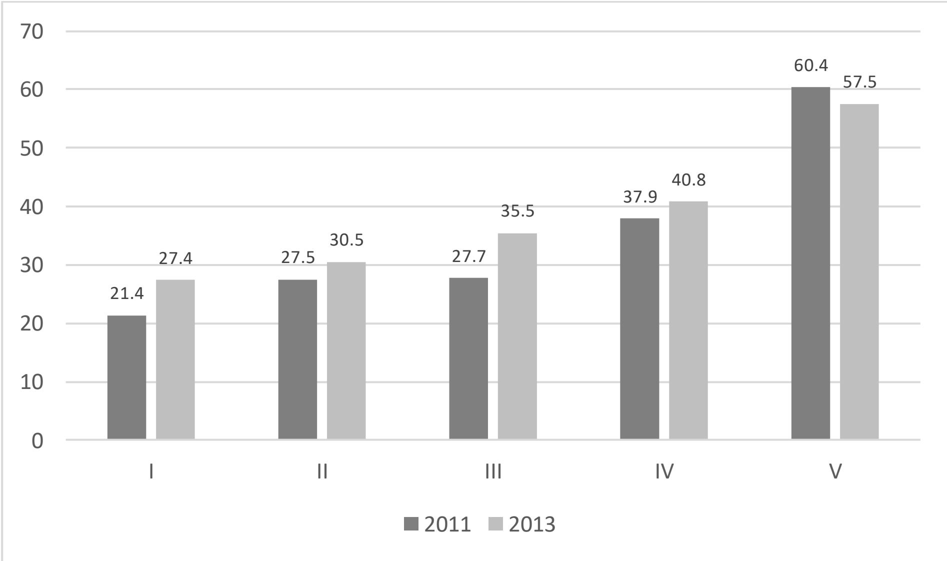


Figure 1.4 Net Enrolment rate in higher education per income quintile. Population aged 18 to 24. *Source: CASEN Survey, 2011-2013. Ministry of Social Development. Chilean Government.*

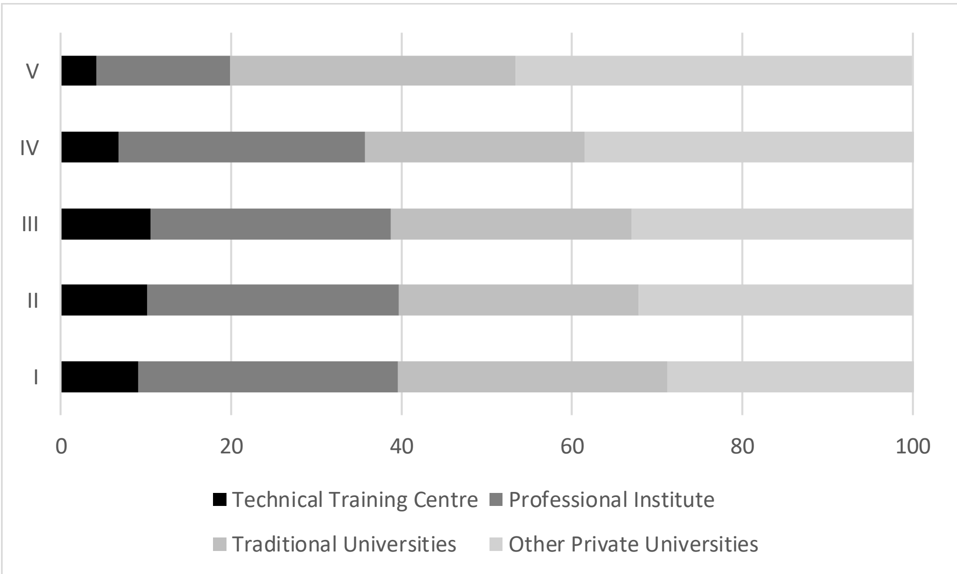


Figure 1.5 Net enrolment rate in higher education by income quintile and type of higher education institution. Population aged 18 to 24. *Source: CASEN Survey, 2011 and 2013. Ministry of Social Development. Chilean Government.*

Inequalities in access to education still affect the Chilean society and are directly linked to the socioeconomic status of students and their families. However, once universal access is almost guaranteed in pre-primary and secondary education, the analysis turns into one concerning quality in education.

1.4 The question of equitable access to quality education

In this section, I aim to assess whether equitable access to quality education for students from different socioeconomic backgrounds exists at different educational levels. Although the question of participation at different educational levels signals towards the existence of opportunities for learning, the quality of educational services offered by different educational providers, as well as the impact that formal education has on levelling family background disadvantages in learning, are crucial elements explaining inequality in educational outcomes.

Pre-school education

Very few studies in the Chilean context have analysed the quality of pre-primary education and its effects on developmental features and cognitive and non-cognitive skills for pre-school children. Although the majority of children attending pre-primary education have access to the public system, differences in the quality of provision, according to the geographical areas and to the public institutions providing early childhood education, have been analysed in previous studies (Villalón et al., 2002). Also, and as previously stated, there is a non-negligible portion of the population accessing private child care. As participation in pre-primary education, especially on the first and intermediate cycles (ages 0 to 4), is quite low in the Chilean context, and even lower for low SES students, it is relevant to assess whether access to early childhood education has a significant impact on children's development in the Chilean case, hence contributing to future inequalities in life between students attending and students not attending pre-primary education. A previous study by Noboa-Hidalgo & Urzua (2012) for pre-school education institutions, found that attending public pre-primary institutions for students between the ages of 0 and 2 had a positive impact on their expressive communication and expressions of feelings, but a negative impact on reasoning skills, with no significant differences when compared to controls in several other dimensions (motor skills, memory, interaction with adults or receptive communication). A later work by Narea (2014) employing slightly different techniques found that, on average, students between the ages of 2 and 3 attending day care showed increased cognitive development, but no significant difference in socio-emotional development, compared to those under maternal care. At the same time, this study found that amongst the children attending childcare, those from lower income households developed lower socio-emotional skills than their peers from higher income households. Although more research is urgently needed on this area, evidence seems to show that pre-school education could be a likely source of educational inequalities in the Chilean context. Future studies using longitudinal data recently gathered by the Chilean Government will certainly shed some light on the implications of this type of education and suggest the best ways to make it more equitable.

School education

The current policy interventions in the school education system in Chile were preceded by massive school reforms over the last 30 years. From 1990 to 2016, national enrolment policies have been accompanied by several initiatives aiming to increase the quality of the education provided, as well as by specific programs targeted to students from more deprived backgrounds. In relation to this, probably the most important policy aiming to improve equity in school education has been the Preferential School Subsidy, recently accompanied by a school reform currently in place to set up a quality assurance framework for school education (National Quality Assurance System). Moreover, an additional bill recently approved by the Chilean Parliament prohibiting profit, student selection and co-payment in subsidized school education in the following years is being implemented. The Preferential School Subsidy began its implementation in 2008 for students in 4th to 6th grade and included an additional subsidy of around 50% to 60% of the regular subsidy for each student attending those subsidized schools listed as vulnerable by the Chilean government. The subsidy is directly transferred to their schools through their administrative bodies to implement a school improvement plan using those resources. Recent studies have shown that this policy had a significant impact on all students in those schools, with an additional positive impact on students listed as vulnerable (Carrasco, Pérez & Núñez, 2015; Correa, Parro & Reyes, 2014). Currently, this subsidy covers students in subsidized schools attending grades 1st to 12th. The National Quality Assurance System is mainly composed by a Quality of Education Agency and a Superintendence for school education. The Quality of Education Agency evaluates a set of educational standards and provides guidelines to schools, in order for them to improve their daily practices and learning outcomes; on the other hand, the Superintendence of Education supervises and ensures the correct use of monetary resources and the compliance with the law in school education.

Despite these important efforts, both average learning outcomes and socioeconomic differences remain significant issues. For instance, the socioeconomic gap in math results between the students in the lowest and highest SES decile in the national standardized examination (SIMCE) are as high as 0.9 standard deviations in 4th grade and 1.1 standard deviations in 10th grade (see Figures 1.6 and 1.7), reflecting an increasing gap when progressing from primary to secondary education. After the beginning of the implementation of the National Preference Subsidy[1], inequality levels decreased in 4th grade, although they have remained relatively stable in 10th grade.

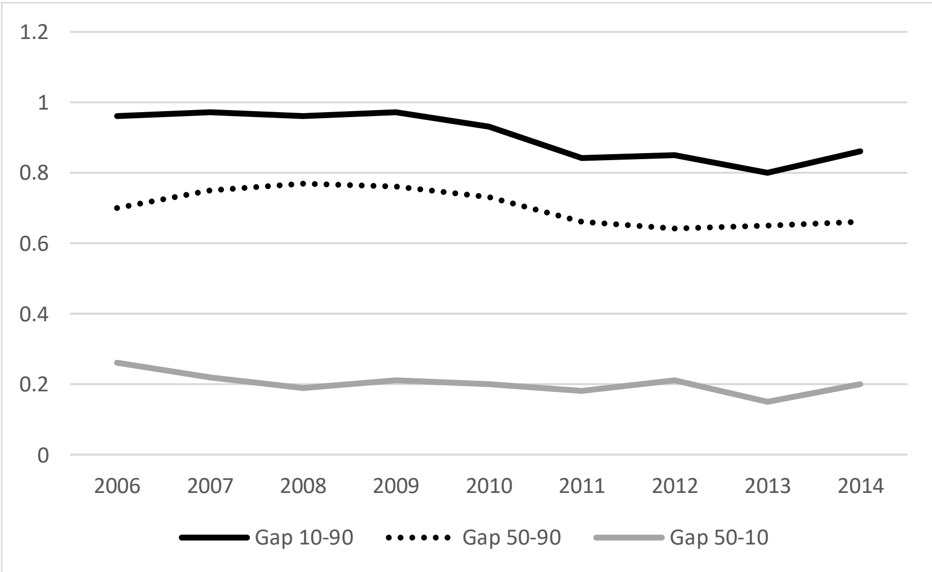


Figure 1.6 Socioeconomic gap in math achievement by income deciles 2006-2014, 4th grade. *Source: Quality of Education Agency (2015), Chilean Government*

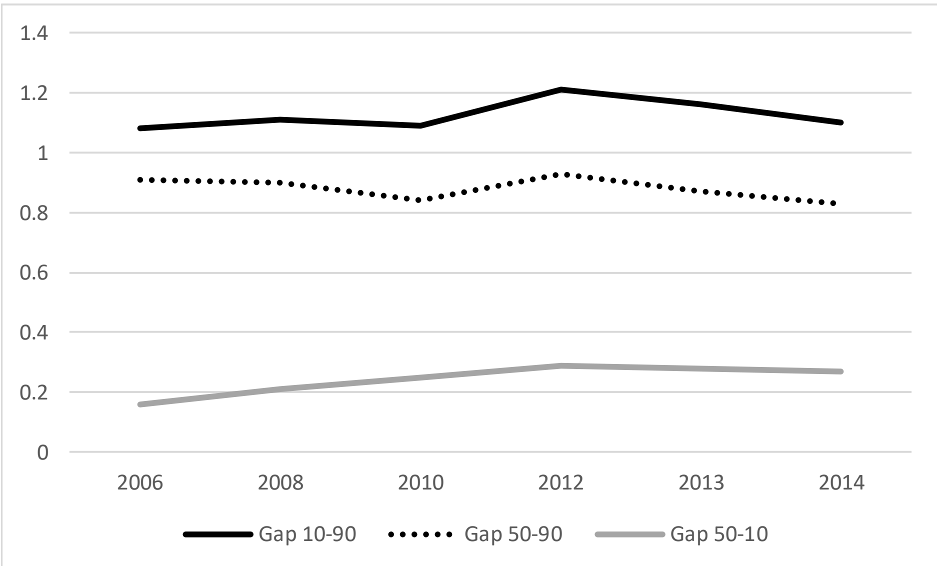


Figure 1.7 Socioeconomic gap in math achievement by income deciles 2006-2014, 10th grade. *Source: Quality of Education Agency (2015), Chilean Government.*

[1] In 2008, the subsidy initially targeted students in 4th grade; the following year it targeted students from both 4th and 5th grade and so on, until reaching regime status for primary education in 2012.

According to international examinations, and when compared to other OECD countries, Chile still has high levels of inequality in educational results, even within the Latin American context (see Figure 1.8). For example, when examining educational results and their association with student socioeconomic status in PISA 2012, Chile was among the most unequal countries in the examination: it ranked second among 65 countries in the strength of the association between student performance and family socioeconomic status in math[2] (OECD, 2013a). Not only are socioeconomic gaps marked and persistent over time, but gender gaps are also present in several subjects.

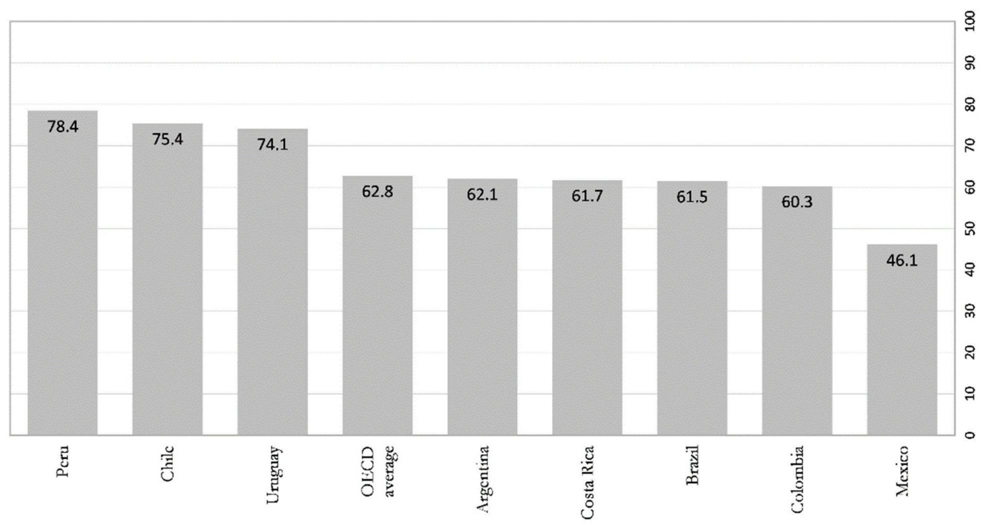


Figure 1.8 Socioeconomic inequality in math achievement for Latin American countries (PISA 2012). *Percentage of between-school variance in student performance explained by the PISA index of economic, social and cultural status of schools. Source: Extract from OECD, PISA 2012 Database, Table II.2.9a.*

Tertiary education

Even though, in the last two decades, access to higher education has increased exponentially, important questions have arisen concerning the quality and pertinence of this educational supply. Although direct comparable measures for quality of educational services are not available across institutions in the Chilean higher education system, highly

[2] Percentage of variation in student performance explained by the PISA index of economic, social and cultural status (ESCS).

important observed differences exist between institutions usually serving students from different socioeconomic backgrounds (DIPRES, 2016). These range from selectivity and expected future incomes for their graduates to drop-outs, quality of teaching, research levels and graduation rates (MINEDUC, 2013; Mizala & Lara, 2013; Muñoz & Blanco, 2013; Torres & Zenteno, 2011). In 2013, the OECD prepared a special report on the Chilean higher education system (OECD, 2013b), which pointed out the necessity of ensuring minimum standards for all new and existing academic programmes and institutions, especially those accessing public funding. In most cases, relatively new institutions – especially those offering technical degrees – currently serve more deprived sectors of the population, which could not access tertiary studies in the past (DIPRES, 2016). The necessity of improved quality assurance systems in higher education is, today, a matter of great national importance. It is, moreover, the subject of ongoing debate, as a new bill including regulations to the current quality assurance system for higher education is under preparation (Congreso Nacional, 2017).

1.5 What are the likely sources of educational inequalities in Chile?

Although it is important to acknowledge the current situation in terms of inequality of educational outcomes in the Chilean education system and the challenges for the following years in terms of access, permanence and quality of education in all educational levels, many questions persist regarding the likely drivers of educational inequality in the Chilean context. It is also important to ask whether these inequalities are mostly a result of structural conditions in the Chilean society, if they can be addressed through reforms of the educational system, and what sort of reforms would be more effective in levelling educational opportunities for those who are disadvantaged.

From a theoretical perspective, the existing literature on the economics of education usually signals education outcomes – and among them inequality in outcomes – as a product of several inputs associated with students and their families, economic and human resources, and institutional and organizational settings. In practice, most studies use a so called educational production function framework[3] to model student outcomes, in which their specifications commonly include student and family inputs (usually

[3] For a discussion of educational production functions specifications see Hanushek (1979, 2008), and Todd and Wolpin (2003).

associated with family resources and human capital), school inputs (including teaching quality and material resources, among others), and country-level inputs, usually signalled as country specific characteristics (such as educational expenditure, school competition, teacher recruitment policies, etc.). Within this framework, I decided to focus on those elements that the literature usually refers to as the main drivers of educational outcomes (especially learning achievement and length of schooling). Later on, I will discuss how these drivers of students' learning achievement and schooling attainment might be related to educational inequality.

1.5.1 Determinants of learning achievement

Student and family inputs

Previous literature has shown that student and family socioeconomic status is one of the main drivers of educational inequality. Sirin (2005), in a meta-analysis from the US incorporating information from 58 different studies, found a moderate association between student socioeconomic status (SES) and educational achievement, and a strong association between measures of school SES and academic performance. TIMSS and PISA international studies have also shown an important association between student socioeconomic status and inequality in achievement (see Woessmann, 2004), although there are large differences in the importance of this association across countries in both studies. As previously mentioned, for the Chilean case, this association is bigger than in most countries. As Sirin (2005) and other international studies show (OECD, 2013a), the largest proportion of this gap is explained by unequal access to learning resources at home and by parental educational and occupational levels, usually also reflected in parents' increased schooling expectations about their children and in students' prior higher cognitive ability, increased motivation for studies and higher cultural capital. It is worth noting though, that different educational systems show different levels of association between these elements and academic achievement. For instance, in Korea, Singapore or Finland, parental occupational status is much less important in explaining academic achievement than in Romania, Germany or the United Kingdom (OECD, 2013a).

School inputs

Several studies in the field of educational effectiveness have addressed the importance of different school characteristics in explaining educational outcomes and their distribution among students. Among many other topics, international research has focused on studying the association between learning achievement and school factors such as school climate, school socioeconomic composition, class characteristics, school leadership, availability of learning resources at home and parental involvement, teaching strategies, teaching practices and their effectiveness.

Although there is vast literature for each of these topics in the field of educational effectiveness, a previous study by Hattie (2008) summarizing information from about 800 meta-analyses on educational effectiveness identifies six main factors affecting academic achievement: the child, the home, the school, the curricula, the teacher and the approaches to teaching. Among those factors related to schools, he included the climate of the classroom, for example welcoming errors and providing a safe, caring environment, and peer influences. Among the factors related to the teacher, he counts the quality of teaching – as perceived by students, teacher expectations, classroom climate management, a focus on teaching clarity, the fostering of effort and the engagement of all students. With regard to teaching approaches, Hattie (2008) finds, among other drivers of student achievement, that teachers who set challenging tasks providing multiple opportunities for students' deliberate practice, who understand the importance of teaching appropriate learning practices, who plan and talk about teaching and ask for feedback from their students tend to be more effective. The literature on teaching practices and their association with teacher effectiveness is immensely rich; however, at the same time, when compared to measures of teacher effects on value-added models, observed teaching practices and strategies still fail to explain an important proportion of the variation on teacher effects across schools and classrooms (see, for instance Kane, Rockoff & Staiger, 2008; Kane & Staiger, 2008).

Another strand of the literature, mostly from economics, has focused on how material educational resources, teachers and their working conditions and sociodemographic characteristics could explain students' achievement. A widely-cited study from the US by Hanushek (1997) comprising information from around 90 different studies, showed that school and class characteristics, such as teacher-pupil ratio and expenditure per student (conditional on the student's household characteristics) had a positive association with student achievement. It also found that teachers' characteristics, such as teacher education, working experience and content knowledge or cognitive skills exams' results also had explanatory value. Those studies containing specifications based on value-added modelling showed consistent results for most cases. After this study, several works in economics have attempted to recover casual estimates on the effect of specific class and school-level resources, such as class-size or expenditure per pupil, and student achievement (Angrist & Lavy, 1999; Card & Krueger, 1992; Jackson, Johnson & Persico, 2015). Although some controversy has surrounded the discussion about the effect of these policies on school education and their cost-effectiveness implications (Hanushek, 2003; Heckman & Carneiro, 2003), there is some agreement on the importance of school resources explaining educational improvement, schooling attainment and economic outcomes. Moreover, these and other studies have shown that the effect of such policy interventions at pre-school and early school stages usually have a greater positive effect on low-SES students and therefore could somehow equalize opportunities in later stages of life (Heckman & Carneiro, 2003; Card & Krueger, 1992; Jackson, Johnson & Persico, 2015).

Although evidence for the Chilean case is much more limited, two crucial school inputs have been analysed in previous studies: class size and school day length. A recent study by García-Gonzalez (2015) found a positive effect of class size on achievement for 4th and 6th graders. Using an instrumental variables approach, he found that a reduction in class size of 10 students could account for up to 10% of a standard deviation in standardized test scores in math. Another study by Bellei (2009), related to the implementation of a full-day schooling policy, found additional 10% of a standard deviation for students in 4th grade.

With regard to teaching practices and their association with student achievement, Carrasco (2014) found a positive association between content knowledge and pedagogical skills and students' achievement gains. He did not find heterogeneous effects according to student SES in most specifications; however, he found systematic differences in the National Evaluation of Public School Teachers results – also associated with higher test scores across schools – in favour of better-off schools, implying teachers could be increasing inequality in outcomes.

Institutional policies and school system characteristics

Policies designed and implemented by central and regional governments or other supra-school organizations are shown to have an important impact, not only on educational outcomes, but also on schools' social composition. School system characteristics such as school accountability, school funding structure, school choice, school autonomy, school competition, student selection policies, student ability grouping, national curriculum, teacher incentives, teaching professional careers and teacher development plans are usually designed in a centralized way. Previous studies have found that school system characteristics, such as school tracking or school autonomy have a direct impact on inequality of educational results (Hanushek & Woessmann, 2006; Pekkala Kerr, Pekkarinen, Uusitalo, 2013; Braga, Chechi & Meschi, 2013; Hanushek, Link & Woessmann, 2013). In a recent study using PIRLS and PISA data, Amermueller (2013) found a positive association between increased school autonomy and bigger inequality in educational results by family SES. The same study also found an association between a bigger proportion of students in private schools and higher inequality in results. Moreover, country case studies examining the association between higher selectivity at schools (admission mechanisms), competition amongst schools, social segregation and educational outcomes also provide evidence of increased inequality in results when these practices are present (Burgess, Propper & Wilson, 2007; Jenkins, Micklewright & Schnepf, 2008; OECD, 2013a). Additionally, similar studies have analysed the role that school accountability could be playing in explaining educational outcomes. These studies reach dissimilar conclusions (Burgess et al., 2005; Jacob, 2005).

For the Chilean case and as previously mentioned, studies by Carrasco et al. (2015) and Correa et al. (2014) found a positive impact of additional spending per pupil and academic achievement on low income students. Figures, in this regard, showed a size effect of around 0.2 additional standard deviations in math scores after 4 years under the subsidy. Carrasco et al. (2015) found that the effect of this subsidy was even greater for the most vulnerable students within the schools under the subsidy scheme, implying a reduction in the socioeconomic achievement gap. Although the evidence concerning the effect of the vocational track on education outcomes is limited, a previous study by Farías (2013) found that the achievement gap could be as big as 0.3 standard deviations in math and 0.2 standard deviations in language at the end of secondary school. Moreover, a study by Contreras, Sepúlveda & Bustos (2010) found a difference of around 7% on average student results in favour of students attending primary schools that select students based on previous ability, raising questions about inequality in outcomes based on student selection and school tracking.

Since Chilean educational institutions have been under important reforms during the last years, the effect of institutional characteristics on inequality of educational opportunities is a topic of special interest for the Chilean case. I partially address this issue by studying the effects of school accountability practices in educational outcomes in an international context in the third empirical chapter of the present thesis.

1.5.2 Determinants of length of schooling

As previously mentioned, and when analysing the factors explaining school drop-outs, especially in secondary education, and the determinants of students' access to higher education (one of the subjects to be studied in the present thesis), as well as persistence in higher education, the current evidence points towards academic achievement as a main driver. Both Chilean and international studies show an important association between previous academic performance and lower chances of school drop-outs and higher probabilities of continuation of studies (mostly explained by performance in pre-school and school education. See, for instance, Heckman & Carneiro, 2003).

Among other determinants discussed in the literature, linked to student characteristics and their families, we can find: student gender and ethnicity, family SES and composition, parental education, job status, students' self-expectations and motivation, etc. Amid those factors usually associated with schools, we find, among others: school type and location, parental engagement at school, school academic performance, students' school absences, school climate, school leadership, school social composition and peer effects (see Ross et al., 2012 and Acuña, Makovec & Mizala, 2010 for the Chilean case).

On a different topic, and as a matter of special interest in economics of education, previous studies have also looked at the role that governmental funding policies could play in explaining differences in access and persistence in higher education. Previous international studies have found evidence of credit constrains affecting access to higher education for lower SES students (Dearden, Fitzsimons & Wyness, 2014). Similar evidence has also been presented in prior studies for the Chilean case (see for instance Rau, Rojas & Urzua, 2013 or Santelices et al., 2016).

1.6 Conclusions and motivation for the next chapters

This chapter outlined an extensive number of possible drivers of inequality in achievement in the Chilean context. The list is varied and it touches on several dimensions. At the same time, evidence about the different drivers of inequality of educational opportunity is scarce for the Chilean case, especially with regard to topics such as early childhood education, school leadership, school climate, peer effects, teacher effectiveness, teaching practices, school drop-outs and access and persistence in higher education. Moreover, apart from the continuous discussion on the effectiveness and efficiency of voucher schools versus public schools and the evaluation of new funding schemes and incentives, very few other institutional characteristics have been assessed with regard to their impact on educational inequality in Chile. A recent school reform has increased accountability systems and autonomy in decision making at schools; it has also improved support from the central government concerning activities at subsidized schools, through the national Education Quality Agency. Also, improved supervision in the use of financial resources and compliance with regulations is being performed by the recently launched Superintendence of Education.

In this thesis, I investigate some of the likely drivers of inequality of educational opportunity in the Chilean context. In the next three empirical chapters, I aim to contribute to this strand of the literature by addressing three topics of great importance in the Chilean context: teacher effectiveness, access to higher education and school accountability.

In Chapter 2, I study how teacher effectiveness could be contributing to educational inequality in Chilean secondary schools. I follow a full cohort of students in lower secondary schools to estimate teacher effects and their distribution across schools from different SES. By using a value-added model, I examine the socioeconomic gap in teacher effectiveness across Chilean secondary schools and its importance in explaining socioeconomic inequality in students' achievement in math and language. I found an important proportion of highly effective teachers in low SES schools, but also much bigger variation in teacher effectiveness across those schools. Variability in teacher effectiveness decreases when moving towards higher SES schools, where there is also a smaller proportion of low-performing teachers. All in all, differences in teacher effectiveness have a levelling impact for students in low SES schools when compared to those in middle SES schools, but no significant impact when compared to students in high SES schools.

In Chapter 3, I explore the likely determinants of inequality in access to higher education in the Chilean context. More specifically, I assess the importance of school quality and other institutional factors explaining students' access to higher education, with an emphasis on those students from disadvantaged backgrounds. I make use of administrative data to follow a cohort of around 270,000 students from the end of primary education to higher education, developing a stratified analysis for around 2,400 schools from 5 defined school SES. My results show that students attending high performing secondary schools are much more likely to attend higher education even after taking into account their past achievement in primary schools. Interestingly, I find no important association between class size or school type and higher chances of entering tertiary studies after controlling for academic achievement in secondary education. On the other hand, those students taking the vocational track are less likely to continue with further studies in low SES schools when compared to their peers taking the academic track. I also found that students from low SES schools are especially sensitive to access to public funding. Those eligible for public funds are much more likely to attend higher education in those schools. All in all, secondary schools make a big difference for lower and lower-middle SES students, as opposed to those from better off backgrounds who are disproportionately more likely to attend higher education, despite their individual academic performance and school characteristics.

In Chapter 4, I attempt to expand the understanding of school accountability and draw lessons for the Chilean case, by studying a set of school practices usually present in school accountability systems and their effects on educational outcomes for the subject of math. I make use of available data for 65 countries in several PISA applications (2000-2012), setting up a panel dataset to exploit variation in school accountability practices within countries over time. I focus on identifying which accountability practices could be increasing (or decreasing) average academic achievement and inequality in educational results at schools. I found a positive impact of posting academic achievement data publicly in inequality in outcomes and no gains in average achievement. My results also suggest that schools' internal use of students' academic results for benchmarking purposes improves average performance and reduces inequality in students' outcomes. My results are mostly robust to different specifications. I found important differences in my results when comparing them to cross-sectional estimates, usually found in the international literature.

Finally, Chapter 5 summarizes the main findings of this thesis and outlines its policy implications. In this chapter I also discuss the overarching conclusions and recommendations that can be drawn after revising both the current state of the Chilean system, in terms of inequality of educational opportunity, and the additional evidence provided by the present study.

Chapter 2

Teacher Effects and Inequality of Educational Opportunity in Chile

2.1 Introduction

Although there is extensive evidence about the importance of teachers in students' academic results, little is known about their relevance in explaining the socioeconomic gap in student achievement. Previous empirical studies from the US, about the gap in academic achievement between lower and higher income students, show such difference could be as big as 1.2 standard deviations in standardized test scores (between students from percentiles 10 and 90 in family income distribution; see Reardon, 2011). According to the Organization for Economic Cooperation and Development (OECD) reports, 1 additional standard deviation in the Programme for International Student Assessment (PISA) examination – around 100 point – is equivalent to 3 years of schooling in upper secondary education (OECD, 2010a). This enormous gap in achievement deeply influences opportunities in life, leading to lower educational attainment and earnings for low-achieving students, usually from more disadvantaged backgrounds (Blundell, Dearden, Goodman & Reed, 2000; Card, 1999; Grossman, 2008; Hanushek & Woesmann, 2012; Heckman, Humphries, Urzua & Veramendi, 2010).

In many countries, income inequality and equality of educational opportunity are at the heart of today's education policy concerns; therefore, it is crucial to analyse the role teachers play in contributing (or not) to equalizing opportunities for those who are worse off. Even though it has been reported that most of the differences in achievement are mainly driven by home and parental characteristics, within school-level determinants, teachers play the most important role impacting students' academic performance (Aaronson, Barrow & Sander, 2007; Chetty, Friedman & Rockoff, 2013; Kane & Staiger, 2008; Rivkin, Hanushek, & Kain, 2005; Rockoff, 2004). Usually, by means of value-added models, studies on teacher effectiveness estimate the single contribution of teachers to students' progress. Although the evidence from the existing value-added literature varies, the additional contribution to students' achievement gains made by a teacher one standard deviation above an average teacher, usually fluctuates between 0.1 and 0.2 standard deviations on student test scores after one year of schooling (for both math and English; see Nye, Konstantopoulos & Hedges, 2004; Slater, Davies, & Burgess, 2012).

In this context, there is extensive literature on the differences in observable characteristics between teachers serving lower and higher income students, as well as on the difficulties of recruiting and retaining teachers in most vulnerable schools, usually showing low academic performance. Hanushek, Kain & Rivkin (2004) found that higher teacher turn-over rates were higher in schools showing poor academic results. Goldhaber, Choi & Cramer (2007) found that teachers in better-off schools tend to show better academic credentials. Lankford, Loeb & Wyckoff (2002) conclude that low-achieving students and low income students attend schools with less experienced teachers, showing worse results in licensure examinations. In the Chilean context, Meckes & Bascopé (2010) found a strong relation between schools' lower socioeconomic status and teachers' poor performance in content knowledge examinations. Additionally, Ortuzar, Flores, Milesi & Cox (2009) show that teachers attending weaker training programmes (semi-presencial or by distance) presented lower results in the Chilean National Teacher Evaluation. At the same time, those teachers were more likely to teach in low achieving schools. Finally, Rivero (2013) finds less qualified teachers tend to be employed in schools with low-income and low-performance students.

Even though the latest evidence could imply that on average teaching is more effective in more affluent schools, this hypothesis has almost not been directly addressed. In fact, there is little research on teacher effectiveness and its relationship with schools' socioeconomic status. Additionally, and if teaching is actually more effective in higher income schools, it is not clear how important this gap in teacher effects would be in explaining the socioeconomic gap in raw measures of educational achievement. Exceptions to this research void are recent works by Sass, Hannaway, Xu, Figlio & Feng (2012), Isenberg et al. (2013) and Mansfield (2015).

By using data for primary school students (3rd to 5th graders) from two states in the US (North Carolina and Florida), Sass et al. (2012) report small differences on average teacher effectiveness between higher and lower socioeconomic status schools in favour of the most affluent schools. However, according to their research, differences would be modest (around 1 to 4% of a standard deviation in student test scores on average, reporting higher variation for teacher effectiveness in math). At the same time, they show that the socioeconomic gap becomes bigger for low achieving teachers: the difference in teacher effectiveness between the lowest performing teachers in higher versus lower poverty schools in math could be as big as 6% of a standard deviation in favour of the former. Furthermore, they find that high-performing teachers are equally or even more effective in low SES schools in math, and only slightly better performing in reading. In a similar fashion, Isenberg et al. (2013) find similar average results, although with important variation across school districts.

On the other hand, using North Carolina state data, Mansfield (2015) reports 9% of total variation in student test scores between schools (as opposed to within-schools), mainly explained by student sorting based on sociodemographic characteristics, whereas only about 1% of such variation could be explained by school quality or teacher quality. He also finds that students with lower expected performance are more likely to attend schools with lower average teacher quality, but differences are modest. Finally, Nye et al. (2004) show higher variation in teacher quality within low-income schools, not accounting for teacher quality variation across schools.

Although the access to effective teaching as a research topic has not been directly addressed in Chile, there are three papers showing a relevant impact of teachers and schools on students' achievement respectively. In particular, Carrasco and Pérez (2013) estimate teacher effects for math in public Chilean secondary schools. Their results account for relevant teacher effects, similar to those found in the international literature. As their focus is the evaluation of a national teacher assessment programme only implemented in public schools, they do not estimate teacher effects in voucher and private schools, which account for around 55% of all schools in 10th grade, serving students usually from middle and higher SES backgrounds. Using a different methodological approach, and for a similar sample of teachers in public schools using the same data, Taut et al. (2016) reach a similar conclusion. On the other hand, Manzi, San Martin & Van Bellegem (2014) find, through random effects estimates, non-negligible differences in school effects for different types of secondary schools (public, voucher and private) usually serving students from dissimilar social backgrounds. They find higher variation in school effects between schools from lower SES, implying less homogeneous school quality than in better off schools. Nonetheless, they do not directly address teacher effects estimation.

To the best of our knowledge, this is one of the very first studies analysing the impact of the distribution of teacher effectiveness and its relationship with education inequality in a developing country. It is also the first study reporting the impact of teacher effectiveness for all types of secondary schools in Chile.

In this context, the aim of this paper is to identify whether and to what extent teacher effectiveness varies across Chilean schools, and if such inequality exists, to examine its significance by comparing it with the raw socioeconomic gap on students' attainment in 10th grade for the subjects of math and language. The chapter proceeds as follows: in the second part we provide a short description of the Chilean school system, as well as of its teachers' labour market. Then we describe the data and sample used and provide descriptive statistics on the school socioeconomic status definition we use in our analysis. Later on we explain the methodology we used in order to estimate the impact of teacher effectiveness, and the techniques utilized to analyse the socioeconomic gap in teacher effectiveness, as well as the variation in teacher effectiveness. In the following section, we present our main results. The next part details a sensitivity analysis. Then, we show the significance of teacher effectiveness in explaining socioeconomic inequality in educational results. Finally, we report our conclusions and policy implications.

2.2 The Chilean school system

The Chilean primary and secondary education system is mainly composed of state and private subsidized schools (voucher schools), accounting for 42% and 51% of 2012 enrolment respectively (MINEDUC, 2012). Private unsubsidized schools account for the remaining 7%. Teachers are distributed in similar proportions: 45%, 46% and 9% respectively. Municipalities are in charge of administrating public schools. Foundation-run schools, religious schools and also for-profit schools make up the private subsidized sector. All state schools remain free (i.e. state subsidized). On the contrary, since 1994, an important proportion of private subsidized schools receive an additional contribution to the public subsidy from students' parents (even though there are many free of tuition schools as well). This financing policy has had many implications in terms of schools' social composition (high social segregation) and students' educational results (Valenzuela, Bellei & De los Ríos, 2013). Financing to state schools mainly depends on attendance rates, as well as on enrolment levels. Additionally, and until 2008, private subsidized schools were legally allowed to select their own students.

2.2.1 Teachers' labour market

Chilean teachers' salaries are heavily regulated by the government in all types of schools. Teachers from subsidized schools are not directly paid by the state, but there is a common minimum hourly wage, by subject and teaching levels for all teachers applying to all schools. For public schools there is a rigid salary structure; minimum wage increases with job experience and training courses. There is also a small school-level bonus, linked to school performance in standardized tests, affecting equally all teachers from the same school. Given their more flexible structure, both voucher and private unsubsidized schools present higher variation across schools in teachers' salaries; nonetheless, voucher schools present average salaries similar to public schools. In private unsubsidized schools, salaries are slightly higher (Centro Microdatos, 2008).

At the same time, the Chilean state has no direct control in the provision of teaching credentials. There are no additional requirements for teachers to teach in Chilean schools after finishing their undergraduate studies, and accredited higher education institutions are free to grant teaching professional titles. The state, moreover, does not directly manage teachers' recruitment policies for public schools, since they are run in a decentralized way by municipalities. Teachers are recruited independently by each school administration body; this applies for private, voucher and also public schools. There are no regulations, hiring policies or guidelines concerning teachers' specific requirements other than holding an academic degree from a recognized higher education institution suitable for the related grade and subject.

2.3 Data and methods

Our analysis is based on merged data from four main sources. Firstly, we use data from the Chilean Educational Quality Measurement System (SIMCE) examination, taken by most students from all types of schools. SIMCE is a standardized test based on item response theory, administrated by the Chilean Ministry of Education since 1988. SIMCE is a high-stakes test, as the Chilean Government uses its results to inform a reward system based on school-level performance (SNED), which affects teachers' pay in a moderate way. It also informs parental decisions for school choice, in a school system where school funding is mostly based on the number of students attending each school. SIMCE has been applied to most students nationwide since 1998, to different cohorts of students at different grades. There is an important number of research studies using data from this national examination[4]. Specifically for our study, we use SIMCE test scores in two subjects (math and language) for one single cohort. We measure the same students when they finish primary education (end of 8th grade) and at the end of 10th grade (in years 2004 and 2006 respectively).

4 See, for instance, Mizala & Torche, 2012; Schneider, Elacqua & Buckley, 2006; Mizala, Romaguera & Urquiola, 2007; McEwan, 2001.

Second, we utilize teacher and students' annual enrolment administrative databases, also managed by the Ministry of Education. This rich information allows us to match teachers to schools, classrooms and students. As we are interested in studying the schooling process between the end of grades 8 and 10 (the first two years of secondary school), we make use of this administrative data for 9^{th} and 10^{th} grade, in years 2005 and 2006 respectively. These databases also provide us with some information about students, such as their gender, age, type of class (academic or vocational) or school they attend.

Third, we accessed datasets with parents' and students' sociodemographic information for most pupils sitting the tests in 10^{th} grade, including their parents' educational level (as years of schooling), family income, school parental fees, number of books at home (as a proxy for family cultural capital), parents' expectations on students' highest educational attainment, and students' pre-school education. This data was gathered as part of the SIMCE examination, by means of a voluntary survey applied to students' parents. Response levels for this survey were about 80% in 2006 for 10^{th} graders. Additionally, by using the individual-level data available by means of these datasets, we constructed some class and school-level measures, such as class size, school average family income and average parental fees, or school selection policies. Finally, we included some basic school-level information in the analysis, available from the datasets mentioned above. Among other information, we included: school socioeconomic status according to the Chilean SIMCE classification (see below), type of school (public, voucher or private) and school enrolment.

2.3.1 Schools' socioeconomic status definition

In order to produce a measure of school socioeconomic status (SES) to report SIMCE test results, the Chilean state categorizes schools in 5 different groups (SES A to SES E, A being the lower and E the higher income SES). This classification is based on a cluster analysis using three key standardized measures for the schools under examination: school average parents' educational level (based on parents' education measured in years, separately), school average monthly family income (self reported), and school vulnerability index, as annually informed by the body in charge of administrating free school meals nationwide (JUNAEB). The school vulnerability index is constructed on an aggregated measure of the proportion of priority students at each school for the corresponding grade and year[5].

Some descriptive statistics for the constructed school SES for all SIMCE takers in 10th grade for the corresponding year can be found in Table 2.1. Secondary schools are unevenly distributed across them; 47% of schools are among the 2 lowest SES (lower and lower-middle SES), whereas 29% are between the 2 highest SES (upper-middle SES and higher SES). As expected, students' average test scores are much lower and variable in schools within the lowest SES. Raw differences show on average the achievement gap between the highest and lowest SES schools is as big as 1.4 standard deviations in student test scores at 10th grade for both math and language. In general, dispersion on parents' educational level is small within schools for each defined SES, as well as income variation, especially for the lower income groups (lower and lower-middle SES schools). In terms of school property, public schools are also concentrated among those two groups. On the other hand, and as expected, private schools are allocated within the highest income SES, and voucher schools are mostly distributed within low and middle SES schools. Interestingly, but not surprisingly, the higher the schools' SES, the greater the number of schools selecting students by means of written examinations. Table 2.1 also reports the amount of teachers per school SES.

[5] Each student's priority status is based on family risk factors associated with school dropout, such as students' geographical zone, family poverty condition, mothers' education and medical care type.

Table 2.1 School's descriptive statistics by school socioeconomic status. All SIMCE takers in 10th grade

	All Schools			Lower SES Schools (SES A)			Lower-Middle SES Schools (SES B)			Middle SES Schools (SES C)			Upper-Middle SES Schools (SES D)			Upper SES Schools (SES E)		
School Level Descriptive Statistics	*N*	Mean	*SD*	*N*	Mean	*SD*	*N*	Mean	*SD*	*N*	Mean	*SD*	*N*	Mean	*SD*	*N*	Mean	*SD*
Students' average score in Math test 2006	2,428	258.7	40.2	474	221.2	18.6	666	236.7	25.1	576	262.9	27.1	382	289.9	27.6	330	313.5	28.3
Students' average score in Math test 2004	2,422	262.7	31.9	473	232.3	14.2	665	244.8	17.8	574	266.2	20.0	381	287.2	22.7	329	308.3	22.3
Students' average score in Language test 2006	2,428	259.4	31.4	474	227.8	14.2	666	241.7	19.3	576	266.0	20.5	382	284.3	20.2	330	300.3	21.3
Students' average score in Language test 2004	2,422	261.5	30.0	473	231.0	15.5	665	244.6	18.4	574	268.6	18.9	381	285.1	19.3	329	299.5	20.8
Students' gender male	2,428	50%	21%	474	52%	18%	666	51%	23%	576	46%	21%	382	49%	21%	330	50%	23%
Students' age (in years)	2,428	15.4	1.5	474	15.6	0.3	666	15.5	2.9	576	15.3	0.3	382	15.3	0.3	330	15.4	0.4
Average mother's education (in years)	2,407	11.6	2.8	465	7.9	1.1	663	9.9	0.8	569	12.2	0.9	382	14.2	0.8	328	15.9	0.8
Average father's education (in years)	2,407	11.8	3.0	465	8.0	1.2	663	10.0	0.9	569	12.3	0.9	382	14.5	0.8	328	16.5	0.7
Students' average number of books at home	2,402	49.0	17.1	464	27.6	8.3	663	40.4	8.3	568	53.5	8.0	381	62.8	7.8	326	73.4	9.3
Students' average monthly family income (usd)	2,405	865	798	464	274	171	663	388	86	569	654	174	381	1,225	320	328	2,614	450
Students' average monthly parental fees (usd)	2,406	47.6	57.7	465	7.3	5.6	663	12.9	9.9	569	30.4	18.6	381	77.1	38.9	328	170.8	19.6
School type public	2,428	31%	46%	474	65%	48%	666	51%	50%	576	14%	35%	382	4%	19%	330	0%	0%
School type private subsidized (voucher school)	2,428	54%	50%	474	35%	48%	666	48%	50%	576	86%	35%	382	81%	39%	330	5%	22%
School type private unsubsidized	2,428	15%	36%	474	0%	0%	666	0%	5%	576	0%	4%	382	15%	36%	330	95%	22%
School average enrolment in Secondary Level	2,428	426.5	408.9	474	422.0	348.0	666	636.7	486.0	576	416.6	417.8	382	271.5	277.0	330	205.3	146.3
School average class size in 10th grade	2,428	34.2	8.6	474	34.7	7.7	666	37.4	6.7	576	36.4	7.3	382	32.2	9.3	330	25.1	8.0
School number of classes in 10th grade	2,428	3.1	2.5	474	3.1	2.2	666	4.3	3.0	576	2.9	2.5	382	2.1	1.6	330	2.0	1.1
School proportion of students in 10th level who attended pre-school education	2,426	72%	18%	473	53%	21%	666	72%	14%	575	78%	13%	382	79%	12%	330	81%	14%
School proportion of students in 10th level who repeated once or more	2,405	21%	17%	463	32%	14%	663	25%	16%	569	17%	15%	382	15%	16%	328	14%	18%
School proportion of students in 10th level in academic course (not vocational)	2,428	80%	39%	474	60%	47%	666	62%	47%	576	92%	26%	382	100%	0%	330	100%	0%
School proportion of parents who declare school selects students	2,167	47%	31%	321	25%	27%	609	37%	31%	544	49%	29%	370	59%	27%	323	69%	21%
Teachers																		
Math teachers	3,910			745			1,323			885			498			459		
Math teachers 2005-2006 (teaching same students in 9th and 10th grade)	2,370			468			837			519			300			246		
Language teachers	4,013			780			1,374			896			506			457		
Language teachers 2005-2006 (teaching same students in 9th and 10th grade)	2,552			556			903			578			294			221		

2.3.2 Estimation sample

We use students' test scores for all students taking math and/or language SIMCE examinations in both 8^{th} and 10^{th} grade for 2004 and 2006 respectively. According to SIMCE official reports, the test was taken by 256,040 students in 10^{th} grade, corresponding to 93% of national enrolment for that level (MINEDUC, 2007). From those students, after the merging process, we recovered test scores for at least one subject for 238,310 students, corresponding to 93% of all test takers. As we only included students for which we have prior scores in the 8^{th} grade in 2004, our final sample consists of 191,432 students (around 75% of all students sitting the test in 2006) and 7,591 teachers (3,746 teaching math and 3,845 language) distributed in 2,292 schools nationwide. From these schools, 31% are public schools, 54% are voucher schools and the remaining 15% are private unsubsidized schools; 93% of these schools are placed in urban areas. We decided not to drop cases with no information or partial information on student and family socio-demographic characteristics, imputing missing values to a constant (zero); we included in our model an indicator dummy for each variable, taking the value 1 when the value on that variable for the observation was missing.

As detailed in Appendix 2A (Table 2A1), the differences in observed characteristics (parental education, family income, etc.) between the estimation sample and all 10^{th} grade SIMCE takers are not particularly relevant. Nonetheless, on average, students in the sample have slightly more educated and better paid parents. Moreover, these students show better scores in SIMCE 2006 examination (around 8-9% of a standard deviation). Finally, and as expected, students in the sample showed lower repetition records than average in previous grades, as they were measured two years before, in 8^{th} grade.

Since we chose to include all students sitting the test in the 8^{th} and 10^{th} grade (in order to have two observations per pupil), we also decided to keep the whole sample of teachers, including those teaching the same students for one or two years (9^{th} grade and/or 10^{th} grade). In our sensitivity analysis section, we detail and specify different estimation samples to test the implied assumptions.

2.3.3 Methods

Our estimation approach is based on four main steps: first, we estimate teacher effects by means of teacher value-added models. Second, and through regression techniques, we use those measures to estimate the existing average socioeconomic gap on teacher value-added across schools, according to their SES classification. With this analysis we also find some class and school level characteristics associated with higher teacher effectiveness in schools. Third, we estimate a quantile regression using the same model, in order to evaluate any differences in this gap at different parts of the teacher effects estimated distribution, specifically for high and low performing teachers. Finally, and to check for some of our models' assumptions, we re-run the same models utilizing different student and teacher samples.

Teacher value-added estimation

To estimate the contribution of teachers on students' achievement gains, we assume teachers' contributions as part of an educational production function. In this case, we follow one of Sass, Semykina & Harris' (2014) specifications, very similar to standard models broadly used in previous value-added literature. They suggest that students' gains in achievement are influenced by two main factors: school educational inputs, mainly conformed by teacher quality and classroom and school level inputs (such as peer effects, school climate, or teacher-student ratio), and individual and family factors, like students' innate ability, personal effort, motivation, availability of learning resources at home, tutoring, parental education and expectations about their children, etc.

In our research, we test several different value-added specifications to obtain estimates of teacher effectiveness, although all of them assume partial persistence of prior scores in future achievement measures. In particular, our models are based on teacher fixed effects estimation, where a dummy variable is placed for each teacher teaching a specific subject in one or more classrooms, in one or more schools. The model also includes school, classroom and student-level covariates, in order to account for student selection into schools and classrooms, as well as for other relevant inputs influencing students' achievement. Our preferred specification is as follows:

(1)

$$\mathrm{A_{ijkzmt}} = \beta_0 + \beta_1 \mathrm{A_{izt-1}} + \beta_2 \mathrm{S_m} + \beta_3 \mathrm{C_{jm}} + \beta_4 \mathrm{X_i} + \mathrm{T_k} + \mu_{\mathrm{ijkzmt}}$$

where, in equation 1, A_{ijkzmt} refers to achievement level in SIMCE test for student i, in subject z, attending class j, taught by teacher k, in school m, at time t. μ_{ijkzmt} is a random error which is assumed to have a mean of zero. S, C and X are vectors of school, classroom and individual characteristics respectively. T is the teacher average effect on her students which captures all common unobserved inputs shared by individuals under teacher k. Regressions are estimated separately per subject. The following table (Table 2.2) summarizes our selected teacher effects estimation models, where models a.4 and a.6 are our preferred specifications. In short, our six specifications vary from a model only including a dummy variable per each teacher in the sample (model a.1), to a model including individual, school and class-level controls (model a.4), to a final model including the latter, as well as measures of class average prior attainment and its dispersion (model a.6).

As in previous studies, our teacher effectiveness estimates are constructed to have a zero mean, so each teacher is compared to an average teacher teaching a student from the students' sample. We follow Sass et al. (2012), and shrink our teacher effectiveness estimates by using a standard Bayesian estimation method[6].

The shrinkage method assumes that values at the tails of the distribution of test scores are more prone to measurement error than those at the centre. This might imply that students who are at the top or bottom of the test scores' distribution should tend to have less accurately predicted test scores. Following this rational, and when estimating the final teacher value-added distribution, the shrinkage method gives less weight to those initial teacher value-added measures from teachers teaching a considerable number of students with test scores at the extremes of the distribution. The shrinkage method will proportionately shrink the value-added estimates of these teachers, according to their variance levels[7], reducing but not eliminating variation in the final teacher value-added distribution. The shrinkage is larger for those teachers with larger unshrunken estimates, and for teachers with more of the types of students who tend to produce large residuals in the value-added regression model. The shrunken teacher value-added distribution is therefore less subject to bias due to measurement error.

[6] Specifically, we use the so-called James-Stein estimator for our estimates of teacher effects using our original Ordinary Least Squares (OLS) estimates from the model (see Efron & Morris, 1973).

[7] As a teacher effect is roughly the average gain in learning for all students under the same teacher, in this case its variance level is a measure of the dispersion of the teacher value-added regression residuals for those students under that teacher.

Assuming that teacher effectiveness estimates based on fewer students are subject to bigger measurement error, we also decided to restrict our sample to those teachers teaching 10 or more students.

Table 2.2 Teacher effectiveness value-added estimation. Model specifications

	Model a.1	***Model a.2***	***Model a.3***	***Model a.4***	***Model a.5***	***Model a.6***
Teacher Fixed Effects	X	X	X	X	X	X
Student Level Controls*		X	X	X	X	X
School and Classroom Level Basic Controls **			X	X	X	X
School Socioeconomic Status Controls***				X		X
Class prior performance ***					X	X

Notes: *Student gender, age, parents' education, family income, school parental fees, student parent's schooling expectations about their child, number of books at home, student attended pre-school education, student repeated a course before 8th grade. ** School enrollment, school's student selection procedures, school rurality, single sex school, class size, school proportion of repeaters. *** School SIMCE SES classification (SES A to SES E), school type (public, private subsidized or private), school's proportion of students with pre-school education, student took school's academic or vocational track, class average family income, class average mother's education ****Class average prior score and standard deviation in both subjects, math and language.

The value-added models we use in the present study are not exempt from criticism. Several studies have shown that teacher effectiveness estimates from value-added models are subject to bias, and seem to be unstable over time for individual teachers, hence they are not suitable as a measure to assess, for instance, individual teachers' professional performance. As the international literature indicates, teacher value-added measures could be biased for several reasons: measurement error in the test scores used to produce them, non-random assignment of teachers to students, other school and classroom unobserved characteristics affecting all students under the same teacher, model misspecifications, etc. For more details on these issues refer to Baker et al., (2010), Rothstein (2009), Koedel, Mihaly & Rockoff (2015) and Lissitz & Jiao (2015). In the following sections we deal with most of these issues in more depth, especially in terms of data limitations and other likely sources of bias, performing several robustness checks trying to address some of these issues, when data permits.

Relationship between Teacher Quality and School Socioeconomic status

To assess the relationship between average teacher effectiveness and school socioeconomic status, we regress our teacher effectiveness estimates on class and school level covariates (including school SES classification). The estimated empirical model is as follows:

(2)

$$\widehat{T_k} = \lambda_0 + \lambda_1 S_m + \lambda_2 C_{jm} + \eta_k$$

In equation 2, T is our teacher effect estimate for teacher k, from equation 1. Again, the subscripts j, k, m represent class, teacher, and school respectively. Vectors S and C stand for school and class level variables. η_k is a random error, assumed to be normally distributed with zero mean. We ran separate regressions for both subjects acknowledging their different teacher effects distributions. In the interest of space, we only report results using our shrunken teacher effects estimates as the dependent variable; we also select teacher quality estimates based on our two preferred specifications (models a.4 and a.6).

In this case, our model specifications are three: a regression of teacher effects estimates on School SES, a second model adding other school and class covariates (such as enrolment, school rurality or class size), and a final specification incorporating school selectivity measures[8]. By adding those covariates, we seek to isolate the school SES effect from other possible confounders. At the same time, these regressions help us understand which specific variables associated with SES at school level are more strongly related to higher or lower teacher effects.

Finally, and to account for the fact that teacher effects distributions also vary by SES, we use the same model specifications to estimate a quantile regression for percentiles 10, 50 and 90 on our preferred teacher effects estimates. With this analysis, we explore systematic differences by SES on teacher effects for high and low performing teachers.

2.4 Data limitations and possible sources of bias

Non-random assignment of teachers to students

When estimating teacher effectiveness in value-added models, one of the main methodological concerns is the non-random assignment of students to teachers, schools or classes. Our model assumes that teachers' assignment to students is uncorrelated with

[8] Percentage of parents declaring that the school selects students based on written exams, and class standard deviation of prior test scores.

any other determinants of students' achievement gains after controlling for our value-added model covariates.

According to Rothstein (2009), if an important correlation between teacher effects estimates and pre-assignment variables (such as lagged scores) is found, there is evidence indicating that the exogeneity assumption of teacher effects does not hold. As he notes, teacher effect estimates could be capturing unobserved factors not necessarily associated with the teacher individual effect in achievement during the time-period under analysis. If that is the case, the estimated teacher effect can no longer be assumed to represent the teacher value-added, as the teacher effect would be endogenous by construction. Using data from the state of North Carolina, Rothstein shows that value added models (including those specifications using both student and teacher fixed effects), produce biased estimates for teacher effects. On the other hand, by using experimental data, Kane & Staiger (2008) show that standard value-added models are approximately good predictors of real teacher effects. Additionally, Chetty et al. (2013) using data from a large urban district in the U.S., observe that teacher effects on value-added models are not largely biased due to students sorting based on observables (parental characteristics) or unobservables.

We test different specifications for our teacher effects estimation, assessing the relationships between our estimates and student and class average lagged scores, also including the latter as a control. As we only have data for one cohort in two points in time, we cannot test for the endogeneity of lagged scores using, for example, student prior test scores as an instrumental variable. However, and as most students change schools between both examinations (around 70%, since many move from primary to secondary schools), teacher effects should not be endogenous for this reason, as there is no possibility that the teacher effect was partially captured in previous test scores. To test this, in the sensitivity analysis section we also estimated teacher effects for a sample including only those students who switched schools between both examinations (8^{th} and 10^{th} grade).

School and classroom versus teacher effects

A second important challenge when estimating teacher effects is our knowledge that their successful identification from other school-level and classroom-level factors is not straightforward. In fact, to do so we must be able to isolate such effects by means of school and classroom level controls and/or exogenous sources of variation (such as teachers teaching more than one school and/or classroom at the same time). The main risk is that we could be capturing some unobserved school or class-level effects, common to all students taught by the same teacher, in our teacher effects measures. For instance, if all students in a certain school are receiving special support from a certain social programme during the period under study, if not included in the model, the programme's contribution to students' achievement would be assimilated to be part of the teacher effect for all teachers teaching in that school.

Acknowledging this identification issue, many studies incorporate schools fixed effects in their specifications. However, by taking this kind of approach, teacher effect estimates no longer represent total teacher effects dispersion, but within-school teacher effects variation. In this work, this specific approach is discarded, as our focus is on between-school variation on teacher effects, rather than within-school variation. In relation to this specific issue and for our specific data, we have a comparatively small number of teachers teaching in more than one school, and a majority of teachers teaching more than one classroom at the same school during the same period, which helps us to strip out other classroom-level common effects from our estimates. However, in the case where a teacher had taught only one class during this period, we were not able to isolate teacher effects from other classroom-level effects. To control for such measures, we used several observable school and classroom level covariates to account for teacher selection by class or school, which could bias our teacher effect estimates.

School SES or other unobserved variables?

In equation 2 and when explaining the relationship between teacher effects and school SES, we assume that all other relevant variables related to teacher effectiveness also correlated with school SES have been accounted for in the model. Our methodological approach seeks to tackle this possible source of bias by including a set of school and class level controls (including class size, school enrolment, school selectivity, etc.). It also helps us understand how much of the variation of the estimated teacher effects is explained by these other factors.

2.5 Results

2.5.1 Teacher value-added estimates

Table 2.3 shows teacher value-added estimates for different specifications. A one standard deviation increase in teacher effectiveness contributes in around 0.15 and 0.2 standard deviations to student test scores for language and math respectively (for our preferred specification which is model a.6). Figure 2.1 illustrates the estimated teacher effectiveness distribution in both subjects for our preferred specification. Our preliminary results showed that, on average, our teacher effect estimates across the proposed models are similar, although the inclusion of class and school level controls decreases variation in teacher effect estimates notably.

Results per subject are in line with prior value-added studies, although variation in the estimated teacher effect is slightly bigger than in most of other related research from other countries using similar methods (see Nye et al., 2004; Isenberg et al., 2013). For teacher effects models with student, class and school covariates (models a.4 to a.6), teacher value-added variation estimates fluctuate between 0.21 to 0.24 and 0.15 to 0.18 standard deviations for math and language respectively. Interestingly, those models including class average prior score measures (a.5 and a.6) present teacher effects around 20% smaller on average. This striking result suggests teacher effects measures in value-added models not including class-level prior performance measures might be upwardly biased, overstating teacher value-added variation measures, by capturing unobserved common fixed characteristics to all individuals under the same teacher in the teacher fixed effect term.

Finally, our results in Table 2.3 also indicate that the difference between shrunken and non-shrunken estimates for teacher effect is not very important, but still non-negligible. The so-called average "shrinkage factor" in the Chilean case is close to 1. Most teachers taught in more than one classroom and, on average, each one taught as many as 50 students in total, with only around 10% of teachers teaching less than 20 students.

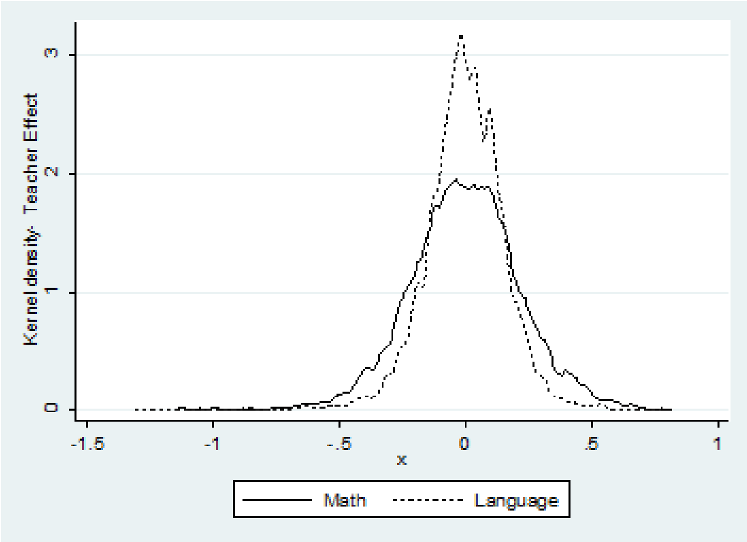


Figure 2.1. Estimated distribution in teacher effectiveness for Math and Language.

Table 2.3 Standard deviation of teacher effects and estimation sample. Math and Language.

	Model a.1	Model a.2	Model a.3	Model a.4	Model a.5	Model a.6
All Teachers						
Math						
Teacher effects Non-Shrunken	0.36	0.35	0.28	0.26	0.23	0.24
Teacher effects Shrunken	0.34	0.33	0.26	0.24	0.21	0.21
Language						
Teacher effects Non-Shrunken	0.30	0.29	0.24	0.21	0.19	0.19
Teacher effects Shrunken	0.27	0.26	0.20	0.18	0.15	0.15

Estimation Sample	***Math***	***Language***
Number of teachers	3,746	3,845
Observations	190,989	190,965
Average students per teacher	51.0	49.7
SD Average students per teacher	36.1	34.4
Min number of students per teacher	10	10
Max number of students per teacher	363	286
Average number of classes per teacher	1.9	1.8
Average Number of schools per teach	1.04	1.03

Our results are in line with previous studies which have shown that, in general, dispersion in teacher value-added measures is bigger for the subject of math when compared to language (Nye et al., 2004; Isenberg et al., 2013). In this case, the underlying hypothesis is that variation in teacher effectiveness between one teacher and another is larger for the case of math at this stage of the schooling process. In our data, this hypothesis is supported by the fact that, in the Chilean context, and for all schools, the dispersion in SIMCE test scores for the subject of math is much bigger than for the subject of language, in both 8th and 10th grade, suggesting larger proportions of both low-performing and high-performing students. This is aligned with the idea that teacher effects are also proportionally more variable for the subject of math.

Another possible explanation that cannot be completely ruled out is that these differences could only have to do with the characteristics of the tests, which would allow for bigger changes in math than in language. Although tests in both years (8th and 10th grade) are equated for each subject, and they are also constructed based upon item response theory (which somehow measures a latent ability), it is not possible to completely rule out the possibility that some of the observed differences in test results across subjects could have to do more with the construction of the tests and/or the contents measured in them.

2.5.2 Teacher effectiveness by school SES

Estimates for our preferred specifications show that there are differences in the mean of the distribution of teacher effectiveness by school SES in both subjects. Figure 2.2 illustrates the distribution of the estimated teacher effects over different values of school average family income (used in this case as a continuous proxy measure of school SES for explanatory purposes). In general, there is a decreasing variation – or higher homogeneity – in teacher effects when moving towards better-off schools, with the exception of the most deprived schools (SES A), where variation is close to the overall average. In Table 2.4 we report some statistics for each defined school SES. On average, teachers in both lower and higher SES schools produce higher impact on their students (around an extra 5% of a standard deviation above an average performing teacher), whereas middle SES schools show teacher effects below average (4% of a standard deviation). The 10-90 gap on teacher effects within each defined school SES can be as big as 0.56 standard deviations in student test scores for math and language, with bigger variation in math, suggesting important variation in teacher effects across schools within each defined SES, especially in low SES schools.

The proportion of teachers statistically significantly different from an average teacher is bigger for lower and middle SES schools, and smaller for higher SES schools. However, the proportion of teachers showing above-average effectiveness is only bigger for higher, lower-middle and lower SES schools (SES E, B and A). At the same time, higher SES schools show a very small proportion of low performing teachers (below average).

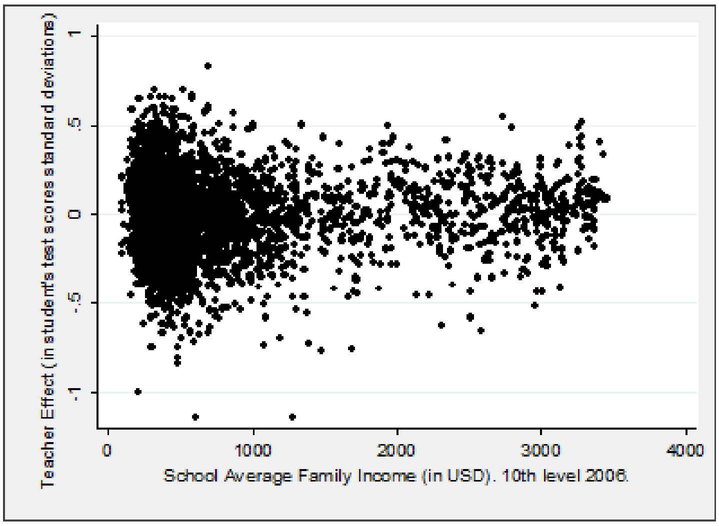


Figure 2.2 Estimated teacher effects versus school average family income (Math).

Interestingly, figures for the subject of language are slightly different. In general, dispersion for teacher effects does not vary so much by school SES and there is an especially relevant proportion of high performing teachers in lower SES schools. A similar table for language can be found in Table 2B1, Appendix 2B.

Table 2.4 Estimated teacher effects by school SES (Math).

	Number of observations	Mean	Avg. std. error	SD	Percentiles 10-90 Gap	Percentiles 25-75 Gap
Lower SES Schools (SES A)	33,686	0.05	0.07	0.20	0.51	0.28
Lower-middle SES Schools (SES B)	74,772	0.00	0.06	0.22	0.56	0.28
Middle SES Schools (SES C)	48,067	-0.04	0.07	0.21	0.53	0.27
Upper-middle SES Schools (SES D)	20,959	-0.01	0.07	0.19	0.44	0.22
Higher SES Schools (SES E)	13,497	0.04	0.09	0.17	0.41	0.22
All Schools	190,981	0.00	0.07	0.21	0.53	0.27

	Number of teachers	Number of teachers different from avg. teacher	Number of teachers above avg. teacher	Proportion of teachers different from avg. teacher	Proportion of teachers above avg. teacher	Proportion of teachers below avg. teacher
Lower SES Schools (SES A)	711	321	156	45.1%	21.9%	23.2%
Lower-middle SES Schools (SES B)	1,283	641	192	50.0%	15.0%	35.0%
Middle SES Schools (SES C)	857	426	85	49.7%	9.9%	39.8%
Upper-middle SES Schools (SES D)	471	171	49	36.3%	10.4%	25.9%
Higher SES Schools (SES E)	423	128	23	30.3%	5.4%	24.8%
All Schools	3,745	1687	505	26.0%	13.1%	12.9%

Notes: Teacher effects estimates from model a.6. Proportion of teachers different from average teacher estimated using confidence intervals with 95% of statistical significance.

As previously mentioned in our methods section, and in order to assess the relationship between different school and class level characteristics (including school SES) and teacher performance, we fitted a regression on our preferred teacher effects estimates (models a.4. and a.6) including those characteristics as covariates in our models. We summarize regression results for math in the following table (Table 2.5).

Figures for math teachers in Table 2.5, show that school SES is very relevant and statistically significant in explaining teacher effectiveness even after including other school and class level determinants related to school SES. On average, the SES gap on teacher effectiveness between different SES diminishes slightly when adding other controls, but remains important. Lower SES schools present higher performing teachers than middle SES schools (around 8% of a standard deviation), whereas the difference between higher and lower SES schools remains statistically insignificant. The size of the estimated gap is quite constant across specifications.

We also find students in smaller classes, rural schools and single-sex schools benefit from higher teacher effectiveness. The degree of association is non-negligible (additional 5-8%

of a standard deviation). Also, those classes with smaller average variation in students' prior test scores present higher performing teachers, suggesting heterogeneous effects across classes. In the case of language, figures are similar in sign but usually smaller in magnitude. Results for language can be reviewed in Table 2B2, Appendix 2B.

Table 2.5 Relationship between teacher effects, school SES and other class and school characteristics (Math)

	(1)	(2)	(3)	(4)	(5)	(6)
	Model a.4	Model a.6	Model a.4	Model a.6	Model a.4	Model a.6
School Socioeconomic Status B (SES B- Lower Middle SES)	-0.0678***	-0.0460***	-0.0680***	-0.0386***	-0.0619***	-0.0375***
	(0.0113)	(0.0114)	(0.0126)	(0.0120)	(0.0133)	(0.0125)
School Socioeconomic Status C (SES C- Middle SES)	-0.105***	-0.0933***	-0.0992***	-0.0847***	-0.0931***	-0.0867***
	(0.0120)	(0.0118)	(0.0143)	(0.0123)	(0.0143)	(0.0132)
School Socioeconomic Status D (SES D- Higher Middle SES)	-0.0648***	-0.0630***	-0.0609***	-0.0567***	-0.0592***	-0.0651***
	(0.0159)	(0.0136)	(0.0168)	(0.0139)	(0.0160)	(0.0145)
School Socioeconomic Status E (SES E- Higher SES)	-0.0150	-0.00770	-0.0323**	-0.00970	-0.0317*	-0.0217
	(0.0122)	(0.0111)	(0.0155)	(0.0138)	(0.0174)	(0.0148)
Ln school enrolment			0.0164**	0.000638	0.0142**	-0.00185
			(0.00705)	(0.00572)	(0.00612)	(0.00581)
Number of students in class			-0.00366***	-0.00118*	-0.00358***	-0.00118*
			(0.000717)	(0.000684)	(0.000692)	(0.000657)
Religious school (religious = 1)			-0.00376	-0.00240	-0.00187	-0.00271
			(0.00994)	(0.00931)	(0.0102)	(0.00910)
Rural school			0.0363*	0.0768***	0.0348*	0.0760***
			(0.0203)	(0.0167)	(0.0194)	(0.0170)
Single-sex school			0.0636***	0.0540***	0.0615***	0.0493***
			(0.0114)	(0.0101)	(0.0112)	(0.0107)
Proportion of parents declaring school selects students					-0.0174	0.0127
					(0.0149)	(0.0146)
Class standard deviation of prior scores- Math (8th grade)					-0.000894***	-0.00112***
					(0.000337)	(0.000317)
Class standard deviation of prior scores- Language (8th grade)					-0.00236***	-0.00140***
					(0.000345)	(0.000303)
Constant	0.0611***	0.0489***	0.0898**	0.0770**	0.233***	0.188***
	(0.00868)	(0.00813)	(0.0428)	(0.0352)	(0.0420)	(0.0364)
Number of observations	190,981	190,981	190,981	190,981	190,981	190,981
R-Squared	0.0229	0.0236	0.0365	0.0348	0.0462	0.0413

Dependant variable: Estimated teacher effect from equation 1. Models a.4 and a.6 as detailed in Table 2.2.
Note. All specifications include schools SES classification. Columns 3 and 4 include other school and class controls, excepting school selectivity and students homogeneity in prior examinations as detailed in Table 2.2. Columns 5 and 6 also include the latter.
Excluded reference categories: School Socioeconomic Status A (Lower SES), Secular school, Urban school, Mixed school. Bootstrapped standard errors clustered at teacher level in parentheses . *** p < 0.01, ** p < 0.05, * p < 0.1. (200 replications)

2.5.3 High and low performing teachers and school SES

From our last figures, we know that, on average, there are important differences in the distribution of teacher effects by SES. At the same time, we also acknowledge that there is bigger dispersion on teacher effects in lower and middle SES schools (see Figure 2.3 below), implying important proportions of high and low performing teachers, as opposed to higher SES schools, where most teachers' performance is similar or above average.

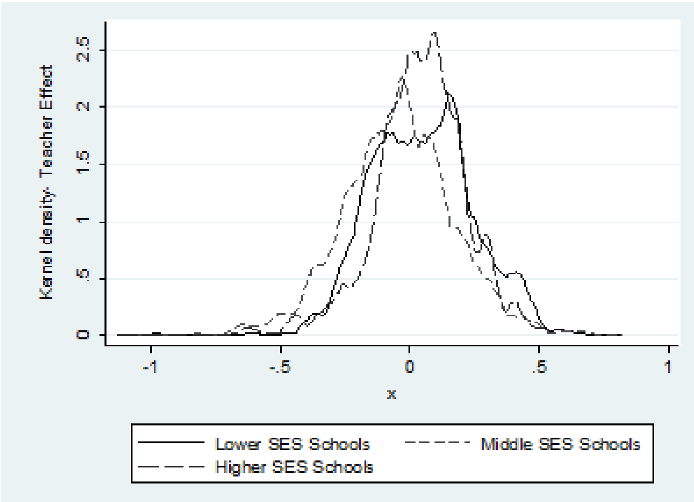


Figure 2.3 Distribution of teacher effectiveness by SES. Math.

In order to examine if the socioeconomic gap on teacher effectiveness also exists for high and low performing teachers, we ran a quantile regression for percentiles 10, 50 and 90 on our preferred teacher effects estimates, using the same model stated in equation 2. Complete regression results by subject can be found in Appendix 2B, Tables 2B4.a and 2B4.b [9].

For the case of math, in Table 2.6, our results show teacher effects vary greatly by School SES for high and low performing teachers. All in all, low performing teachers in more deprived schools are much less effective than those in higher SES schools, but still more effective than in middle SES schools. At the same time, high-performing teachers in low SES schools are more effective than in all other types of schools, which implies that there is high potential for achievement improvement within this subpopulation. In particular,

[9] We also estimated "unconditional quantile regressions" as detailed in Firpo, Fortin & Lemieux, 2009. The estimated coefficients are quite consistent with those reported here, both in size and direction.

summarized figures indicate that, when comparing low performing teachers in higher income versus lower income schools (column 1) those schools from the lowest SES (SES A) show, on average, teachers 4% of a standard deviation less effective than those at higher SES schools (SES E). On the other hand, the gap between higher SES schools versus middle SES schools (showing the worst performers) can be as big as 0.1 standard deviations in favour of the former.

For high-performing teachers, figures are slightly different, showing bigger disparities across schools. The size of the gap remains quite stable across model specifications. On average, high-performing teachers in low SES schools outperform teachers from middle, higher-middle and higher SES schools by around 6 to 9% of a standard deviation (Column 3) and are equivalently effective to those in lower-middle SES schools. Interestingly, the presence of high-performing teachers seems to be strongly associated with smaller class size (see detailed regressions results in Table 2B.4.a, Appendix 2B).

The reasons why high-performing teachers in more deprived contexts (low SES schools) are more effective than in other schools could be several. One possible explanation is that high performing teachers can produce much bigger gains in achievement in students showing very poor initial levels of performance in the tests when they were initially assessed in 10^{th} grade. In other words, the scope for improvement is much bigger. Another possible explanation is that some of the effective teachers working in vulnerable contexts could be especially motivated to teach those students, also influencing students' motivation, and then producing bigger improvements in their students than their peers in other schools. In relation to the latter, the case could be that some of the high performing teachers in low SES schools chose to teach in these schools for specific reasons, and that those teachers are willing to spend extra time and effort educating and motivating their students.

Table 2.6 Teacher effects and School SES. Quantile regression results (Math)

	Model Specification 1			Model Specification 2			Model Specification 3		
	Percentile 10	Percentile 50	Percentile 90	Percentile 10	Percentile 50	Percentile 90	Percentile 10	Percentile 50	Percentile 90
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
School Socioeconomic Status B (SES B- Lower Middle SES)	-0.0730***	-0.0354**	-0.0258	-0.0814***	-0.0307*	-0.0173	-0.0834***	-0.0342**	-0.0146
	(0.0155)	(0.0147)	(0.0206)	(0.0113)	(0.0157)	(0.0227)	(0.0127)	(0.0152)	(0.0271)
School Socioeconomic Status C (SES C- Middle SES)	-0.108***	-0.0842***	-0.0897***	-0.106***	-0.0795***	-0.0714***	-0.111***	-0.0856***	-0.0738**
	(0.0189)	(0.0152)	(0.0244)	(0.0145)	(0.0168)	(0.0221)	(0.0172)	(0.0149)	(0.0326)
School Socioeconomic Status D (SES D- Higher Middle SES)	-0.0313	-0.0632***	-0.0973***	-0.0133	-0.0613***	-0.0841***	-0.0386	-0.0754***	-0.0910***
	(0.0197)	(0.0168)	(0.0292)	(0.0207)	(0.0192)	(0.0266)	(0.0306)	(0.0211)	(0.0307)
School Socioeconomic Status E (SES E- Higher SES)	0.0429*	0.00356	-0.0613**	0.0638***	-0.00615	-0.0812***	0.0381	-0.0226	-0.0989***
	(0.0224)	(0.0192)	(0.0255)	(0.0213)	(0.0166)	(0.0255)	(0.0315)	(0.0200)	(0.0345)
Constant	-0.199***	0.0462***	0.311***	-0.346***	0.0683	0.470***	-0.246***	0.175***	0.559***
	(0.00824)	(0.0123)	(0.0192)	(0.0607)	(0.0440)	(0.0599)	(0.0720)	(0.0472)	(0.0771)
Number of observations	190,981	190,981	190,981	190,981	190,981	190,981	190,981	190,981	190,981

Dependant variable: Estimated teacher effect from equation 1.
Note: All specifications include schools SES classification. Columns 4 to 6 include other school and class controls, excepting school selectivity and students homogeneity in prior examinations as detailed in Table 2.2. Columns 7 to 9 also include the latter.
Excluded reference categories: School Socioeconomic Status A (Lower SES), Secular school, Urban school, Mixed school.
Bootstrapped standard errors clustered at teacher level in parentheses . *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. (200 replications)

For the subject of language, trends are quite different from those in math. For both low and high-performing teachers, those teachers in schools from the lowest SES (SES A), seem to be much more effective than their colleagues in middle and higher SES schools. The gap is especially big for low performing teachers. However, apart from schools in the lowest SES, the difference in teacher effectiveness across all other schools is usually much smaller than for math teachers. In this case, the gap tends to attenuate slightly when adding some additional controls to our model. Results can be found in Table 2B3, Appendix 2B.

Although our results are in line with the international literature, which shows that the dispersion in test results is usually bigger for the subject of math than language (implying a bigger proportion of both high and low performing teachers for math in all types of schools), the fact that the SES gap for high and low performing teachers also differs between subjects according to the school´s SES could have other explanations. One of them is that, as the language test assesses mostly reading skills at the age of 12 and 14, in this case, it is possible that, as students in low SES schools have a lower performance level at the starting point (in 12th grade), they might be able to experience bigger gains in achievement during the period under study in the SIMCE test. This could be the case if high achieving students could not improve as much as low achieving ones, due to a possible "ceiling effect"[10] in the test for the subject of reading. Also, we cannot completely rule out the possibility that our teacher effects are endogenous for any of both subjects, and thus their distribution is subject to bias.

2.5.4 Discussion of results

Although results are not strictly comparable, as schools' student composition and SES definitions, as well as student characteristics vary across studies, our figures suggest that there are no big differences in the average effectiveness of teachers between high and low SES schools in a short period of time, which is in line with similar studies where differences, if any, would be modest (Sass et al., 2012; Isenberg et al., 2013; Mansfield, 2015). At the same time however, according to our results, the picture seems to be much

[10] In this case we understand "ceiling effect" as the possibility that many students in high SES schools reach scores which are close to the highest score, and then they are less likely to experience important achievement gains in this specific test (SIMCE).

more complex, as teacher effects distributions vary largely by SES, which implies that, behind average values, there are relevant differences across school types.

Even though our study findings support the thesis that high SES students access a bigger proportion of teachers who are more effective than an average teacher, we also find that students in lower SES secondary schools would be especially sensitive to teaching quality, showing important achievement gains under certain teachers. Moreover, there is an important proportion of highly effective teachers showing high performance in low SES schools – indeed, they show even higher effectiveness than those in higher SES schools – driving average teacher effectiveness in low SES schools well above the overall average. This encouraging finding is similar to that of Sass et al. (2012), who also found highly effective math teachers are even more effective in higher poverty schools. At the same time, and in relation to the latter, we also strongly support the thesis that teacher effectiveness is much more variable in lower income schools (Nye et al., 2004; Aaronson et al., 2007; Sass et al., 2012), implying big proportions of both high and low performing teachers in more deprived contexts.

It is however difficult to believe that these differences across schools would be purely due to an uneven allocation of effective and ineffective teachers across schools from different SES. Although this hypothesis cannot be empirically addressed with the available data (as we have a very small portion of teachers teaching in more than one type of school), we believe that students' characteristics play a role in this. Teacher skill matches with students' ability to learn, and also with their potential to experience achievement gains in a specific point in time under a specific test. In this regard, our findings support the idea of heterogeneous teacher effects according to student and class characteristics (Aaronson et al., 2007; Lockwood & McCaffrey, 2009; Loeb, Soland & Fox, 2014). At the same time, we partially differ from one of these studies, which suggests a strictly increasing relationship between student SES and achievement gains (Aaronson et al., 2007). Indeed, our findings suggest that, on average, and under a lot of variation within school groups, the relationship would be non-linear, but quadratic and not strictly increasing, therefore benefiting both lower and higher SES students.

The reasons why average teacher effectiveness seems to be higher in both higher and lower SES schools in the Chilean context could be numerous. As previously mentioned, it is unlikely that this would be produced solely by the allocation of the most effective teachers in lower and higher SES schools and of the less effective teachers in middle SES schools. The little available evidence in Chile actually shows that better-off students would access more qualified teachers on average (Carrasco, 2014; Meckes & Bascopé, 2010). We believe that this is related to the fact that teacher effects are heterogeneous according to students' prior performance levels, and Chilean schools are extremely homogeneous in this measure due to social segregation. As Lockwood & McCaffrey (2009) suggest, the amount of variation on teacher effects due to changes in class and school composition is likely to be more important in more homogeneous schools, influencing those in more deprived schools (SES A) and better-off schools (SES E), which are the most homogeneous in the Chilean case. At the same time, higher SES students are likely to benefit from a comparatively higher proportion of highly qualified teachers, from whom they can also benefit, and a smaller proportion of low performing teachers.

Also, we cannot completely rule out the possibility that we are not only measuring teacher effectiveness but also some aspects related to students' characteristics shared by all students under the same teacher, even after controlling for several individual, school and class level measures. However, if this was the case and our figures were mostly based on student sorting across schools, it is very likely that peer or school effects or unmeasured individual level gain enhancers (like social capital or ability to learn) would affect teacher effects measures for students from all SES – and especially those who are in middle and higher SES schools – and not only those in high and low SES schools. In fact, under these assumptions, the socioeconomic gap should tend to look bigger between lower and higher SES schools, and smaller between middle and higher SES schools.

2.6 Sensitivity analysis

In this section, we seek to address the question of whether teacher effects estimated distributions vary considerably under different assumptions on the estimation sample, as well as on the employed methods.

2.6.1 Estimation sample

As previously mentioned, in case our estimated teacher effects are endogenous due to a correlation between them and previous average scores at class or school level, as a result of previous influence of teachers and schools in those past test scores, results should differ across different samples. In order to asses this possibility, we estimate teacher effects distributions using our preferred specifications, only for those students who switched schools between the 8th and 9th grade (around 70% of the sample). In this case, there is no possibility of an association between current teacher effects and average past performance levels due to prior influence of those teachers in past test scores. Our results show that our teacher effectiveness estimated distributions by SES are extremely stable, and do not vary appreciably. The size of the socioeconomic gap in teacher effectiveness holds. Unfortunately, for the case of higher SES schools we cannot make any statement, as the number of teachers with a relevant number of school switchers (more than 10) is extremely low for us to estimate a distribution (around 15 teachers), therefore results are not representative.

Secondly, we also estimate all specifications including only those teachers who taught students during both years (9th and 10th grade). Initially, we decided to keep the whole sample of teachers, including those teaching the same students for one or two years (9th grade and/or 10th grade). In that case, the underlying assumption is that teacher effects are additive in time, so the teacher effect for those teachers teaching a student for only one year is assumed to account for half the weight in achievement gains when compared to the effect of those teachers who taught a student for two years in a row. In order to check for the plausibility of this assumption, we reduced our sample to those teachers and students taught only by the same teacher for both years, and looked for differences in our teacher effectiveness estimates[11]. For differences between this sample and the original one, see Table 2A1 (last column), Appendix 2A. Regression outcomes for this reduced sample of students and teachers show teacher effectiveness estimates are quite similar to those estimated using the full sample. Table 2C1 in Appendix 2C summarizes teacher effectiveness estimates per subject for both teacher samples. Results show that the differences on teacher effects between the original and this reduced sample, on average, are small for both math and language teachers (approximately 20-25% bigger for the reduced sample in language and almost identical in math).

[11] In this case the sample consisted of 4,456 teachers (2,147 for math and 2,309 for language) and 83,468 and 87,821 students respectively, distributed in almost the same number of schools.

2.6.2 Teachers fixed versus random effects

Finally, we test for the validity of teacher random effects estimation. In case random effects estimates are consistent, they could lead us to more efficient estimates of teacher effects. To check for this, we ran a Sargan-Hansen test[12] to assess the consistency of random effects estimators. Results can be found in Table 2C2, Appendix 2C. For all specifications we strongly reject the hypothesis of consistency for random effects estimates. In general, random effects figures show a similar teacher effects overall distribution to fixed effects estimates for most specifications; however, individual teacher estimates are not necessarily similar (see Figure 2C1, appendix 2C), and also, teacher effectiveness distributions do not differ greatly across different SES. When examining the relationship between our teacher random effects estimates and school SES using the regression models specified in equation (2), we find no significant difference across different SES, even after controlling for other related measures, such as class size, type of course, school rurality, selectivity, etc. On the other hand, intra-class correlation estimates for teacher effects in Table 2C3, Appendix 2C, show that models including fixed effects present much higher correlation than random effects estimates for the same specifications.

2.7 How important is teacher effectiveness in explaining educational inequality?

As a final exercise, in Table 2.7 we report the relative raw gap on students' academic achievement among schools from different SES in 10^{th} grade, as well as the proportion of this gap which could be explained by teacher effectiveness differentials according to our estimations. Although we only have teacher effects measures for a short period of time (8^{th} to 10^{th} grade), this helps us to understand how teacher effectiveness could actually help – or not – overcoming the socioeconomic gap during that time span.

When compared to the raw socioeconomic gap in students' achievement in the subjects of math and language, our figures show average teacher effects (in a 2-year period) could account for as much as 11% in such gap for our preferred specification (model a.6), when

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[12] The Sargan-Hansen test is a heteroscedasticity-robust estimator for unbalanced clustered panel data. Its estimates are equivalent to Hausman test statistics under homoscedasticity in balanced panels, with independent and identically distributed (i.i.d) residuals.

comparing lower and middle SES schools (SES A and SES C). However, for the case of math, differentials on average teacher effectiveness would only help in explaining the raw gap between lower, lower-middle, and middle SES schools (SES A or B vs. C), whereas they do not have a relevant importance in explaining the gap between lower-middle or middle SES schools (SES B or C), and higher or middle-higher SES schools (SES E or D). Moreover, on average, differences in teacher effectiveness in the studied period would actually help to explain an increase in the socioeconomic gap in students' achievement between middle SES schools (SES C) and better-off schools (SES D or E) in up to 7%.

In the case of language, figures are more encouraging. Differentials in average teacher effectiveness have a big equalizing effect, especially for those students in more deprived schools. At the same time, there is no increment in the gap due to differences in teacher effectiveness between middle and higher SES schools, as average teacher effects are quite similar across those schools. For complete figures in language, see Table 2D1 in Appendix 2D.

Table 2.7 Teacher effects and the socioeconomic gap (Math)

	Socioeconomic Gap in 10th grade (in test scores standard deviations)	Average Teacher Effect difference (model a.4)		Average Teacher Effect difference (model a.6)		Pctg. of the Socioeconomic Gap explained by teacher effects difference (Model a.4)		Pctg. of the socioeconomic Gap explained by teacher effects difference (Model a.6)	
	(1)	(2)		(3)		(4)		(5)	
Lower SES (reference category, SES A)	-	-		-		-		-	
Lower-middle SES (SES B)	0.25	**-0.06**	*0.01*	**-0.04**	*0.01*	**-24.8%**	*4.3%*	**-15.0%**	*3.9%*
Middle SES (SES C)	0.77	**-0.09**	*0.01*	**-0.09**	*0.01*	**-12.1%**	*1.5%*	**-11.3%**	*1.4%*
Upper-middle SES (SES D)	1.31	**-0.06**	*0.01*	**-0.07**	*0.01*	**-4.5%**	*1.0%*	**-5.0%**	*0.9%*
Higher SES (SES E)	1.67	-0.03	*0.01*	-0.02	*0.01*	-1.9%	*0.7%*	-1.3%	*0.7%*
Lower-Middle SES (reference category, SES B)	-	-		-		-		-	
Middle SES (SES C)	0.52	**-0.03**	*0.01*	**-0.05**	*0.01*	**-6.0%**	*2.1%*	**-9.5%**	*1.8%*
Upper-middle SES (SES D)	1.06	0.00	*0.01*	**-0.03**	*0.01*	0.3%	*1.1%*	**-2.6%**	*1.0%*
Higher SES (SES E)	1.42	**0.03**	*0.01*	**0.02**	*0.01*	**2.1%**	*0.8%*	**1.1%**	*0.7%*
Middle SES (reference category, SES C)	-	-	-	-	-	-		-	
Upper-middle SES (SES D)	0.54	**0.03**	*0.01*	**0.02**	*0.01*	**6.3%**	*2.4%*	**4.0%**	*2.1%*
Higher SES (SES E)	0.90	**0.06**	*0.01*	**0.07**	*0.01*	**6.8%**	*1.3%*	**7.2%**	*1.2%*
Upper-Middle SES (reference category, SES D)	-	-	-	-	-	-		-	
Higher SES (SES E)	0.36	**0.03**	*0.01*	**0.04**	*0.01*	**7.6%**	*3.6%*	**12.1%**	*3.4%*

All values in **bold** significant at 95% level. Standard errors in *italics*.

Note: School socieconomic gap in achievement on SIMCE test (in student test scores standard deviations).

2.8 Conclusions, policy implications and further research

The present study focuses on teacher effectiveness in secondary schools and its relationship with school socioeconomic background. We find important differences in average teacher effectiveness for schools from different SES, as well as relevant variation across schools within each defined socioeconomic group. This suggests that effective, average and underperforming teachers are unevenly distributed and also perform differently in different backgrounds in the Chilean context. In the case of math, even though we find relevant proportions of high and low performing teachers in all types of schools, effective teachers in more affluent schools still outperform largely those in middle SES schools. Moreover, underperforming teachers are even less effective in more deprived schools when compared to those teaching in higher SES schools. More encouragingly, we find an important proportion of highly effective teachers in low SES schools.

Our results show that, when compared to the raw socioeconomic gap in educational achievement, differentials on average teacher effectiveness across schools from different SES in a short period of time could account for a relevant proportion of this gap, suggesting that improvements in teaching quality at low SES schools could lead to substantive drops in educational inequality.

All these findings imply that, in the Chilean context, teacher effectiveness is a relevant driver for the existence of inequality of educational opportunity. In circumstances when public policies looking to enhance quality of teaching are one of the main priorities in the educational agenda for most countries (including Chile), our evidence suggests that this is a critical factor for tackling educational inequality.

Furthermore, policy efforts on improving teacher effectiveness in schools with more disadvantaged students need to offer incentives to effective teachers, for them to consider moving to more vulnerable schools, increase retention of high performing teachers, recruit high achieving students to the teaching profession, and develop focused programmes seeking improvements to teaching practices and standards. These changes may assist in reducing the socioeconomic gap.

However, the implementation of such policies is not simple, as the identification of good teachers is not straightforward. There is extensive literature showing the technical and ethical issues related to the use of individual value-added measures as quality of teaching proxy indicators for high stakes decisions (Baker et al., 2010; McCaffrey, Lockwood, Koretz, Louis & Hamilton, 2004). Our empirical results also point towards the inconvenience of such procedures in the Chilean context, as teacher effects would be highly influenced by contextual and socioeconomic factors. The use of alternative "measures" of teaching quality, such as results in teachers' national assessment programmes, principal evaluations, the use of academic credentials, or test scores in university entrance examinations, are also not exempt from controversy. This situation implies that the generation of more transparent, accurate and reliable instruments for teachers' assessment is also a matter of high importance.

Chapter 3

Access to Higher Education for Socially Disadvantaged Students in Chile. Do Secondary Schools Actually Matter?

3.1 Introduction

There is an important amount of research indicating the private and social benefits of wider access to tertiary education[13]. In this context, policy makers usually debate on what are the best policies to be implemented in order to increase higher education attendance rates within more vulnerable sectors of the population. Although many public programs nowadays are taking place worldwide to boost participation of most vulnerable students through, for example, increased funding by means of grants and loans, special enrolment quotas for highly talented vulnerable students, mentoring programs during high school education, and alternative types of part-time tertiary education programs for those who entered the labour market (Gándara, 2004; Koljatic & Silva, 2013), there are still important differences in participation rates and persistence in higher education for students from different socioeconomic backgrounds (Smith & Naylor, 2001; McCowan, 2007; Christie, Munro & Fisher, 2004).

Even though there is no conclusive research regarding the main reasons for low participation in tertiary education for low SES students, most studies have provided evidence of important credit constrains[14], as well as lower schooling expectations by the students and their families. There is also some research showing lower academic readiness for further studies, as well as some distaste for studies affecting students' decisions.

Prior research on the influence of schools in educational outcomes has focused on the role of school quality in academic achievement in secondary school education, as well as on the benefits of school quality in success in higher education and wages[15]. Most of this strand of the literature concentrates on the long-term effects of school quality rather than on its influences on career decisions and length of schooling. Only few studies have

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[13] On earnings, wellbeing and social mobility among others.

[14] Most of these studies have found that financial aid has a positive effect on access to higher education and retention, although the impact seems to be heterogeneous, as low-income students are more sensitive to changes on financial aid than middle or high income students. See Carneiro & Heckman (2002) and Dearden, Fitzsimons & Wyness (2014). For the Chilean case, Rau, Rojas & Urzúa (2013) study the effect of financial aid in access and persistence in higher education.

[15] For instance, Dearden, Ferry & Meghir (2002) find positive school effects for males attending a selective or private school on educational attainment and wages, but no effect of class size on those outcomes when school type is controlled for. Dolton & Vignoles (2002) show additional economic returns to certain school subjects, such as math. Smith & Naylor (2005) found students in free schools in the UK were more likely to enter higher education and would outperform their pairs from public schools at university.

directly addressed the role secondary schools are playing in shaping career decisions and opportunities for posterior studies in tertiary education, and very few focus on studying heterogeneous effects according to school and student SES.

In Germany, Görlitz & Gravert (2015) show that a school curriculum reform associated with increased exposure to certain subjects, such as foreign languages, math and natural sciences increased enrolment levels in higher education importantly. Their findings are similar to those of Altonji (1995) and Aughinbaugh (2012) in the US who also found a positive association between those subjects and college enrolment. Malamud & Pop-Eleches (2011) found later tracking in Romanian schools increased the probability of access to tertiary education for low SES students, but had no effect in completion. In a cross national comparison, Brunello & Checchi (2007) find that students in vocational secondary education are less likely to attend tertiary education. This hypothesis is reinforced in other country studies in Europe (Holm, Jæger, Bernt & Reimer, 2013; Dustmann, 2004).

In a study with a similar approach to ours, Dustmann, Rajah & Van Soest (2003), find that certain school variables, such as class size, matter in career decisions. Interestingly, their results show that a smaller teacher-pupil ratio affects continuation to tertiary studies through increased performance in academic examinations, but also directly affects the decision of posterior studies, even after controlling by university entrance examination results, school type, parental expectations, income and earlier measures of academic achievement. At the same time, Card & Krueger (1992) also found teacher-pupil ratio influences length of schooling.

Although Chilean literature on access to higher education is limited, there are two works worth noticing. Farías & Sevilla (2015) show that the vocational track in Chilean secondary schools, which is usually the one chosen by low SES students, would discourage students to attend higher education. Acuña, Makovec & Mizala (2010) show that attending high performing schools in 10th grade is associated with higher probabilities of entering higher education and lower chances of dropping out, conditional on individual ability, school type, and student SES, although they do not study the existence of heterogeneous effects according to school SES. Also, they do not investigate the main ways by means of which school quality could be affecting access to tertiary studies.

In this work, our main goal is to examine the socioeconomic gap in access to higher education and its characteristics, as well as the mechanisms through which schools could make a difference to low SES students. We attempt to address how important secondary schools are in explaining access to higher education in the Chilean context. In particular, we assess the importance of different observed school-level factors in explaining access to higher education, with an emphasis on those schools working with students from disadvantaged social backgrounds.

The Chilean school education system is one of very particular characteristics, showing an important proportion of private providers running state-funded schools, and high levels of inequality in students' academic achievement, as well as social segregation. At the same time, according to different reports, in absolute terms, Chile is among the best performing countries in international examinations in Latin America, although far behind the average of OECD countries. Its special characteristics make it a relevant case study.

3.2 Chilean schools and access to higher education in Chile

Most Chilean secondary schools are either public or private subsidized (voucher schools), accounting for 40% and 51% of 2014 enrolment respectively (MINEDUC, 2014). Private unsubsidized schools explain the remaining 9%. Municipalities are in charge of administrating public schools, whereas foundation-run schools, religious schools and also for-profit schools make up the private subsidized sector; all state schools are free of tuition. On the contrary, since 1994, an important proportion of private subsidized schools receive an additional contribution to public subsidy from students' parents (even though there are many free of tuition schools as well). This financing policy has had many implications in terms of schools' social composition (high social segmentation) and students' educational results (Valenzuela et al., 2013). Schools' state financing mainly depends on attendance rates, as well as on enrolment levels. Until 2008, private subsidized schools were legally allowed to select their students.[16] Similar to many countries in Europe, students' formal tracking into vocational or academic education is performed in 10th grade. The vocational track lasts for 2 years, until 12th grade. A parallel 2-year

[16] According to recent studies, there are no relevant differences on average attainment between Chilean public and private subsidized schools after taking into account students' sociodemographic characteristics (Lara, Mizala & Repetto, 2011).

academic track applies for those choosing academic courses. Tracking usually implies changing schools, as most secondary schools specialize in either academic or vocational education, with a very few of them running both tracks. In practice, when moving from primary to secondary schools, most students choose the type of school according to their focus in upper secondary education (vocational or academic). A majority of students change from primary to secondary schools at the end of 8^{th} grade (around 70%); another relevant portion moves for a first or second time right before starting upper-secondary education. The vocational track focuses on one or more different available specialties.[17] There is no formal articulation between vocational secondary education and technical tertiary education. See appendix 3C for a diagram by Farías & Sevilla (2015) on the Chilean school system course structure.

Most Chilean students sit a university entrance examination called University Selection Test (PSU) which is taken annually at the end of their final year of school education (12^{th} grade). Eligibility to academic programs in tertiary education is mainly based on results in this test, as well as on students' grade point average during secondary education. Also, state funding for tertiary studies depends on these results. Even though the test is voluntary, a big majority of students sit the examination (in 2008, attendance was nearly 85% of the cohort for those who did not repeat any courses or dropped out while in secondary education). Although variation does exist according to school SES, as much as 70% of students in lower SES schools sat the examination in 2009, whereas this number increased to 95% in middle SES schools (see Table 3B1 in Appendix 3B for more detail).

3.3 The Chilean higher education system and state financial aids for students

The Chilean higher education system is composed by universities, professional institutes (IP) and Technical Training Centres (CFT). Enrolment in higher education for those students from more unprivileged backgrounds has increased dramatically in the last decade, although big differences still persist across students from different socioeconomic backgrounds (see figure 3.1). This dramatic increase has been mostly driven by an expansion in the offer of academic programs, and a boost in the number of higher

[17] The economic sectors with the most common specialties in 2006 were: administration, electricity, metal-mechanic and nutrition.

education private institutions, mainly explained by wider access to state grants and loan programs targeting low and middle income students. Since 2006, the "State Guaranteed Loan Programme", has given improved access to funding to more socially disadvantaged students. Up to 2005, most grants were only given to students attending traditional universities. These institutions are usually characterized by higher levels of selectivity through university entrance examinations, and most of them usually receive students from more affluent backgrounds (OECD, 2009).

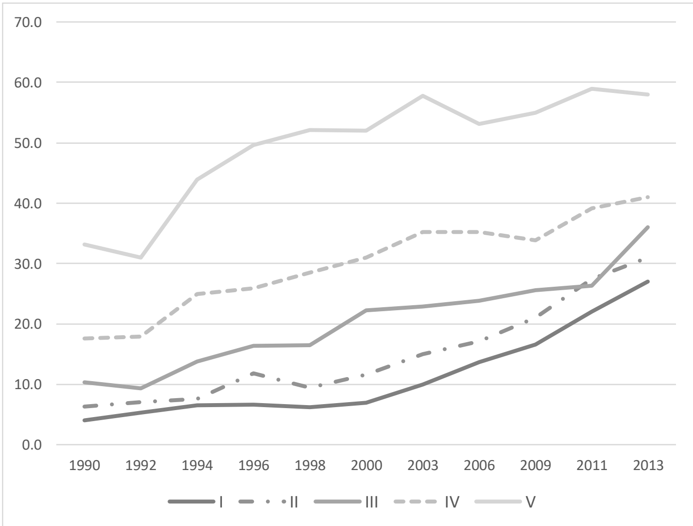

Figure 3.1 Net higher education coverage by income quintile in Chile. 1990-2013. Source: CASEN survey. Ministry of Social Development, Chilean Government.

In order to become eligible to apply for state funding for university programs, most public loans and grant programs (including the State Guaranteed Loan Programme) require students to have achieved more than 475 points at the university entrance examination (PSU). In fact, the threshold of 475 points is quite high for students from disadvantaged backgrounds, and limits importantly the availability of public funding for them (see figure 3A2, Appendix 3A and Table 3B1, Appendix 3B). For short vocational education programs, there is limited financing depending on students' performance during secondary education (a minimum grade point average of 5.3 out of 7 is required). This is not the case for professional careers, where funding depends only on PSU scores. Even though access to public funding becomes an important entry barrier to higher education for students from disadvantaged backgrounds, in practice there is an important proportion of the higher education intake enrolled on evening programs[18]. Students in those programs usually also work during the day to fund their studies, and commonly come from lower and middle income backgrounds. According to the OECD report on Chilean higher education (OECD, 2009), the Chilean tertiary education system is one of very high fees when compared to other countries.

3.4 Empirical approach

3.4.1 Data

To carry out our analysis we make use of individual-level administrative data to follow a cohort of Chilean students from upper primary education to tertiary education. More specifically, we follow the cohort of students who were on their final year of primary school (8th grade) in 2004 until they finish secondary education and decide whether or not to enter higher education the year after 12th grade (2009) or even up to 2 years later (2011).

Our data comes from four different sources. First, we access student-level administrative data which allows us to identify students' school and classroom during their final year of primary school and all 4 years while in secondary education (9th-12th grade). With this information we are also able to determine the school-track that students took during upper-secondary education (academic or vocational). Second, we retrieved information on students' University Selection Test (PSU) scores and GPA at the end of 12th grade. With this information, we can determine if students were entitled to public funding for professional and technical programs. Third, we accessed students' results for the SIMCE national examination when making the transition to upper secondary education (10th grade) and right before entering secondary schools (end of 8th grade). We also recovered pupil and family characteristics for all students who sat the test in 8th grade, whose parents' completed a questionnaire about socio-demographic information (about 80% of students). The questionnaire contained information about parental education, income, expectations about their children's schooling, student pre-school education, number of books at home, etc. Fourth, we accessed administrative datasets containing individual-level data with the enrolment status for students in all higher education institutions up to

[18] Around 27% of the total enrolment in higher education in 2015 (21% in 2009), mostly concentrated among Professional Institutes. See CNED (2016).

3 years after the cohort under study finished school education (2009-2013); this allows us to know if the student enrolled (or not) in tertiary education and the type of academic program they attended (professional or vocational).

School socioeconomic status definition

We make use of the Ministry of Education official measure of school socioeconomic status for all schools that participated in the SIMCE examination in 10th grade in 2006. This measure is produced and delivered by the Chilean State to report national examinations results. The Chilean state categorizes schools in 5 different groups (SES A to SES E, where SES A is lower and SES E higher SES). This measure is based on a cluster analysis on school level observed measures of family background. The measures used to construct the groups are the following: school average parents' educational level (based on parents' education measured in years, separately), school's average monthly family income (self-reported), and school vulnerability index, as annually informed by the body in charge of administrating free school meals nationwide (JUNAEB).[19] We recovered the SES classification for 2,422 schools, from which 31% were public, 54% voucher and 15% private.[20]

3.4.2 Estimation sample

Our potential sample corresponds to 293,177 students in 8th grade in 2004, which initially reduces to around 267,489 students for whom we have information on test scores for that year. From those, around 73% also have SIMCE test scores in 2006, 61% attended 12th grade on time, and 51% sat the University Selection Test in 12th grade (see Table 3.1). We decided to include in our estimation sample all students who had test scores in math and/or language SIMCE examinations in both 8th and 10th grade for 2004 and 2006 respectively, completing a final sample of 162,449 students. The main reasons why the final sample is significantly smaller is because we only include in our analysis those students who finished school on time and did not drop out from the school system.

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[19] The school vulnerability index is constructed on an aggregated measure of the proportion of priority students at each school for the corresponding grade. Each student's priority status is based on different measures of family risk factors associated with school drop-out, such as students' geographical zone, family poverty condition (based on a family survey applied to all households applying to public support programs), mother's education and type of medical care (derived from monthly income).

[20] In the cases where we did not have information on school SES for that year, we used information for students sitting the test in 10th grade in 2008 (around 3% of the cases).

According to the Ministry of Education, yearly drop-out rates were around 7% for secondary schools in that period, whereas repetition levels were above 8% on average each year. We decided to restrict our sample to these students as individual scores at the end of primary schools would allow us to take into account student selection into secondary schools. As already mentioned, we decided to include only those students also sitting SIMCE test in 10th grade, which decreases our final sample in around 7%.

Table 3.1 Progression of 2004 cohort sample through the education system.

	Year	Number of individuals
Enrolled in 8th grade	2004	293,177
Sat SIMCE examination in 8th grade	2004	267,489
Enrolled in 10th grade	2006	215,679
Sat SIMCE examination in 10th grade	2006	194,939
Enrolled in 12th grade with scores in 8th and 10th grade	2008	162,449
Sat University Entrance Examinations in 12th grade	2008	135,990
Enrolled in Higher Education	2009-2011	115,797

We report non-negligible differences in observed characteristics in 8th grade between all test takers in that year (2004) for SIMCE examination and those who were present in 12th grade in 2008 (see Appendix 3C, Table 3C1). As expected, those students in 8th grade who had better academic results by that age, showed higher family income and parental education, and lower repetition records. There is also a slightly bigger participation of students from private and voucher schools, and a modestly larger presence of students coming from schools from middle and higher socioeconomic status.[21]

We decided not to drop cases with no information or partial information on student and family sociodemographic variables, imputing missing records to the mean value within each defined school SES.[22] As we chose to include all students sitting the test in 8th, 10th and 12th grade, we also decided to keep the whole sample of students, including those who switched schools during secondary education (around 20%).

[21] Our final sample consists of 162,449 students (around 82% of all students in 12th grade in 2008) distributed in 2,416 schools nationwide. From this sample, 45% attended public schools, 46% voucher schools, and the remaining 9% private unsubsidized schools in 12th grade. 44% of students attended the vocational education track at their schools.

[22] Also including an indicator dummy for each variable, taking the value 1 when the value on that variable for the observation is missing. In order not to estimate wrong standard errors, we decided to bootstrap them.

In Table 3.2 we detail some descriptive statistics showing differences in observed characteristics between those students in our final sample, and those in the sample who entered higher education during the following 3 years after they attended 12^{th} grade in 2008.

Table 3.2 Individual and school-level descriptive statistics. Estimation sample in 12th grade vs. enrolled in higher education (2009-2011).

	Enrollment in12th Grade 2008 with SIMCE scores in 2004 and 2006 (2008 cohort)			Enrollment in HE 2009-2011 with SIMCE scores in 2004 and 2006 (2008 cohort)			Difference
	N	Mean	SD	N	Mean	SD	(in standard deviations)
Student Level							
Student did not sit University Entrance Examination in 09	162,449	0.16	0.4	115,797	0.07	0.3	(0.24)
Student is eligible for public grants and loans	162,449	0.41	0.5	115,797	0.54	0.5	0.27
Student GPA	135,990	55.4	9.3	107,879	56.5	7.8	0.12
University Entry Examination average score (PSU 09)	135,990	458.4	175.3	107,879	500.1	142.2	0.24
SIMCE 06 examination average score (10th grade)	162,449	265.3	52.9	115,797	278.9	50.1	0.26
SIMCE 04 examination average score (8th grade)	162,449	266.3	45.1	115,797	277.2	42.8	0.24
Gender in 8th grade	162,449	0.53	0.5	115,797	0.54	0.5	0.02
Family income (in USD)	150,996	868.9	1,056.7	108,084	1,040.8	1,176.1	0.16
Parents' schooling (in years)	122,949	10.5	3.7	84,322	11.5	3.7	0.26
Number of books at home	153,379	53.6	57.8	109,779	62.5	60.9	0.15
Monthly parental fees (in USD)	151,232	41.1	85.0	108,336	52.0	96.4	0.13
Student's parents schooling expectations (in years)	148,458	15.4	1.8	106,382	15.8	1.4	0.25
Student attended pre-school education	110,236	0.63	0.5	82,622	0.68	0.5	0.10
Student attendend vocational education in 12th grade	162,449	0.44	0.5	115,797	0.31	0.5	(0.26)
Student repeated course once or more before 8th grade	154,084	0.07	0.3	110,316	0.05	0.2	(0.08)
Student attended rural school in 8th grade	162,449	0.11	0.3	115,797	0.07	0.3	(0.13)
Student attended public school in 8th grade	162,449	0.50	0.5	115,797	0.41	0.5	(0.18)
Student attended private subsized school in 8th grade	162,449	0.41	0.5	115,797	0.46	0.5	0.10
Student attended private school in 8th grade	162,449	0.09	0.3	115,797	0.13	0.3	0.14

Table 3.2 (continuation)

	Enrollment in12th Grade 2008 with SIMCE scores in 2004 and 2006 (2008 cohort)			Enrollment in HE 2009-2011 with SIMCE scores in 2004 and 2006 (2008 cohort)			Difference
	N	Mean	SD	N	Mean	SD	(in standard deviations)
School and Class Level							
School's proportion of students sitting University Entrance Examination in 09	162,449	0.83	0.2	115,797	0.88	0.2	0.25
School's proportion of students eligible for public funding in 09	162,449	0.40	0.3	115,797	0.49	0.3	0.29
School average University Entry Examination score (PSU 09)	162,364	439.7	111.9	115,788	472.5	106.2	0.29
Student's school average SIMCE 06 (10th grade)	162,449	265.3	35.3	115,797	274.7	34.5	0.27
Student's school average SIMCE 04 (8th grade)	162,449	266.1	27.5	115,797	273.7	26.9	0.28
School's average number of book's at home	162,449	3.27	0.6	115,797	3.44	0.6	0.27
School's proportion of repeaters before 8th grade	162,449	0.08	0.1	115,797	0.06	0.1	(0.29)
School's avg. parental expectations on their children's lenght of schooling (years)	162,449	15.39	0.9	115,797	15.67	0.8	0.30
School's average father's schooling years	162,432	11.01	2.8	115,783	11.76	2.8	0.27
School's average mother's schooling (in years)	162,424	10.69	2.6	115,777	11.40	2.5	0.28
School's proportion of mothers with higher education degree	162,445	0.36	0.3	115,796	0.42	0.3	0.24
School's average number of people at home	162,449	4.97	0.5	115,797	4.91	0.5	(0.13)
School's average family income	162,449	889.8	903.2	115,797	1,055.9	1,007	0.18
School enrolment in 12th grade 2008	162,449	146.3	111.7	115,797	143.9	114.1	(0.02)
Class size in 12th grade	162,449	29.4	9.0	115,797	30.2	8.8	0.09
School type public in 12th grade	162,449	0.45	0.5	115,797	0.39	0.5	(0.12)
School type private subsidized in 12th grade	162,449	0.46	0.5	115,797	0.49	0.5	0.06
School type private in 12th grade	162,449	0.09	0.3	115,797	0.12	0.3	0.11
School SES A in 10th grade (lower SES)	162,449	0.17	0.4	115,797	0.10	0.3	(0.19)
School SES B in 10th grade (lower-middle SES)	162,449	0.38	0.5	115,797	0.32	0.5	(0.12)
School SES C in 10th grade (middle SES)	162,449	0.25	0.4	115,797	0.31	0.5	0.14
School SES D in 10th grade (higher-middle SES)	162,449	0.12	0.3	115,797	0.16	0.4	0.13
School SES E in 10th grade (higher SES)	162,449	0.08	0.3	115,797	0.11	0.3	0.11

Differences in achievement are substantial and quite constant over time in absolute terms. On average, those students entering higher education usually perform around 0.25 of a standard deviation higher in academic tests (or around 15 points in SIMCE and 40 points in University Selection Test (PSU) scores). They also come from more privileged backgrounds, as they show higher family income and parental education, as well as higher parental expectations on their children's schooling. Also, there is a smaller proportion of students attending rural schools in primary education. Interestingly, a much smaller proportion of students who took the vocational education track attended higher education (31% vs. 44 %).

Regarding school characteristics, those students attending higher education come disproportionately from schools where there were better results at University Selection Test, as well as higher average performance in national examinations in 10th grade. Those schools are predominantly classified as middle to higher SES schools by the Ministry of Education (58% of the total enrolment as opposed to 45% of the sample cohort in 2008). They also show higher average parental expectations, education and income. As expected, those schools received students with higher average scores in 8th grade.[23]

3.4.3 Model specification

In order to investigate the determinants of improved access to higher education, we estimate a discrete choice model where the dependant variable takes the value 1 if the student enters any higher education institution during the following 3 years after finishing school, and zero otherwise. Taking into account the related literature, we assume that students' decisions on participation in higher education are mainly influenced by financial

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[23] Some descriptive statistics for our estimation sample according to school SES can be found in Table 3B1, Appendix 3B. Secondary schools are unevenly distributed across them; 46% of schools are among the 2 lowest SES (lower and lower-middle SES), whereas 30% on the two highest SES (upper-middle SES and higher SES). As expected, students' average test scores are much lower in schools within the lowest SES. Raw differences show on average the achievement gap between the highest and lowest SES schools is as big as 1.6 standard deviations in student average test scores at 10th level (for the average of the subjects of math and language). In general, dispersion on parents' educational level is small within schools for each defined SES, as well as income variation, especially for the lower income groups (lower and lower-middle SES schools). In terms of schools' property, public schools are concentrated among those two groups too. On the other hand, and as expected, private schools are allocated among the highest income SES, and voucher schools (private subsidized) are mostly distributed within lower and middle SES schools.

constraints, as well as other individual, family, school and institutional factors such as individual ability and motivation, family income, expectations and cultural capital; other factors include peer influences and school academic performance, national grants and loans programs, and national and institutional student selection mechanisms characterizing access to different types of institutions in tertiary education. We follow a specification similar to that of Dustmann, Rajah & Van Soest (2003). More formally:

(1)

$$\Pr\left(HE_{ij} = 1\right) = F(X_{ij}, E_{ij}, EX_{ij}, A_{ij}, S_j)$$

where $\mathrm{F(z)} = e^{z}/(1 + e^{z})$ is the logistic function.

In our specifications X is a vector of individual and family characteristics, E represents student eligibility for public grants and loans, EX represents student's results at University Entrance Examinations (PSU), A is a vector containing measures of academic achievement from 8^{th} to 12^{th} grade, and S is a vector of school characteristics in secondary education. We observe individual i choice who attended school j in 12^{th} grade.

Among the individual and family characteristics in the model, we include: student gender, parental education, parental income, number of people at home, number of books at home, monthly fees paid by parents and parental expectations about their children's years of schooling in 8^{th} grade. We also include student attendance to pre-school education, school tracking taken by the student in upper secondary school (academic or vocational), and type of school attended at the end of primary education (rural or urban). As measures of academic achievement we include student's University Selection Test results in 12^{th} grade (PSU), cumulative GPA in secondary education, SIMCE examination scores in 10^{th} grade and at the end of primary school (8^{th} grade), and students' grade repetition record before 8^{th} grade.

As schools' observed characteristics we include: proportion of students eligible for public funding to enter higher education, average academic results in the University Selection Test in 12^{th} grade, class size, enrolment and school type. Although we cannot directly observe decision drivers, we assume students' decision making and expectations about themselves are influenced by their teachers and peers; so as part of those school factors influencing students' decisions we proxy peers performance and cultural capital by using school aggregated measures of achievement, parental expectations, and education before entering secondary education.[24]

3.4.4 Estimation methods

In our study, we decided to develop a stratified analysis, running separate regressions for students attending different school types according to their socioeconomic status definition (SES A to SES E), comparing our estimates across samples later on. With this approach, we aim to take into account the fact that each determinant influences students' decisions on access to tertiary education differently, according to student and school socioeconomic status. For instance, we know that the eligibility to state loans and grants might be crucial for students from disadvantaged backgrounds, but not necessarily for those students coming from higher income families. When looking at school level determinants we acknowledge it is very likely that certain school characteristics might make a difference only in certain specific social contexts. In our case, we are especially interested in lower and middle SES schools, although we also report regression results for all schools together.

In order to differentiate the direct effect of secondary school in students' academic performance and eligibility for funding from other determinants of access to higher education, we estimate 3 different specifications: the first one includes school academic quality, as well as other school-level characteristics and individual level determinants. In this case we only incorporate student individual achievement in 8th grade, right before entering secondary education, to account for selection into schools.[25] This specification seeks to capture all variation in student intake in tertiary studies explained by those school quality variables. A second specification also includes the proportion of students eligible for public funding at school level as an additional explanatory variable, to identify the importance of this specific measure of school academic quality on the access to higher education. A final specification incorporates student individual results in academic examinations in secondary education (PSU examination, SIMCE and GPA scores), which

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[24] Among those observed school level factors we include: school's average score in SIMCE test in 8th grade, school's percentage of students who repeated before 8th grade, school average mother's education, school's parent average expectations on their children's schooling (in years), and average family income.

[25] As previously mentioned, we also included school performance and other school level aggregated measures of cultural capital at the end of primary education, to account for students' selection into secondary schools.

account for the direct influence of those school characteristics on individual academic performance, conditional on other school, family and individual inputs.[26] [27]

3.5 Results

In the present section, we detail our main findings. Results for all schools together, and separate regressions by school SES, can be found in Table 3.3.

3.5.1 The role of secondary schools in academic performance and access to higher education

Certainly, our main interest is to investigate how important secondary schools are in explaining access to higher education, especially for disadvantaged students. Regarding this, we believe schools could be influencing students' access to higher education in 3 main different ways in the Chilean context: 1) Affecting students' academic results and then facilitating (or restricting) access to more selective institutions and academic programs. 2) Influencing students' eligibility for public funding for both professional and vocational programs. 3) Shaping students' expectations and predispositions towards higher education, and therefore influencing their decision to enter tertiary studies.

When assessing the complete effect of school quality (including that on students' academic outcomes), regression results on the first columns per SES[28] in Table 3.3 show that, conditional on equivalent average and individual attainment levels in 8^{th} grade, higher performing schools influence students access importantly (see also Figure 3.2 for these results). On average, those schools showing one additional standard deviation in University Selection Test results show students 3.4 percentual points (pp) more likely to attend higher education. This effect however, seems to be stronger among lower-middle SES schools (5.3 pp), and lower SES schools (3.6 pp) than to middle SES schools (3.2 pp). The effect is smaller for upper-middle and higher SES schools, where most students attend higher education, despite school average academic results.

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[26] In order to account for the fact that students in the same school are influenced by similar observed and unobserved factors, we estimate robust standard errors clustered at school level in all our specifications.

[27] We also ran a second set of regressions estimating a linear probability model for equation 1, including school fixed effects, in order to capture all time-invariant unobserved factors at school level which might be influencing students' decisions related to continuation to tertiary studies. These results are available on request, and gave us an idea of how much schools explain variation at an individual level.

[28] Columns 1, 4, 7, 10, 13 and 16.

Interestingly, and from our results in specification 2, an important part of the effect in access to higher education of school academic quality in secondary education (proxied through PSU test scores at 12th grade), is explained by the proportion of students at school level who were eligible for public funding given their academic results (see second column per SES, Table 3.3). When looking at differences across the different SES, we find that the influence of such proportion at school level becomes much more critical for students in low SES schools (5.7 pp) and lower-middle SES schools (6.1 pp).

On the other hand, our results are in line with those of Farías and Sevilla (2015), showing that those students taking the vocational track (usually in vocational secondary schools) have a much lower probability of attending higher education, even after taking into account academic performance through several measures of individual achievement (see figure 3.3). This is especially alarming as low SES schools have an important proportion of students in the vocational track. On average, those students attending vocational education are around 6 percentual points less likely to attend tertiary studies when compared to those attending academic courses. This negative association is even stronger in low SES schools, where this gap increases to 9 percentual points.

Finally, we acknowledge that even conditional on similar individual performance, parental expectations and income, those pupils in schools showing higher parental expectations of their children before accessing secondary education, show a higher chance of entering tertiary studies (see third column per school SES on Table 3.3 and Figure 3.3). This sort of *peer effect* is strong, especially in lower and lower-middle SES schools (up to 4 percentual points of additional chance to enter HE, for an extra standard deviation in average parental expectations). This finding persists even when conditioning on school average performance entering secondary education, which is also a strong determinant among low SES schools.

It is worth noting that, when analysing the estimated coefficients for any school level-aggregated measure included in our models, results must be taken with caution. It could always be the case that what we identify as a direct meaningful association between access to higher education and the school-level explanatory variable could be just a spurious correlation, or an overestimated or underestimated association. This would be the case if any other unobserved factors, not accounted for in the model, are both strongly related to access to higher education and the school-level covariate of interest. For instance, when using school-level test performance average values in 10th grade as an explanatory variable to explain an individual's probability to enter higher education, one could argue that it is not school performance that is related to higher chances of entering higher education, but just the average social capital at school, which is strongly related to average test scores at school. In this case, the association we are assuming to be true could be just masking another association (school average social capital and access to higher education). Although we include some related measures in our models in order to take those factors into account (for instance measures of average income and average parental education), part of the different dimensions of social capital could not be completely reflected on these variables. Therefore, the estimated values in the coefficients for school-level average test scores variables (strongly related to social capital) could still be partially reflecting the importance of social capital instead of that of academic achievement explaining access to tertiary studies.

When analysing the role individual measures of academic achievement plays in access to higher education (see third column per SES, Table 3.3), we find the most relevant academic determinants are the eligibility for public funds (defined by student academic performance), scores in PSU test, and in a second level of importance, academic results in 10th grade and grade point average in secondary education (see also Figure 3.2 for these results). We also find that even after conditioning on these measures of attainment, students' performance in primary education (measured in 8th grade) has a non-negligible explanatory value for pupils in lower-middle SES schools. These results suggest that academic achievement in primary education could also be a mechanism through which certain students could start setting their schooling expectations, at a very early stage.

The relevance of each one of these individual measures is quite high (see Figure 3.2). For instance, a student eligible for public funding is 5.5 percentual points more likely to attend higher education conditional on similar academic attainment levels and sociodemographic characteristics. However, this average effect almost duplicates in low SES schools, where eligible students are 9 percentual points more likely to attend higher education. At the same time, in these contexts, those pupils showing one additional standard deviation in PSU test scores are around 10 percentual points more likely to attend tertiary studies. The importance of academic achievement diminishes when moving towards better-off schools, where this effect drops to one fifth (2 pp). As expected, students from better-off families seem to attend higher education despite their relative performance among their peers and access to public funding. In relation to the latter on average those students who do not sit university examinations are 15 percentual points less likely to attend higher education. However, and as described in Table 3.3, such effect increases to 20 percentual points for low SES students and drops to only 5 percentual points in higher SES schools.

3.5.2 Non-academic individual level determinants

Regression outputs for all students in 12th grade in columns 1, 2 and 3 on Table 3B2, Appendix 3B, show that on average access to higher education is highly dependent on academic performance, but also on student socioeconomic status. There is a high level of association between family income, parental schooling and access to higher education. On average, one additional standard deviation on parental education (around 4 years) is associated with 2.6 additional percentual points on the probability of access to higher education. The same applies for family income (3 pp) and parents' schooling expectations about their children (3.4 pp). Also, women are 2 percentual points more likely to enter tertiary education, conditional on equivalent academic results. This gender gap increases to 5 percentual points in low SES schools. Interestingly, we also found that the number of people at home is a determinant for students attending lower to middle SES schools, whereas it is not relevant for those from better-off schools.

Table 3.3 Determinants of access to higher education by student's school SES. 2008 cohort.

Average marginal effects *	SES A SCHOOLS (LOWER SES)			SES B SCHOOLS (LOWER-MIDDLE SES)			SES C SCHOOLS (MIDDLE SES)			SES D SCHOOLS (UPPER-MIDDLE SES)			SES E SCHOOLS (HIGHER SES)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Individual-Level Determinants															
Student did not sit University Entry Examination (1 or 0)			-0.209***			-0.207***			-0.123***			-0.0670***			-0.0491***
			(0.00716)			(0.00515)			(0.00607)			(0.00676)			(0.00762)
Student eligible for HE Public Funding (1 or 0)			0.0908***			0.0831***			0.0428***			0.000932			1
			(0.0126)			(0.00680)			(0.00471)			(0.00425)			(0.00527)
Student GPA (1.0 to 7.0)			0.0295***			0.0307***			0.00710***			-0.00172			-0.00253
			(0.00695)			(0.00330)			(0.00197)			(0.00166)			(0.00182)
Student SIMCE test score in 8th grade	0.105***	0.106***	0.00826	0.0845***	0.0850***	0.00907***	0.0401***	0.0402***	0.00198	0.0106***	0.0106***	-0.000655	0.0120***	0.0120***	0.00331
	(0.00371)	(0.00350)	(0.00525)	(0.00246)	(0.00299)	(0.00303)	(0.00196)	(0.00195)	(0.00258)	(0.00143)	(0.00146)	(0.00241)	(0.00191)	(0.00213)	(0.00240)
Student SIMCE test score in 10th grade			0.0423***			0.0301***			0.0138***			0.00336			0.00446*
			(0.00535)			(0.00355)			(0.00312)			(0.00237)			(0.00250)
Student University Entry Examination average score			0.0989***			0.0875***			0.0452***			0.0247***			0.0206***
			(0.00418)			(0.00268)			(0.00225)			(0.00250)			(0.00290)
Gender (1 or 0)	0.0731***	0.0728***	0.0507***	0.0302***	0.0296***	0.0206***	0.0153***	0.0142***	0.0116***	0.0103***	0.0101***	0.0109***	0.0143***	0.0142***	0.0155***
	(0.00758)	(0.00862)	(0.00722)	(0.00597)	(0.00582)	(0.00542)	(0.00409)	(0.00416)	(0.00399)	(0.00373)	(0.00340)	(0.00304)	(0.00271)	(0.00327)	(0.00285)
Number of people at home	-0.0200***	-0.0198***	-0.0159***	-0.0241***	-0.0240***	-0.0196***	-0.0141***	-0.0139***	-0.0120***	-0.00155	-0.00155	-0.00155	0.00216	0.00216	0.00194
	(0.00340)	(0.00288)	(0.00297)	(0.00227)	(0.00215)	(0.00185)	(0.00192)	(0.00157)	(0.00153)	(0.00221)	(0.00210)	(0.00212)	(0.00160)	(0.00204)	(0.00176)
Student's parents schooling expectations (in years)	0.0599***	0.0601***	0.0436***	0.0632***	0.0634***	0.0474***	0.0294***	0.0296***	0.0243***	0.00514	0.00516*	0.00386	0.00333	0.00339	0.00369
	(0.00335)	(0.00310)	(0.00286)	(0.00218)	(0.00261)	(0.00221)	(0.00242)	(0.00176)	(0.00195)	(0.00334)	(0.00289)	(0.00325)	(0.0151)	(0.0113)	(0.00635)
Student attended rural school in 8th grade (1 or 0)	-0.0415***	-0.0403***	-0.0279***	-0.0261***	-0.0268***	-0.0192***	-0.00603	-0.00873	-0.0129	-0.00529	-0.00585	-0.00879	0.00174	0.00176	0.000276
	(0.00700)	(0.00669)	(0.00747)	(0.00737)	(0.00658)	(0.00735)	(0.00954)	(0.00732)	(0.00905)	(0.0134)	(0.0134)	(0.0104)	(0.0134)	(0.0160)	(0.0116)

(Table continues on the next page)

Table 3.3 (Continuation)

Average marginal effects *	SES A SCHOOLS (LOWER SES)			SES B SCHOOLS (LOWER-MIDDLE SES)			SES C SCHOOLS (MIDDLE SES)			SES D SCHOOLS (UPPER-MIDDLE SES)			SES E SCHOOLS (HIGHER SES)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
School-Level Determinants															
School percentage of students who are eligible for funding		0.0570***	0.0135		0.0610***	0.0194		0.0269***	0.0101*		0.00593	0.00459		0.00691	0.00745*
		(0.0209)	(0.0199)		(0.0128)	(0.0122)		(0.00629)	(0.00594)		(0.00412)	(0.00378)		(0.00462)	(0.00396)
School's University Entry Examination average score	0.0360***	0.0243**	0.000454	0.0532***	0.0282***	-0.00753	0.0322***	0.0124	-0.0172*	0.00885	0.00406	-0.0139**	0.0262***	0.0232***	0.00609
	(0.0115)	(0.0120)	(0.0113)	(0.00791)	(0.00975)	(0.00990)	(0.00967)	(0.00937)	(0.00902)	(0.00656)	(0.00602)	(0.00693)	(0.00525)	(0.00576)	(0.00573)
School SIMCE test score in 8th grade	0.00114	-0.0114	0.0101	0.0188*	0.000374	0.0277**	0.00147	-0.00820	0.00603	0.00154	-1.25e-05	0.00758	-0.0184***	-0.0186***	-0.0135***
	(0.0151)	(0.0188)	(0.0151)	(0.0112)	(0.0109)	(0.0118)	(0.00942)	(0.00878)	(0.00886)	(0.00519)	(0.00503)	(0.00551)	(0.00388)	(0.00530)	(0.00502)
Class size in 12th grade	0.0223***	0.0222***	0.00401	0.0203***	0.0208***	0.00894***	0.00588**	0.00570**	0.00176	0.00138	0.000974	0.000136	0.00250	0.00186	0.00187
	(0.00564)	(0.00417)	(0.00433)	(0.00352)	(0.00378)	(0.00239)	(0.00274)	(0.00287)	(0.00286)	(0.00228)	(0.00169)	(0.00181)	(0.00248)	(0.00260)	(0.00211)
Vocational course in 12th grade	-0.181***	-0.170***	-0.0927***	-0.141***	-0.119***	-0.0783***	-0.0530***	-0.0442***	-0.0276***	-0.0216	-0.0245	-0.0165			
	(0.00988)	(0.0103)	(0.00963)	(0.00807)	(0.00868)	(0.00916)	(0.00771)	(0.00762)	(0.00670)	(0.0243)	(0.0265)	(0.0291)			
School type public in 12th grade (1 or 0)-Ref. Voucher school	0.00302	0.00199	0.00816	-0.00394	-0.00444	-0.00648	-0.0122	-0.00914	-0.00557	-0.0170**	-0.0162**	-0.0162**			
	(0.0126)	(0.00979)	(0.0129)	(0.00829)	(0.00409)	(0.00682)	(0.00802)	(0.00652)	(0.00682)	(0.00738)	(0.00702)	(0.00667)			
School type private in 12th grade (1 or 0)				0.0582**	0.0690***	0.181***				-0.00485	-0.00116	-0.00143	0.00422	0.00616	0.00696
				(0.0265)	(0.0215)	(0.0250)				(0.00888)	(0.00778)	(0.00797)	(0.00649)	(0.00680)	(0.00679)
School average student's parents schooling expectations (years)	0.0294***	0.0259***	0.0371***	0.0409***	0.0347***	0.0375***	0.0333***	0.0239**	0.0195**	-0.00612	-0.00692	-0.00673	-0.00453	-0.00437	-0.00729
	(0.0108)	(0.00906)	(0.0106)	(0.00937)	-0.00802	(0.0104)	(0.0108)	(0.0101)	(0.00953)	(0.0116)	(0.0139)	(0.0153)	(0.0193)	(0.0144)	(0.0138)
Observations	26,904	26,904	26,904	62,195	62,195	62,195	41,017	41,017	41,017	19,019	19,019	19,019	13,314	13,314	13,314
Number of students enrolled in Higher Education (2009-11)	11,030	11,030	11,030	37,317	37,317	37,317	36,095	36,095	36,095	18,448	18,448	18,448	13,047	13,047	13,047
Percentage of students in Higher education (2009-11)	0.41	0.41	0.41	0.60	0.60	0.60	0.88	0.88	0.88	0.97	0.97	0.97	0.98	0.98	0.98
Number of Clusters	466	466	466	659	659	659	576	576	576	383	383	383	332	332	332
Pseudo R2			0.1465			0.1351			0.1288			0.031			0.059

Bootstrapped standard errors clustered at school level in parentheses (200 replications). *** p<0.01, ** p<0.05, * p<0.1. All non-dummy regressors standardized.
Note 1: Additonal controls not included on the table: School enrolment in 12th grade, school percentage of students who repeated course before 8th grade, school average mother's education (included in specifications for all columns). Parental schooling (in years), number of books at home, parental fees (in USD), student attended pre-school education (1 or 0), student switched school in 8th grade (1 or 0), student repeated course once or more before 8th grade (1 or 0).

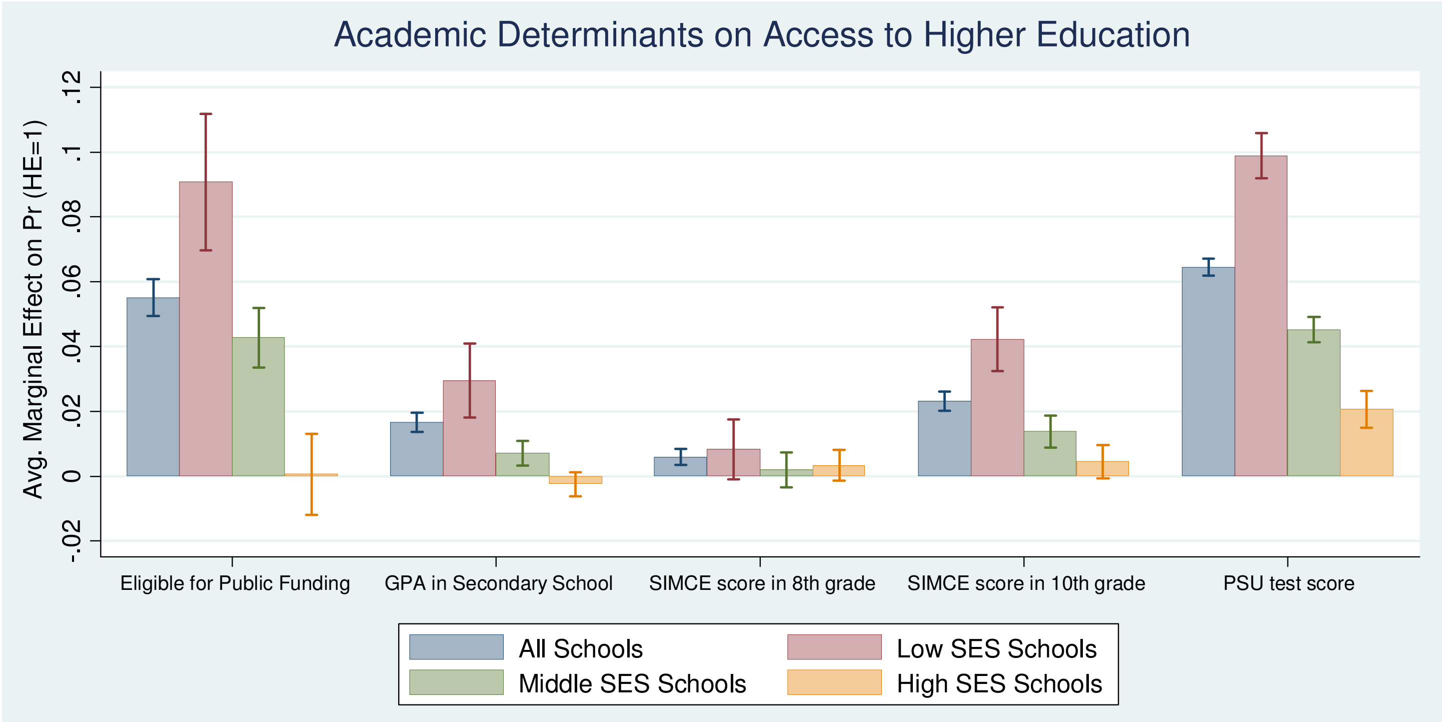

Figure 3.2 Academic determinants on access to higher education by school SES.

Note 1: Average marginal effect on the probability of access to higher education. All measures of student individual achievement (GPA, PSU test score, SIMCE scores) standardized to have a zero mean and standard deviation of 1. Eligibility for public funding takes value 1 or 0 depending on PSU score over/below 475 threshold and GPA or GPA over/below 5.3 (in a scale of 1.0 to 7.0). Note 2: Confidence intervals significant at 95% significance level. Bootstrapped standard errors clustered at school level (200 replications).

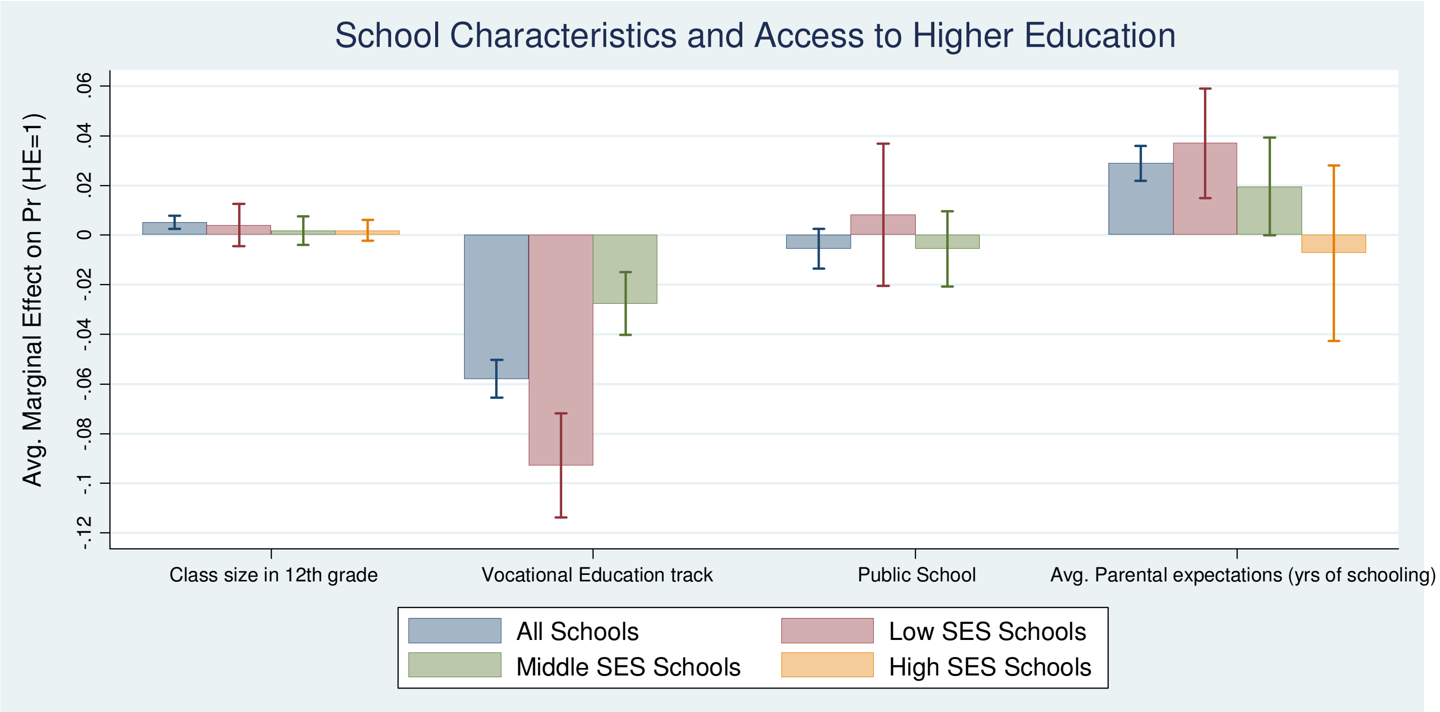

Figure 3.3 School characteristics and access to higher education by school SES.

Note 1: Average marginal effect on the probability of access to higher education. Al continuous measures at school or class level standardized to have a zero mean and standard deviation of 1. Vocational education track takes value 1 or 0 depending on type of course attended by the student in 12^{th} grade.

Note 2: Confidence intervals significant at 95% significance level. Bootstrapped standard errors clustered at school level (200 replications).

3.6 Conclusions and policy implications

When assessing the importance of secondary school quality in access to higher education we find schools have a big influence, especially for students in deprived contexts. These results are quite encouraging, as they imply that even though primary education has an important role in explaining continuation to tertiary studies, its determinant position could be partially reverted during secondary education, mainly through improvements in academic achievement at University Selection Tests. Moreover, peers and schools seem to influence students' decisions importantly. In this regard, the effect that school culture could have in incentivizing further education through higher shared parental expectations on their children's schooling is also an interesting finding.

On the other hand, we also acknowledge that even though individual measures of academic achievement at school have some influence in enrolment after taking into account university entrance examinations results, they do not seem to be especially important in explaining access to higher education in vulnerable schools in the Chilean context. As results in the University Selection Test are highly explained by family background and do not necessarily reflect students' academic potential, the incorporation of alternative mechanisms for vulnerable talented students to access selective institutions – such as students' grade point average rankings – is a matter of urgency. Although some progress in equality has been made by taking these types of measures at some selective institutions, still much more needs to be done.

One finding of concern is the negative effect the vocational education track in secondary education has in discouraging students' access to tertiary studies in the Chilean context, as well as the financial constrains many students seem to be experiencing. Both aspects affect importantly the students' career decisions and opportunities in life. In relation to the latter, the effect that public funding seems to be having on students' decisions is particularly relevant in low SES schools. Tuition fees are especially high in the Chilean tertiary education system; therefore, resources should be made available for both lower and middle SES students in order to foster higher participation in more vulnerable populations. In this regard, the threshold of 475 points at the University Selection Test to access public funds for university studies seems to be extremely restrictive, especially for vulnerable students, and should be lowered substantively. As results in this test are strongly associated with student background, this policy provides improved access to public funding to students from middle SES contexts rather than to those from low SES backgrounds, who are more dependent on them, as our results show. Even though a special partial scholarship not linked to University Selection Test results is made available for short technical programs, this is not the case for professional careers. This presents a big issue in terms of equal access to educational opportunities for students from deprived contexts. At the same time, regulations on the maximum fee higher education institutions can charge for the different academic programs, could also be a suitable policy in the Chilean context, where tuition fees are extremely high.

Chapter 4

Institutional Policies and Inequity in Education. Do School Accountability Practices Increase Inequality of Educational Opportunity? A Panel Cross-national Study Using PISA.

4.1 Introduction

Along with schools' learning standards reform, accountability reform is one of the most important events taking place in different educational systems around the world. According to recent reports by World Bank (Bruns, Filmer & Patrinos, 2011) and OECD (2010b), accountability systems are increasingly prevalent around the world, in both developed and developing countries, with a large number of them introducing national examinations and other forms of school accountability systems to their schools over the last 20 years (Benavot & Tanner, 2007).

Even though several studies, especially in the US, have shown that certain accountability systems have a positive impact on average educational achievement (Woessmann, 2005; Jacob, 2005; Carnoy & Loeb, 2002; Bruns, Filmer & Patrinos, 2011), very few studies examine their effects on inequality of outcomes and their implications for equity in education (Braga, Checchi & Meschi, 2013; Burgess, Propper, Slater & Wilson, 2005; Schütz, West & Woessmann, 2007; Woessmann, 2005). Moreover, although there is some evidence, provided by cross-national studies, suggesting school accountability practices (external exit examinations) would not affect equity in educational results at a country level importantly (Schütz, West & Woessmann, 2007), these results rely on cross-sectional data, where it is difficult to isolate school accountability from the institutional setting of each specific country which might be affecting equity in education. At the same time, whether there are "positive" or "negative" accountability practices for equity, and whether the effect of accountability depends on other institutional characteristics (such as school autonomy, school competition and selection policies), remains a fairly open question. Moreover, with the exception of a few studies (Braga, Checchi & Meschi, 2013; Bruns et al., 2011; Smith, 2016), most of the evidence about the effect of accountability systems on educational outcomes comes from the US and the UK. Hence, the question of whether this trend applies in other countries with different institutional characteristics remains open to research. In this work, we tackle this question by making use of PISA information, setting up a panel dataset for 65 different countries and 5 waves for a time-period of over 10 years.

Depending on how they are designed, accountability systems could produce incentives for school agents to respond to their pressures in different forms, by following different strategies at schools. At the same time, depending on the characteristics of the information provided to parents, they could also react to this information in different ways. Incentives to parents, and also to schools themselves, could potentially have a positive or negative impact on the socioeconomic gap in educational achievement, as well as on students' social composition at schools (Figlio & Loeb, 2011; Bifulco & Ladd, 2007).

Accountability constitutes one of the most controversial school reforms of the last years, with many advocates as well as detractors. No matter the position on this issue, certainly the use of standardized student assessments has had an important impact on the schools' environment and culture, head teachers' aims and strategies, and teachers' goals, strategies and practices (Hamilton et al., 2007; Rouse, Hannaway, Goldhaber & Figlio, 2013). Studying school accountability systems and their effects remains a topic of high interest and importance, as it has reshaped the way education systems seek to improve their educational standards. Along with other institutional characteristics, such as privatization levels, school autonomy, and students' admission policies, the existence of school accountability systems seems to be one of the main features currently characterizing educational systems.

On the one hand, accountability supporters believe school accountability is a powerful tool for informing decision making at schools, thus improving academic results and rewarding best performing schools for their good work while holding bad performing schools into account (Brundrett & Rhodes, 2011; Bruns et al., 2011; Hopkins, 2007; Jacob, 2005; Ladd, 2002; Schütz, West & Woessmann, 2007). On the other hand, its detractors argue that certain school accountability systems unnecessarily increase competition among schools, increase students' social and academic segregation, force teachers to focus on specific contents (narrowing the national curriculum) and on specific students, and over-standardize the educational process, narrowing its goals, while also increasing tensions within educational communities (Hamilton et al., 2007; Rouse et al., 2013; Reback, 2008).

By using data available for several PISA waves and exploiting the variation in measures of school practices associated with school accountability within countries over time, the present work aims to study some of the mechanisms by which accountability systems could be increasing (or decreasing) average academic achievement and inequality in educational results at schools. We find that publicly posting achievement information increases inequality of outcomes, while no gains in average achievement are observed in most of our specifications. On the other hand, our results suggest that schools' internal use of students' academic results for benchmarking purposes is linked to improved average performance and reduced levels of inequality in student outcomes. Our results are mostly robust to different model specifications.

This study expects to make a contribution to that brunch of the literature concerned with the effect of accountability systems in educational outcomes as measured by PISA test scores. Unlike other previous works in this topic using PISA data, such as that of Schütz, West & Woessmann (2007), Smith (2016), or Woessman (2005), this study examines data from a large number of countries, while it is also able to isolate other country-specific fixed institutional characteristics by measuring school accountability practices for each country in repeated occasions. We also aim to understand the concept of school accountability in a broader way, by analysing different practices and institutional characteristics usually associated to school accountability separately.

4.2 Conceptualizing school accountability

Conceptualizing school accountability is not a trivial task, as many different definitions have been introduced to the literature, not allowing for one, generally accepted and agreed upon definition. Several studies understand school accountability systems as those where students' centralized assessments are used to inform schools' internal policies, or to evaluate school performance when meeting certain educational standards and/or goals (Brundrett & Rhodes, 2011). Other studies focus on the mere existence of external examinations (Woessmann, 2005), whereas others focus on the use of students' results in those examinations to inform different actors (e.g. head teachers, central governments, parents) about schools and students' performance (see, for instance, Burgess & Briggs, 2010).

Some accountability systems make use of explicit sanctions and rewards for those schools performing above or below what it is expected. Others do not explicitly make use of such sanctions, however, they implicitly – by publicly announcing these results – give certain signals to the different stakeholders, aiming thus to influence their decisions (and appraisals). The so called "high-stakes" accountability systems usually incorporate concrete mechanisms to reward/sanction schools for their performance in the set standards, whereas "low-stakes" systems inform the public about academic results, but do not usually take direct, concrete actions.

In any case, the idea behind accountability systems is that information about students' results is used as a mechanism to hold schools, head teachers and teachers accountable. As outlined by Figlio & Loeb (2011), the principal-agent problem provides a rationale for school accountability: if school systems' stakeholders (parents, central governments, education local authorities) are not able to observe the results of the educational process, then principals, teachers and schools could behave in a way that is contrary to the stakeholders' benefit. On the other hand, by providing information on students' educational achievement, those school actors could be held accountable by school communities and governments, putting pressure on them to achieve the set educational goals for their students.

The complexity and diversity of the different existing accountability schemes makes it difficult to venture into a specific definition of school accountability (and to make generalizations about any research findings). In this study, we work with a broad definition of school accountability, whereby we understand school accountability as any school or government practice where information about standardized assessments is used to: 1) inform governments or members of the public about schools' academic results, 2) evaluate schools by comparing their performance with other schools and/or national benchmarks and 3) inform schools' internal policies and decisions. By using available information from PISA, this work will explore different school practices associated with this definition of school accountability and ask whether these practices could impact average student achievement and inequality in educational outcomes for the subject of math.

4.2.1 School accountability in Chile

School accountability systems in Chile have been in place for almost 30 years (Bruns et al., 2011; Mizala & Urquiola, 2013). The so-called SIMCE test[29] was established in 1997, and since then, parents, municipalities and governments have used this examination to

[29] The SIMCE test is a census standardized examination currently applied to most students in 4th, 8th and 10th grade.

assess schools' academic performance. The Chilean education system is one of mixed provision, with an important proportion of voucher schools which have been running for more than 30 years, informing and promoting school choice among parents (Ladd, 2002).

In 2000, an economic incentive was established to reward those schools performing above the expectations, according to the students' socioeconomic status. However, and based on recent studies, the so-called SNED programme did not have any substantial impact on educational outcomes (Mizala & Urquiola, 2013). Nonetheless, and according to a previous study, this programme seems to have affected schools' internal practices and assessments (Contreras & Rau, 2012).

Even though in Chile there is a long tradition of using standardized tests to assess the educational process, a new law aiming to establish a system for quality assurance of education was passed in 2009.[30] The National System for Quality Assurance (SNAC) established new institutions in charge of tracking, rewarding, sanctioning and supporting schools to achieve a set of educational goals defined by certain educational standards. At the same time, schools were classified according to their relative performance in the SIMCE test, as well as in other educational outcomes of interest.

4.3. Previous evidence: the effect of accountability on educational outcomes

International evidence about the effect of different accountability procedures on equity in education is mixed and limited. Although there is extensive literature, especially from the US, about the effect of accountability practices on educational outcomes (Carnoy & Loeb, 2002; Hanushek & Raymond, 2004, 2005; Jacob, 2005) there are very few cross-national studies evaluating the effect of accountability practices on educational outcomes incorporating inequality of educational results as a relevant measure. The main reason for the lack of studies of such nature is the absence of comparable information across countries, which in turn leads to few international datasets with information about these practices.

[30] For details on the law's contents see Congreso Nacional (2010).

One important exception to this has been the use of PISA in previous studies. Following a slightly different approach to ours, and by using PISA 2006 information, Schütz, West & Woessmann (2007) found that the presence of external exit exams led to improved outcomes and had no important impact on equity. They find no association between student SES and the effect of external exit exams on education outcomes. However, one of the authors, in a prior study using TIMMS and PISA data at country level (Woessmann, 2005), found a negative association between accountability and equity in outcomes, mainly explained by the fact that higher ability students would show a bigger positive response while under accountability systems, increasing the socioeconomic gap in educational achievement. On the other hand, a recent report by OECD using PISA 2009 data showed a positive association between student outcomes and school accountability (posting academic results publicly) when schools exhibit higher levels of autonomy (OECD, 2011), although the study also used only one PISA wave to imply those associations. As previously mentioned, these and other comparisons make use of cross-sectional data to estimate the effect of accountability systems on educational outcomes, where it is difficult to isolate school accountability from other institutional and school system characteristics affecting equity in achievement.

Another notable exception is a previous work by Braga, Checchi & Meschi (2013), who built up a long panel dataset for 24 European countries, including school accountability as well as other school systems' institutional reforms in their analysis. By using regression techniques, their results suggest that the introduction of accountability systems (such as standardized test and school evaluations) had a positive or null impact on average achievement, while it increased inequality in educational results importantly, by spreading the overall distribution of test results. In this study, the authors examine the impact of school accountability at different parts of the distribution of educational attainment, finding important differences amongst their estimates. Their results reinforce the idea that accountability practices could have a negative effect on low performing students while improving high performing students' results, leading to increased inequality in outcomes. Furthermore, other related research in the US and the UK shows certain accountability policies at schools may lead to unintended consequences: increasing educational inequality through, for example, parental school choice, school's student admission policies and higher selectivity at schools, or teachers focusing on academically advantaged students or on those students more likely to improve schools' results (see

Burgess, Propper, Slater & Wilson, 2005; Burgess & Briggs, 2010; Krieg, 2008; Jacob, 2005; Hanushek & Raymond, 2004, 2005).

In relation to national or state-level studies, and as part of the No Child Left Behind Act[31] in the US, many papers aimed to study the direct impact of this policy on educational outcomes (Dee & Jacob, 2011; Hanushek & Raymond, 2004, 2005; Jacob, 2005; Krieg, 2008). In general, their findings suggest a consistent positive effect on average educational outcomes, although figures about the impact of the policy on the overall distribution of educational outcomes and its implications are subject to more debate, as many of these studies report an increase in inequality of results.

In the UK, another country with a long tradition in the use of standardized tests, Burgess et al. (2005) found a very small positive effect of making results public in educational outcomes, with low ability students being the least benefited. In another study, Burgess, Wilson & Worth (2011) found that the abolishment of school performance league tables in Wales led to a significant drop in achievement at its schools.

In other countries, results are mixed. A recent report by the World Bank (Bruns et al., 2011) summarizing information on school accountability in more than 10 countries, found that there is evidence of improved outcomes in many developing countries, showing different sorts of school accountability systems, although findings in terms of relevance and direction differ across countries and initiatives. The available international evidence does not indicate whether specific accountability practices might have a different impact on equity in emerging countries, when compared to the developed world (see Hanushek, Link & Woessmann, 2013 for the case of school autonomy). Also, the question of whether certain types of school accountability practices increase equity, whereas others don't, remains open. These issues clearly point towards the necessity for further examination of this topic. This study seeks to explore different types of school accountability practices and their impact on educational outcomes.

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[31] No Child Left Behind was a US Act of Congress which mandated all public schools in the US receiving public funding to administer standardized evaluations in a set of educational standards annually to all students in Elementary and Secondary Schools to track academic progress. Each state oversaw the design and administration of the test, and schools were expected to improve their results over time. If the schools' results were repeatedly under the expected levels of achievement, a series of steps were taken to improve them.

4.4 Data and methods

This work uses available data gathered from the Programme for International Student Assessment (PISA). PISA has been applied to several countries since 2000. The available results gathered up to 2012 comprise five different applications every three years (2000-2012), although the countries assessed in each wave differ from each other, with most countries in our analysis being present in three or four occasions[32]. The test is applied to 15 year old students attending any type of school and grade, covering three different areas (math, reading and science) and aims to assess a number of skills and competences defined as crucial by OECD[33]. Results for each application and subject are standardized to have an overall mean of 500 and a standard deviation of 100 points across the OECD countries.

In order to produce a representative sample of the student population for each country, a two or three stage sampling procedure was performed for each application[34]. Although the number of schools and students differs by country and application, usually not less than 1,500 students per country were assessed in each wave, with around 35 students per chosen school.

We constructed a country-level panel dataset, by merging data on student achievement, school institutional features (aggregated measures of schools observed characteristics and internal policies) and student characteristics for all five PISA available waves, comprising a potential final sample of around 1,700,000 students from 75 different countries. We restricted our sample to those countries with at least two PISA applications and available information about school practices (65 countries). Our sample contains countries with different levels of economic development, languages spoken and geographic locations, incorporating countries in Latin America, South East Asia, South Asia, Africa, Central and Eastern Europe, North America and Oceania.

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[32] In 2000, 32 countries participated, with 28 OECD and 4 Non-OECD countries. In 2003, 41 countries participated, with 30 OECD and 11 Non-OECD countries. For 2006 and 2009 they were 57 and 75 in total. Finally, in 2012, 65 countries participated in the study, from which 34 were OECD countries.

[33] 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).

[34] Usually, a school within each defined strata is chosen and later on a sample of students from each school is drawn. Replacement protocols for schools and minimum response rates per school are also included in the sampling framework.

As previously stated, we were able to access and link information about schools' characteristics, students' demographic characteristics and students' households characteristics. As part of the application process, all students were given a questionnaire to complete which included information on parental education and occupation, working status, immigration status, language spoken at home, educational resources available at home, etc. In our specifications we make use of several individual and family characteristics which are present in all involved PISA applications questionnaires. In Table 4.1, average figures for student and family characteristics can be found for the applications in the years 2000 and 2012. Our estimation sample is slightly smaller for those years and will be detailed in the following section.

Table 4.1 Students' and family characteristics by PISA wave (years 2000 & 2012).

	PISA 2000					PISA 2012				
	Obs	Mean	SD	Min	Max	Obs	Mean	SD	Min	Max
Student Level Characteristics										
Math score. PISA test.	127,388.0	477.95	113.98	-108.9	864.04	480,174.0	469.41	103.33	19.8	962.23
Age	126,229.0	15.69	0.32	14.3	16.25	480,058.0	15.78	0.29	15.2	16.33
Gender (female=1)	126,442.0	0.51	0.50	0	1	480,174.0	0.50	0.50	0	1
Inmigration background (1st generation=1)	127,388.0	0.04	0.19	0	1	466,619.0	0.06	0.23	0	1
Inmigration background (2nd generation=1)	127,388.0	0.10	0.30	0	1	466,619.0	0.06	0.24	0	1
Inmigration background (other Language at home=1)	117,169.0	0.11	0.31	0	1	460,295.0	0.12	0.33	0	1
Index of socioeconomic status (ESCS)	123,024.0	-0.48	1.09	-4.61	2.73	468,383.0	-0.27	1.13	-5.95	3.69
School Level Characteristics										
School operation (publicly operated=1)	105,527.0	0.83	0.38	0	1	471,930.0	0.80	0.40	0	1
School funding (share of budget paid by government)	118,463.0	0.84	0.26	0	1	428,373.0	0.80	0.31	0	1
School funding (share of budget paid by fees)	106,085.0	0.13	0.25	0	1	411,766.0	0.17	0.30	0	1
School location (small town=1) Ref cat.: Village or rural area	103,170.0	0.21	0.41	0	1	471,356.0	0.20	0.40	0	1
School location (town=1)	103,170.0	0.32	0.47	0	1	471,356.0	0.30	0.46	0	1
School location (city=1)	103,170.0	0.23	0.42	0	1	471,356.0	0.26	0.44	0	1
School location (large city=1)	103,170.0	0.13	0.34	0	1	471,356.0	0.14	0.35	0	1
Student teacher ratio	100,904.0	17.06	18.94	0	310.5	425,150.0	15.37	10.73	0	335.29
Number of students	104,327.0	786.60	604.03	0	9815	451,107.0	847.34	696.57	0	11483
Share of fully certified teachers	127,404.0	0.86	0.28	0	1	480,174.0	0.86	0.30	0	1
Shortage of math teachers=1, 0 otherwise	120,995.0	0.38	0.48	0	1	466,551.0	0.38	0.49	0	1
Shortage of science teachers=1, 0 otherwise	120,622.0	0.38	0.49	0	1	466,029.0	0.38	0.49	0	1
Shortage of language teachers=1, 0 otherwise	121,162.0	0.34	0.47	0	1	466,552.0	0.34	0.47	0	1
Share of full time teachers	105,072.0	0.85	0.21	0	1	459,069.0	0.83	0.26	0	1

4.4.1 Measures of student socioeconomic status

By utilizing part of the sociodemographic information on students and their families, and for each application separately, the OECD produces an index of socioeconomic status for each student household: the so called "PISA index of Economic, Social and Cultural Status" (ESCS), which is produced via principal component analysis techniques[35], summarizes information and makes it comparable across countries within application. Recently, this measure has been made comparable across the different PISA applications by OECD.

There is important variation in the ESCS index across and within countries (OECD, 2013a). On the other hand, the association between SES inequality and inequality of results is not straightforward either, suggesting that it is not possible to see a direct association between socioeconomic inequality and inequality in educational outcomes at country level (Freeman, Machin & Viarengo, 2011; Woessmann, 2004). In our estimations, we make use of this measure as a proxy for student socioeconomic status, looking for systematic differences in the relationship between school accountability practices and student educational outcomes, according to their measures of socioeconomic status.

4.4.2 Measuring school accountability

To produce measures of school accountability, we make use of information obtained from questions directed at school principals as part of the PISA application. The school questionnaire reports information on school characteristics (e.g. property, funding, tuition fees, enrolment, teachers' body), internal policies (school autonomy, competition with other schools, assessment practices), teachers' characteristics and parental involvement, among others.

There are several items of interest in the school questionnaire related to school accountability. In one of them, school principals are asked about the use of standardized

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[35] More specifically, this index makes use of information derived from measures of occupational status, parents' educational level and home possessions, as well as books available at home. More information on this index and its comparability over time can be found at OECD (2014).

assessments. More specifically, they are asked whether their school made use of standardized assessments to: a) compare the school academic results with other schools; b) compare the school academic results with national or regional benchmarks and c) monitor the school's progress from year to year. On a second item, and with regard to the use of academic results by external agents, they are asked: a) whether school academic achievement results are posted publicly and b) whether results are tracked over time by an administrative authority.

For most of the items previously mentioned, and as they were originally measured at school level, we produced an aggregated measure at country level for each PISA wave separately. More specifically, we produced a variable reflecting the proportion of schools in each country showing such practices. Unfortunately, we do not possess information for all these variables for all PISA applications, so our analysis involves information for only a limited number of PISA waves for each item. For example, for 2006 we only have available data on the use of external examinations by external agents (whether students' academic results are posted publicly and/or tracked over time by an administrative authority). For the case of internal use of academic results (whether the school used its academic results to compare itself with other schools and/or with national benchmarks), different questions were asked across different examination years, so we focused on the items where more PISA waves were available (years 2000, 2003, 2009 and 2012). In our regressions results we decided to use only those measures of school accountability that were consistently measured over time (using exactly the same questions), something that reduced the number of PISA waves available.

In relation to the previous issue, and in order to have complete data for the whole time span, as part of our robustness checks we attempted to impute part of the missing data on our measures of school accountability, making use of the information available in all PISA waves. However, in our results section, we only report results without imputation on these key variables (making use only of original records, for those years where exactly the same questions on accountability were asked), as our imputation results are not completely consistent for all items and across PISA waves. Other results including imputation on some of the school accountability measures for certain waves can be found in the Appendix 4D and will be discussed in the robustness checks section.

For our models not including imputation on measures of school accountability, we have a uniform treatment for all missing data at school and student level, whereby we follow the standard procedure of imputing missing data to a constant, adding a dummy indicator as an indicator of missingness, subsequently assessing their statistical relevance.

4.4.3 Descriptive statistics

As mentioned at the beginning of this section, in total, we work with a sample of 65 countries. Since we need information at school level to construct our measures of school accountability, we eliminated from the sample those countries with no information about school practices. We also decided to eliminate all countries present only in one PISA application[36].

Within countries, we dropped from our sample those schools with no information about school practices and school characteristics. We also dropped all the cases where we had no information at all about student, family or household characteristics. Our final estimation sample ranges from 1,324,000 to 1,160,000 students, in accordance with the PISA waves and covariates included in the specifications.

In Table 4.2 we can observe values for all utilized school accountability measures at country level, as well as PISA scores in the subject of math per country (average results and dispersion) for years 2000 and 2012 when available[37][38].

Figure 4.1 shows how one of the school accountability measures (school achievement data is posted publicly) looks over time for the period between 2006 and 2012. From this measure, we can see that several countries showed important fluctuations in a short period of time, whereas others remained quite stable. Countries like Bulgaria, Brazil, Chile, Singapore, Turkey and Korea showed important variations in a six-year period,

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36 In particular, we took France out of the sample for the first reason, and 13 other countries for the second.
37 When information was not available we replaced it with the closest available PISA examination for that country.
38 We decided to include all countries with information in PISA 2000 although, in practice, results for this wave are not strictly comparable to results in 2003 and later applications for all countries. Countries like the Netherlands, the United Kingdom and Luxemburg showed some issues related to response levels, language used in the application or sampling, which affected comparability over time. In this case we decided to include them in our sample anyway, as for most practices under study we do not make use of the PISA 2000 head teachers' questionnaires or test scores, but explore differences mostly between the PISA test in 2003 (or 2006) and 2012.

whereas others like Argentina, Great Britain, Italy, Mexico and the US remained relatively stable over time. Figures and tables with the information for all other accountability measures can be found in Appendix 4A.

Given the figures below, one of the limitations of the present study is that, as detailed in our preferred model specification in the following section, the identification of the effect of accountability practices on educational outcomes relies on significant changes over time within countries on the measures of interest. However, only a limited number of the 65 countries in our analysis show important levels of variation in such measures in the time-period under study. For instance, for the school practice of posting achievement results publicly (see Table 4.2) only a small number of countries show important changes. Only 20 countries show changes of more than 10 percentage points in the proportion of schools implementing such practices. This number drops to 8 when only taking into account those countries showing changes over 20 percentage points. For the case of tracking results publicly, 26 countries show changes of 10 percentage points or more, and only 6 countries show changes of 20 percentage points or more. For benchmarking practices, the number of countries showing important variations is relatively bigger. For the school practice of comparing results with other schools, the number of countries involved is 30 – for changes of 10 percentage points or more – and 9 – for changes of 20 percentage points or more. Finally, for the practice of comparing school results with national benchmarks, the number of countries increases to 47 and 38 respectively.

This means that our results will be mostly based on those countries showing significant changes. At the same time, however, and as revised in the following sections, our cross-sectional estimates (exploiting variation across countries) show very dissimilar results to our panel estimates. Therefore, we still decided to focus our analysis on those model specifications including country fixed effects, where we believe a more causal interpretation can be derived.

Table 4.2 Descriptive statistics on school accountability per country. PISA 2012-2000. Estimation sample

Country	Average Achievement in PISA Math			Average Dipersion in PISA Math (SD)		
	2012	2000	chg	2012	2000	chg
	(2009)	(2003/06/09)		(2009)	(2003/06/09)	
ALB	394.6	381.2	4%	91.3	106.7	-14%
ARE****	433.9	420.7	3%	89.8	92.3	-3%
ARG	388.5	387.4	0%	76.3	117.4	-35%
AUS	503.8	533.7	-6%	96.0	89.5	7%
AUT	505.6	514.8	-2%	92.7	92.4	0%
AZE**/***	430.8	475.9	-9%	64.3	47.6	35%
BEL	515.2	519.3	-1%	102.3	105.3	-3%
BGR	438.4	429.6	2%	93.6	110.8	-16%
BRA	388.5	332.8	17%	78.3	96.8	-19%
CAN	518.0	533.0	-3%	88.7	84.6	5%
CHE	530.5	528.3	0%	94.4	99.5	-5%
CHL	422.4	382.9	10%	80.3	93.4	-14%
COL***	376.6	369.6	2%	75.0	88.0	-15%
CRI****	407.2	409.9	-1%	68.5	71.6	-4%
CZE	498.8	497.5	0%	94.6	95.9	-1%
DEU	513.7	489.8	5%	96.4	102.0	-6%
DNK	499.9	513.7	-3%	82.1	85.9	-4%
ESP	484.6	476.4	2%	87.3	90.1	-3%
EST***	520.0	514.9	1%	80.5	80.4	0%
FIN	519.1	537.1	-3%	85.9	80.1	7%
GBR	494.0	529.7	-7%	94.6	91.7	3%
GRC	453.5	447.3	1%	87.6	107.9	-19%
HKG	561.4	560.5	0%	95.9	93.2	3%
HRV***	471.0	467.2	1%	87.7	83.3	5%
HUN	477.7	487.9	-2%	93.9	98.6	-5%
IDN	375.5	366.1	3%	72.0	85.9	-16%
IRL	501.1	503.0	0%	84.4	84.3	0%
ISL	493.1	515.0	-4%	92.4	84.2	10%
ISR	466.8	433.6	8%	104.9	130.1	-19%
ITA	485.0	458.8	6%	92.5	89.7	3%
JOR***	385.6	383.8	0%	77.6	83.4	-7%
JPN	536.7	556.8	-4%	93.5	87.2	7%

Country	School Accountabily-Resuls Posted			School Accountabily-Resuls Tracked			School Accountabily-Benchmarking I (Other schools)			School Accountabily-Benchmarking II (National Performance)		
	2012	2006	chg	2012	2006	chg	2012	2003	chg	2012	2000	chg
	(2009)	(2009)		(2009)	(2009)			(2009)		(2009)	(2003/06/09)	
ALB+	0.26	0.29	-0.02	0.84	0.80	0.04	0.72	0.75	-0.03	0.69	0.65	0.04
ARE+/v	0.42	0.39	0.03	0.88	0.85	0.02	0.61	0.56	0.04	0.69	0.00	0.69
ARG+	0.10	0.08	0.02	0.74	0.49	0.25	0.07	0.14	-0.07	0.24	0.24	0.00
AUS	0.64	0.52	0.12	0.89	0.85	0.04	0.38	0.38	0.00	0.53	0.43	0.09
AUT	0.05	0.07	-0.02	0.52	0.55	-0.03	0.21	0.33	-0.11	0.24	0.08	0.16
AZE+/++/v	0.81	0.78	0.03	0.74	0.65	0.09	n.a	0.80		n.a	0.22	
BEL	0.03	0.04	-0.01	0.50	0.53	-0.03	0.17	0.06	0.11	0.22	0.07	0.15
BGR+	0.50	0.18	0.32	0.87	0.73	0.14	0.77	0.60	0.17	0.78	0.59	0.19
BRA	0.33	0.20	0.13	0.88	0.84	0.04	0.46	0.25	0.21	0.63	0.35	0.28
CAN	0.48	0.47	0.01	0.88	0.80	0.08	0.54	0.39	0.15	0.75	0.42	0.32
CHE	0.03	0.06	-0.03	0.46	0.36	0.10	0.23	0.13	0.10	0.38	0.14	0.24
CHL+	0.57	0.36	0.22	0.87	0.74	0.13	0.37	0.39	-0.02	0.50	0.39	0.11
COL+/v	0.47	0.31	0.16	0.82	0.76	0.06	0.60	0.56	0.04	0.68	0.08	0.59
CRI+/v	0.12	0.08	0.04	0.96	0.77	0.19	0.48	0.36	0.12	0.60	0.01	0.58
CZE	0.35	0.48	-0.13	0.44	0.54	-0.11	0.53	0.57	-0.04	0.48	0.45	0.04
DEU	0.08	0.12	-0.04	0.31	0.48	-0.17	0.23	0.17	0.06	0.37	0.11	0.27
DNK	0.35	0.35	0.00	0.63	0.27	0.36	0.47	0.03	0.43	0.49	0.04	0.45
ESP	0.13	0.09	0.04	0.77	0.66	0.11	0.34	0.23	0.12	0.41	0.18	0.22
EST+/v	0.34	0.50	-0.16	0.79	0.86	-0.07	0.53	0.59	-0.06	0.64	0.10	0.53
FIN	0.03	0.05	-0.01	0.54	0.52	0.01	0.26	0.36	-0.10	0.48	0.57	-0.09
GBR	0.77	0.76	0.01	0.88	0.84	0.03	0.86	0.77	0.09	0.91	0.86	0.05
GRC	0.26	0.29	-0.04	0.58	0.48	0.10	0.22	0.09	0.12	0.17	0.08	0.09
HKG	0.33	0.55	-0.22	0.67	0.62	0.05	0.31	0.18	0.13	0.42	0.21	0.21
HRV+/v	0.26	0.31	-0.05	0.88	0.81	0.06	0.64	0.64	0.00	0.68	0.16	0.52
HUN	0.47	0.28	0.19	0.56	0.35	0.21	0.68	0.68	0.00	0.78	0.53	0.25
IDN	0.20	0.15	0.04	0.63	0.61	0.02	0.88	0.71	0.17	0.71	0.74	-0.03
IRL	0.19	0.18	0.01	0.43	0.45	-0.02	0.30	0.08	0.22	0.69	0.35	0.34
ISL	0.26	0.24	0.02	0.70	0.66	0.04	0.57	0.57	0.01	0.71	0.79	-0.08
ISR+	0.45	0.35	0.10	0.90	0.66	0.24	0.49	0.27	0.22	0.63	0.39	0.25
ITA	0.32	0.30	0.01	0.26	0.27	-0.01	0.31	0.24	0.07	0.55	0.20	0.34
JOR+/v	0.21	0.28	-0.07	0.82	0.80	0.02	0.56	0.65	-0.09	0.67	0.22	0.45
JPN	0.06	0.10	-0.04	0.07	0.17	-0.09	0.15	0.11	0.04	0.17	0.09	0.08

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	Average Achievement in PISA Math			Average Dipersion in PISA Math (SD)		
	2012	2000	chg	2012	2000	chg
Country	(2009)	(2003/06/09)		(2009)	(2003/06/09)	
KAZ******	432.2	405.5	7%	71.0	83.7	-15%
KGZ/*******	331.2	310.6	7%	80.7	86.4	-7%
KOR	554.3	547.6	1%	98.7	84.5	17%
LIE	534.2	513.8	4%	93.1	98.0	-5%
LTU*****	478.2	486.0	-2%	88.8	89.3	-1%
LUX	489.6	446.1	10%	95.3	92.2	3%
LVA	490.4	461.7	6%	81.8	103.0	-21%
MAC*	538.1	527.4	2%	94.7	87.1	9%
MEX	413.2	386.8	7%	74.4	82.4	-10%
MNE*****	409.5	398.6	3%	82.3	84.6	-3%
MYS******	421.3	404.2	4%	81.3	73.6	10%
NLD	522.4	563.3	-7%	91.6	87.2	5%
NOR	489.7	498.7	-2%	90.3	91.4	-1%
NZL	500.3	537.9	-7%	99.9	98.9	1%
PER	368.1	291.9	26%	84.5	106.9	-21%
POL	517.6	470.7	10%	90.5	102.5	-12%
PRT	486.5	453.4	7%	94.0	90.7	4%
QAT*****	376.9	318.2	18%	99.2	90.7	9%
QCN******	611.7	599.6	2%	100.4	102.6	-2%
ROU*****	445.3	414.5	7%	81.1	83.7	-3%
RUS	481.9	478.3	1%	86.5	103.8	-17%
SGP******	573.4	562.6	2%	105.5	104.7	1%
SRB*****	449.1	434.9	3%	90.4	92.1	-2%
SVK*	481.5	498.6	-3%	101.4	92.2	10%
SVN*****	500.8	504.7	-1%	91.1	89.1	2%
SWE	478.2	509.7	-6%	91.3	93.3	-2%
TAP	559.1	550.0	2%	115.7	103.0	12%
THA	426.6	432.7	-1%	82.0	82.7	-1%
TUN*	387.6	358.9	8%	78.1	81.8	-5%
TUR*	447.4	423.8	6%	91.2	105.9	-14%
URY*	409.1	421.8	-3%	88.5	99.0	-11%
USA	480.7	492.6	-2%	90.0	97.4	-8%

	School Accountabily- Resuls Posted			School Accountabily- Resuls Tracked			School Accountabily- Benchmarking I (Other schools)			School Accountabily- Benchmarking II (National Performance)		
	2012	2006	chg	2012	2006	chg	2012	2003	chg	2012	2000	chg
Country	(2009)	(2009)		(2009)	(2009)			(2009)		(2009)	(2003/06/09)	
KAZ+/+++/v	0.78	0.82	-0.04	1.00	0.99	0.01	0.89	0.89	0.00	0.87	0.36	0.51
KGZ+/++/v	0.64	0.57	0.06	0.97	0.95	0.02	n.a	0.84		n.a	0.26	
KOR	0.69	0.17	0.52	0.89	0.52	0.37	0.63	0.51	0.12	0.69	0.30	0.39
LIE++++	0.083	0.083	0.00	0.25	0.42	-0.17	0.33	0.33	0.00	0.50	0.09	0.41
LTU+/v	0.30	0.25	0.05	0.75	0.75	0.00	0.56	0.46	0.10	0.58	-0.02	0.60
LUX	0.14	0.55	-0.41	0.60	0.74	-0.15	0.38	0.10	0.28	0.62	0.21	0.41
LVA	0.31	0.32	-0.01	0.58	0.46	0.12	0.85	0.64	0.22	0.91	0.62	0.30
MAC /vi	0.11	0.12	-0.01	0.47	0.44	0.02	0.16	0.15	0.00	0.22	0.08	0.15
MEX	0.37	0.39	-0.02	0.89	0.89	0.01	0.67	0.53	0.14	0.74	0.54	0.20
MNE+/v	0.76	0.76	0.00	0.96	0.82	0.14	0.69	0.44	0.24	0.76	-0.16	0.93
MYS+/++++/v	0.35	0.19	0.16	0.96	0.96	0.00	0.68	0.73	-0.05	0.80	0.27	0.54
NLD	0.80	0.81	-0.01	0.71	0.83	-0.12	0.55	0.43	0.12	0.59	0.63	-0.04
NOR	0.50	0.45	0.05	0.78	0.50	0.28	0.44	0.43	0.01	0.62	0.53	0.09
NZL	0.68	0.63	0.05	0.84	0.85	-0.01	0.78	0.68	0.10	0.82	0.88	-0.06
PER+/++++/v	0.10	0.11	-0.01	0.61	0.65	-0.03	0.39	0.37	0.02	0.41	-0.15	0.57
POL	0.46	0.43	0.02	0.71	0.73	-0.02	0.59	0.62	-0.03	0.58	0.36	0.22
PRT	0.50	0.32	0.18	0.84	0.67	0.17	0.63	0.23	0.40	0.83	0.17	0.65
QAT+/v	0.40	0.43	-0.03	0.93	0.74	0.19	0.73	0.65	0.08	0.73	0.03	0.70
QCN++++/v	0.03	0.01	0.03	0.61	0.68	-0.07	0.56	0.62	-0.06	0.50	0.04	0.46
ROU+/v	0.67	0.63	0.04	0.70	0.64	0.05	0.69	0.81	-0.13	0.67	0.31	0.36
RUS	0.73	0.70	0.02	1.00	1.00	0.00	0.97	0.80	0.17	0.91	0.78	0.13
SGP+/++++/v	0.47	0.61	-0.14	0.95	0.97	-0.02	0.77	0.81	-0.04	0.91	0.37	0.54
SRB+/v	0.52	0.51	0.01	0.52	0.64	-0.13	0.51	0.50	0.01	0.29	-0.25	0.55
SVK /vi	0.74	0.26	0.48	0.79	0.76	0.03	0.65	0.47	0.19	0.65	0.41	0.25
SVN+/v	0.52	0.29	0.22	0.63	0.71	-0.08	0.41	0.43	-0.03	0.56	0.00	0.57
SWE	0.75	0.61	0.14	0.90	0.79	0.11	0.83	0.62	0.21	0.89	0.75	0.14
TAP+/v	0.15	0.33	-0.18	0.48	0.31	0.18	0.40	0.45	-0.04	0.37	-0.10	0.47
THA	0.75	0.69	0.06	0.98	0.83	0.15	0.77	0.59	0.17	0.86	0.58	0.28
TUN /vi	0.16	0.17	-0.01	0.76	0.78	-0.02	0.68	0.69	-0.01	0.67	0.71	-0.04
TUR /vi	0.63	0.33	0.30	0.95	0.79	0.17	0.78	0.60	0.18	0.69	0.57	0.12
URY /vi	0.09	0.12	-0.03	0.71	0.63	0.09	0.11	0.14	-0.03	0.15	0.20	-0.05
USA	0.84	0.87	-0.03	0.92	0.93	-0.01	0.83	0.68	0.16	0.90	0.75	0.16

Note 1: School Accountability- Results Posted: Percentage of schools where achievement data are posted publicly (e.g. in the media); School Accountability- Results Tracked: Percentage of schools where achievement are tracked by an administrative authority. School Accountability- Benchmarking I: Percentage of schools where assessments are used to compare the school with other schools; School Accountability- Benchmarking II: Percentage of schools where assessments used to compare the school to <district or national> performance.

Note 2: * Information on achievement for 2003 instead of 2000 ** Information on achievement for 2009 instead of 2012 ***Information on achievement for 2006 instead of 2000 ****Information on achievement for 2009 instead of 2000.

Note 3: + Information on accountability measures for 2009 instead of 2003. ++ Information on accountability measures for 2009 instead of 2012. +++ Information on accountability measures for 2006 instead of 2000. ++++ Information on accountability measures for 2009 instead of 2006. v Information on accountability measures for 2003 instead of 2000. vi Information on accountability measures for 2009 instead of 2000.

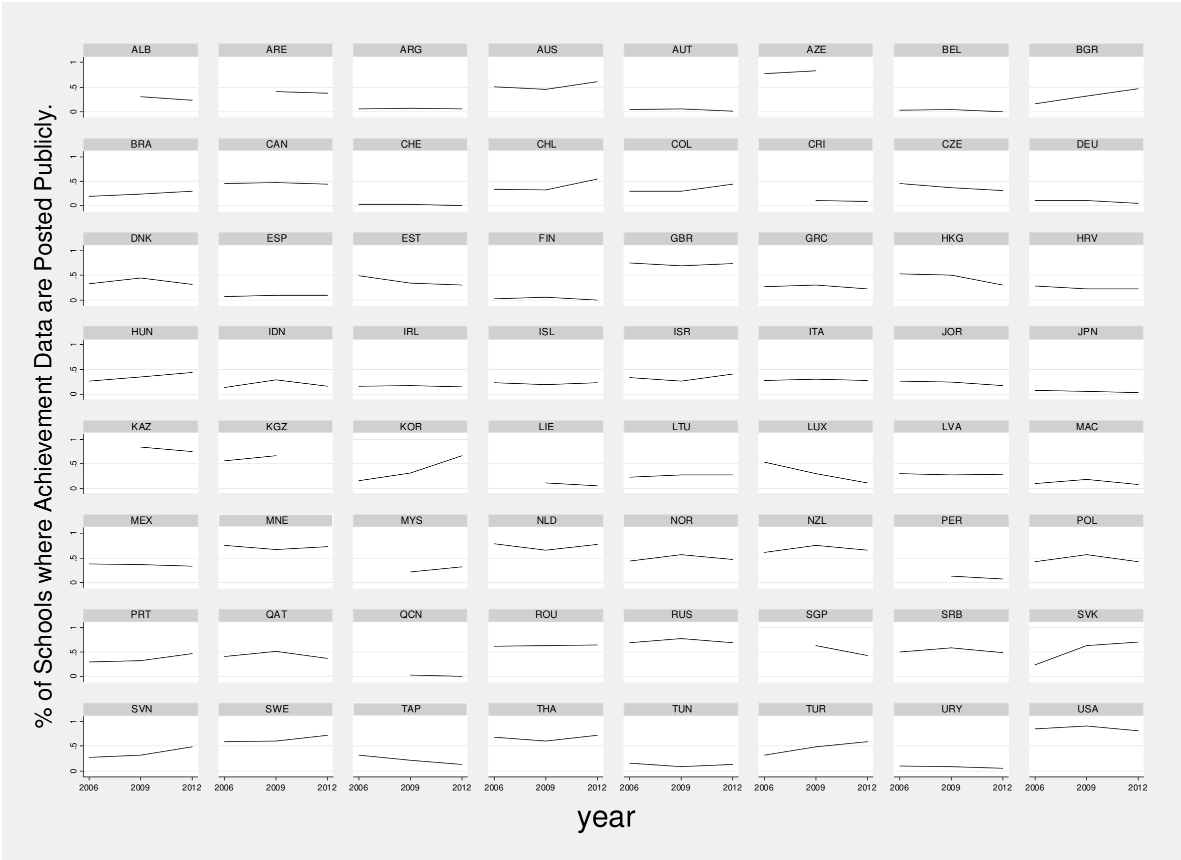

Figure 4.1 Percentage of schools where academic results are posted publicly (PISA 2006-2012).
Note. All countries with two or more applications in years 2006, 2009 and 2012.

4.4.4 Empirical model

Our empirical approach is based on an educational production function framework, where students' educational results are affected by personal and family characteristics, as well as school and institutional characteristics. We assume school accountability as an institutional feature measured at country level. This and other institutional characteristics affecting educational outcomes vary over time within countries, while others remain fixed. We follow a linear formulation, similar to that of Hanushek, Link & Woessmann (2013), where student achievement at a certain point in time can be modelled by the following equation:

$$A_{csti} = \beta_I I_{ct} + \beta_s S_{csti} + \beta_x X_{csti} + \varepsilon_{csti} \qquad (1)$$

where A is a vector of PISA math test scores for individual i in time t, in country c and school s. S is a vector of observed school characteristics, X is a vector of individual and household characteristics, and I is a vector containing institutional characteristics in country c in time t.

We can expand the error term ε to account for unobserved heterogeneity at country level and over time.

$$\varepsilon_{csti} = \mu_c + \mu_t + \mu_{cti} \qquad (2)$$

In this case, both parameters μ_c and μ_t denote country specific fixed effects, absorbing all institutional characteristics fixed in time affecting attainment, and time fixed effects, to account for cohort effects across PISA examinations. The error μ_{cti} is assumed to be random and uncorrelated to the measures of interest of school accountability contained in vector I.

The measure of student socioeconomic status used by OECD through the ESCS index is incorporated in the vector of student characteristics X. In this case, and as we are interested in studying whether school accountability is associated with inequality in outcomes according to student SES, we incorporate an interaction term between student SES and time-varying institutional characteristics I to the model. Following a similar approach to that of Amermueller (2013), our preferred specification is the following:

$$A_{csti} = \beta_{I1} I_{ct} + \beta_{I2}(I_{ct}\ x\ ESCS) + \beta_s S_{csti} + \beta_x X_{csti} + \mu_c + \mu_t + \mu_{cti} \quad (3)$$

Our parameters of interest are β_{I1} and especially β_{I2}, measuring the impact of school accountability in students' average results and in inequality of students' results, respectively. A positive sign in this last coefficient means there are heterogeneous effects of school accountability measures in educational outcomes according to student SES.

In order for our estimates to have a causal interpretation, the main assumption in this case is that variations in our measures of school accountability contained in vector I are orthogonal to variations in other time-varying institutional factors not included in the model and then contained in the error term, which could be affecting educational outcomes. If this assumption does not hold, only an association could be implied.

The main advantage of this specification is that we can exploit variations on school accountability within countries over time, allowing us to separate those variations from fixed institutional factors also affecting inequality of outcomes. Those fixed institutional factors are usually correlated to school accountability measures and unobserved in most cross-sectional studies.

Our main concern, however, is that we identify the effect from a very small sample of observations, as we measure most country level variables only up to three times, and we have a limited number of countries available (65). As this renders our estimation more sensitive to the model specification, we are only able to incorporate few time-varying institutional characteristics related to school accountability at a time. We add other time-varying institutional characteristics in some of our specifications as part of our robustness checks when available[39]. In the following table, we show a correlation matrix between our different measures of school accountability and other institutional characteristics for PISA 2012. Of particular importance is the high correlation between our different measures of school accountability. Hence, we decided not to include them all in one model, but to test their association with educational outcomes one at a time.

[39] In the present version of this work, we added school property, school competition, funding policies and school admission policies in some of our specifications.

Table 4.3 Country-level correlations matrix. School accountability and other institutional characteristics. PISA 2012

PISA 2012 (Observations=65 countries)	**Results Posted**	**Results Tracked**	**Benchmarking I**	**Benchmarking II**	**School Admission Policies I**	**School Admission Policies II**	**School Competition**	**School Operation**	**School Funding**
School Accountability-Results Posted	1.00								
School Accountability-Results Tracked	**0.61**	1.00							
School Accountability- Benchmarking I	**0.67**	**0.21**	1.00						
School Accountability- Benchmarking II	**0.70**	**0.29**	**0.90**	1.00					
School Admission Policies I	-0.19	0.10	-0.11	-0.04	1.00				
School Admission Policies II	-0.01	0.03	0.28	**0.18**	**-0.25**	1.00			
School Competition	0.06	0.06	0.03	0.11	**0.33**	-0.25	1.00		
School Operation (public)	0.16	0.22	**0.36**	**0.38**	-0.25	**0.33**	**-0.48**	1.00	
School Funding (private fees)	-0.15	0.09	-0.10	-0.07	0.25	-0.02	**0.29**	**-0.39**	1.00

Note 1: School Accountability- Results Posted: Percentage of schools where achievement data are posted publicly (e.g. in the media); School Accountability- Results Tracked: Percentage of schools where achievement are tracked by an administrative authority; School Accountability- Benchmarking I: Percentage of schools where assessments are used to compare the school with other schools; School Accountability- Benchmarking II: Percentage of schools where assessments used to compare the school to <district or national> performance; Admission Policies I: Percentage of schools using prior achievement a a criteria for student selection; Admission Policies II: Percentage of schools using residential area as a criteria of student selection; School Competition: Percentage of Schools declaring to be competing for students with other schools; School Operation: Percentage of schools declaring to be public; School Funding: Average percentage of school's total funding coming from parental fees.

Note 2: Correlations in **bold** significant at 95% level.

To take into account the fact that our data comes from 5 different PISA examinations, each one with a particular survey design, and also that PISA incorporates 4 imputed plausible values for each test score, we make use of the *Repest* Stata module[40] to estimate our regression models. The *Repest* module allows us to work with pooled data from several PISA waves, estimating consistent coefficients and standard errors.

4.5 Results

In Table 4.4 we find a summary of our initial results. In this case, we report our estimates for the effect of four school practices related to school accountability in educational outcomes. We report results including country fixed effects with no imputed data on school accountability measures and no other time-varying institutional characteristics.

Our results in column 1 show that there is a negative effect of posting achievement data publicly in inequality of educational results. As our measure of student socioeconomic status is constructed to have zero mean, a positive sign in this coefficient corresponds to a positive association between student SES, accountability practices and educational achievement, implying that students from higher socioeconomic status react to this accountability measure in a stronger way when compared to their peers from more disadvantaged backgrounds, increasing educational inequality. On the other hand, we do find a positive effect of posting academic information publicly on average student achievement in PISA. However, as detailed in our robustness checks section, when adding some other time-varying institutional characteristics, this association fades.

[40] The *Repest* command estimates statistics using replicate weights, accounting for survey designs in the estimation of sampling variance. It was especially designed by OECD to be used with PISA data. It also takes into account the fact that plausible values are used. The average estimator across plausible values is reported and the imputation error is added to the variance estimator.

Table 4.4 Panel estimates of the effect of school accountability on educational outcomes

	(1)	(2)	(3)	(4)	(5)
Dependent variable	PVMATH	PVMATH	PVMATH	PVMATH	PVMATH
Country level accountability measures and interactions with student SES (Index of Socioeconomic Status ESCS)					
School Accountability- Results posted	**13.262**				
	4.538				
Student ESCS X Results posted	**11.158**				
	1.419				
School Accountability- Results Tracked		***-16.417***			
		6.564			
Student ESCS X Results Tracked		**-3.442**			
		1.467			
School Accountability- Benchmarking I			58.587		
			9.570		
Student ESCS X Benchmarking I			**-9.427**		
			1.434		
School Accountability- Benchmarking II				**47.710**	**62.909**
				6.399	5.661
Student ESCS X Benchmarking II				**-6.770**	**-7.700**
				1.466	1.565
Country fixed effects	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Year fixed effects	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Student level sociodemographic characteristics	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
School characteristics	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Other country level accountability-related covariates (admissions, etc)	**No**	**No**	**No**	**No**	**No**
Imputed covariates on school accountability	**No**	**No**	**No**	**No**	**No**
Constant	**196.390**	**199.681**	**173.766**	**201.624**	**285.742**
	12.5719	12.6700	12.2701	21.9060	11.5152
Observations	1,323,701	1,324,038	1,197,324	1,197,324	1,310,803
R-Squared	0.40	0.40	0.39	0.39	0.39
Number of countries	65	65	65	65	65
Number of PISA waves involved in the estimation	**3**	**3**	**3**	**3**	**4**
PISA Waves	**2006/09/12**	**2006/09/12**	**2003/09/12**	**2003/09/12**	**2000/03/09/12**

Coefficients in **Bold** p<0.01, ***Bold italic*** p<0.05, *Italic* p<0.1. Robust standard errors clustered at country level.

Note 1: School Accountability- Results Posted: Percentage of schools where achievement data are posted publicly (e.g. in the media); School Accountability- Results Tracked: Percentage of schools where achievement are tracked by an administrative authority; School Accountability- Benchmarking I: Percentage of schools where assessments are used to compare the school with other schools; School Accountability- Benchmarking II: Percentage of schools where assessments used to compare the school to <district or national> performance.

Note 2: All specifications include controls for students' age, gender, migration status, type of school attended, school funding scheme, school location, student teacher ratio, share of fully certified teachers, number of students at school, shortage of teachers in math, science and language, share of full-time teachers, and student socioeconomic status as measured by PISA ESCS index.

At the same time, our results show that benchmarking practices, also associated with school accountability, would have a positive effect both on inequality and on average achievement. Results in columns 3, 4 and 5 show that both school practices: 1) using academic assessments to compare the school with other schools, and 2) using academic assessments to compare with district or national performance, are associated with higher average achievement and lower inequality in outcomes for the subject of math. Moreover, and as detailed in our next section, these findings are robust to specifications including other country-level institutional characteristics changing over time. In most cases, our results remain almost unchanged. In very few cases the size effect of these accountability practices on inequality becomes slightly smaller, but it is still statistically significant.

When revising our estimation results for pooled cross-sectional estimates for similar specifications – not accounting for fixed unobserved heterogeneity at a country level – (Table 4B1, Appendix 4B), results differ importantly both in direction and effect size in most cases. Our interpretation of these results is that the inclusion of a country fixed effect seems to be crucial for having a better identification of the true effect of accountability practices on educational outcomes. As noted by Schütz, West & Woessmann (2007), in order for pooled cross-sectional estimates to capture the real effect of such practices on educational outcomes, all other institutional characteristics correlated to school accountability also affecting educational achievement must be controlled for. The idiosyncratic characteristics of school systems affecting educational inequality could be several. Factors such as average teaching quality, teaching strategies, school tracking, ability grouping, head teachers' leadership skills, as well as other cultural factors are likely not to be fully observed in their complexity. Hence, any sort of identification utilizing variation across countries instead of within countries, only controlling by observed institutional factors, is likely to be biased.

4.6 Robustness checks

4.6.1 Additional controls

In this section, we aim to check how stable our figures are after including some additional controls in our specifications. More specifically, we will examine if our results hold when considering other time-varying institutional characteristics, which could be both correlated to variations in our measures of school accountability and to changes in students' academic results. We add several available institutional characteristics originally measured at school level, which we aggregate to country levels for each PISA wave, following a similar approach to the one we used to construct our measures of school accountability. Among the measures used we have: proportion of schools declaring they are competing for students with other schools (as a proxy of school competition among schools at country level), average percentage of spending funded by parental fees at schools (as a measure to proxy private spending in the school system), proportion of schools showing student selection policies using residential area or prior academic results as selection criteria (as proxy of the school system selectivity in their admission policies).

As we have few observations at a country level, we estimate these specifications including each one of these controls separately, also adding a few specifications with more than one of these institutional characteristics at a time. Results for two of our accountability measures (achievement data posted publicly and use of assessments to compare the school with other schools) are shown in Table 4.5; results for the other two measures of interest (results tracked by an administrative authority and use of assessments to compare the school to national performance) can be found in Appendix 4C, Table 4C1. In most cases, our results remain almost unchanged. In very few cases the effect size of the impact of accountability practices in inequality becomes smaller but still statistically significant. From Table 4.5, and as previously mentioned, for the case of results posted publicly after controlling for institutional factors, the impact on average achievement fades, whereas for the case of inequality in achievement, the negative impact holds after including several controls (with the only exception of parental fees, although the effect becomes significant again after controlling for other institutional factors).

As the association between posting results publicly and average outcomes changes across specifications, it is important to understand the possible mechanisms behind this. From our results, the effect of posting results publicly fades after including any of the two following institutional characteristics in our models: Admission Policies (whether residential area or student past achievement are commonly used as admission criteria in that country), and School Funding (percentage of school income coming from parental fees or government funding). For the case of admission policies, our results suggest that a more homogeneous student composition at schools (linked to selective admission policies) could be related to both educational outcomes and higher levels of accountability (although the direct association between accountability and admission policies in general is still weak. See Table 4.3). This makes sense in countries where accountability systems are accompanied by competition across schools and selective admission policies. In those countries, admission policies could work as a confounder, since the factor that could be actually leading to higher average results would presumably be peer effects and student homogeneity in classrooms, as opposed to accountability itself. The same would apply to school funding. Higher public funding would be positively related to higher accountability (although again in a relatively weak manner). In our sample, a bigger proportion of government funding would be also associated to higher educational outcomes. Therefore, in this case, funding could have acted as a possible confounder.

For the case of comparison of educational results with other schools ('Benchmarking I' on the tables), both results hold, for the effect on average achievement and for the effect on educational inequality[41].

We acknowledge that the association between school accountability practices and other time-varying institutional characteristics not included in our specifications, such as school autonomy, could lead to differences in our results, although we believe that in most countries, these characteristics should tend to remain stable, and their changes should also be uncorrelated to changes in our measures of school accountability and to students' educational outcomes (especially for our estimates based on a six-year period). If this was not the case, then our estimates cannot have a causal interpretation.

A causal interpretation for our results could also not be assigned if, for instance, some of the other institutional characteristics included in our models, which are somehow related

[41] In this case, we could not include school competition and admission policies as time-varying controls, since this data was not available in the school questionnaire for all the years under analysis (this item was missing in 2003). The same situation applies when examining the effect of using students' results to compare with national performance in PISA achievement ('Benchmarking II' in Table 4C1, Appendix 4C).

to school accountability, do have an effect on achievement for a certain proportion of the population (for instance low SES students) and therefore affect inequality in outcomes. Although they are not importantly correlated with our measures of accountability (as can be seen in Table 4.3), country-level characteristics such as school competition or school admission policies could make the estimated association between accountability practices and educational outcomes fade after we also include them in our models in an interaction term with student SES. We decided not to include these interaction terms in our specifications, given the small amount of observations we have at a country level.

On another related issue, we acknowledge that, as our key country-level measures of school accountability have been constructed using the head teachers' questionnaire, and they depend on the sample of schools chosen for each country, they have been measured with error. If we assume that this measurement error is independent of any of the other explanatory variables in our model, this would mean that our estimates for the effect of school accountability practices could have been downwardly biased towards zero. In practice, this implies that our results could be understating the importance of accountability practices explaining average educational outcomes and inequity in education.

Table 4.5 Robustness checks. Panel estimates of the effect of school accountability in educational outcomes

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Dependent Variable	PVMATH	PVMATH	PVMATH	PVMATH	PVMATH	PVMATH	PVMATH	PVMATH	PVMATH	PVMATH	PVMATH	PVMATH	PVMATH
Country level accountability measures and interactions with SES (Index of Socioeconomic Status ESCS)													
School Accountability- Results posted	**11.105**	**15.826**	*9.748*	3.735	*-2.349*	6.516	*-10.032*	-0.616					
	5.796	5.959	5.891	5.524	6.224	6.027	5.895	5.756					
Student ESCS X Results posted	**8.473**	**6.698**	*6.801*	5.390	*2.136*	3.357	*3.129*	4.501					
	1.485	1.465	1.455	1.407	1.422	1.428	1.390	1.420					
School Accountability- Benchmarking I									**58.587**	**52.140**	**45.574**	**40.646**	**28.145**
									9.570	9.016	9.776	9.274	8.569
Student ESCS X Benchmarking I									**-9.427**	**-10.501**	**-8.752**	**-8.160**	**-8.607**
									1.434	1.573	1.459	1.409	1.565
Other country level time-varying institutional characteristics													
School Operation (Public)		**Yes**						**Yes**		**Yes**			**Yes**
School Competition			**Yes**				**Yes**	**Yes**					
School Admission Policies I (Residential area)				**Yes**			**Yes**	**Yes**					
School Admission Policies II (Student past achievement)				**Yes**			**Yes**	**Yes**					
School Funding I - Average Proportion of Private Spending (Parental fees)					**Yes**		**Yes**				**Yes**		**Yes**
School Funding II - Average Proportion of Public Spending (Government)						**Yes**						**Yes**	**Yes**
Country fixed effects	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Year fixed effects	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Student level sociodemographic characteristics	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
School characteristics	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Other country level accountability-related covariates (admissions, etc.)	**No**	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**No**	**No**	**Yes**	**Yes**	**Yes**
Imputed covariates on school accountability	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**
Constant	**199.172**	**191.935**	**207.267**	**197.067**	**197.963**	**204.625**	**199.883**	**196.823**	**137.766**	**174.232**	**175.814**	**186.094**	**187.350**
	12.8110	13.0270	12.8831	12.8389	12.9869	12.8762	13.0025	13.1717	12.2701	12.4290	12.3825	12.4447	12.4254
Observations	1,323,701	1,305,310	1,318,551	1,323,701	1,303,175	1,303,175	1,298,025	1,279,634	1,197,324	1,180,227	1,177,164	1,177,164	1,160,067
R-squared	0.396	0.397	0.397	0.396	0.399	0.399	0.399	0.401	0.393	0.391	0.396	0.396	0.395
Number of countries	65	65	65	65	63	63	63	63	65	65	63	63	63
Number of PISA waves involved in the estimation	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
PISA Waves	**2006/09/12**	**2006/09/12**	**2006/09/12**	**2006/09/12**	**2006/09/12**	**2006/09/12**	**2006/09/12**	**2006/09/12**	**2003/09/12**	**2003/09/12**	**2003/09/12**	**2003/09/12**	**2003/09/12**

Coefficients in **Bold** p<0.01, ***Bold italic*** p<0.05, *Italic* p<0.1. Robust standard errors clustered at country level.

Note 1: School Accountability- Results posted: Percentage of schools where achievement data are posted publicly (e.g. in the media); School Accountability- Results Tracked: Percentage of schools where achievement are tracked by an administrative authority; School Accountability- Benchmarking I: Percentage of schools where assessments are used to compare the school with other schools; School Accountability- Benchmarking II: Percentage of schools where assessments are used to compare the school to <district or national> performance.

Note 2: Admission Policies I: Percentage of schools using residential area as a criteria of student selection; Admission Policies II: Percentage of schools using prior achievement a a criteria for student selection; School Competition: Percentage of schools declaring to be competing for students with other schools; School Funding I: Average percentage of school's total funding coming from parental fees; School Funding II: Average percentage of school's total funding provided from the government.

Note 3: All specifications include controls for students' age, gender, migration status, type of school attended, school funding scheme, school location, student teacher ratio, share of fully certified teachers, number of students at school, shortage of teachers in math, science and language, share of full-time teachers, and student socioeconomic status as measured by PISA ESCS index.

4.6.2 Data imputation for PISA waves with missing data

As we usually have three PISA waves available for our measures of school accountability, we attempted to impute those measures for those PISA waves when information on accountability practices was not available in the school questionnaire, by using other information available at school level for those years[42]. To do so we used multiple imputation techniques aiming to impute the existence of such practices at school level, aggregating data at country level later. Our original results tend to hold only for certain school practices (more specifically for those practices related to benchmarking at schools, where we had more relevant information from other items in the school questionnaire); both the effect size and sign of the association remain fairly constant for those cases, especially those related to the effect of such practices in inequality of academic results. However, this was not the case for those school practices related to the external use of academic results (namely posting academic results publicly and tracking educational results by an administrative authority), where results are not necessarily consistent for different numbers of PISA waves involved; also, sometimes the effect changes sign or turns to be statistically insignificant (for detailed results see Table 4D3, Appendix 4D). It is our belief that the available information on school questionnaires and student questionnaires did not allow us to impute precisely all our measures of school accountability. For the methods used to produce those imputed measures, descriptive statistics, and results with imputed data for several PISA waves, refer to Appendix 4D.

4.7 Further results: Can we build a latent construct meaning school accountability?

If from our broad definition of school accountability different individual measures of it show a dissimilar impact on educational outcomes, this may imply that different underlying dimensions could be part of what we broadly understand as school accountability. In this case, it is interesting to explore how our different measures of

[42] We took this approach because we had some other information about school level practices for almost all years, which was strongly correlated with some (two) of our school accountability practices. For one PISA wave (2009) there was a focus on school accountability and we had almost complete information for all our accountability measures. We then tried to make use of that information to impute missing measures of accountability for other years.

accountability relate to each other, what we could understand as their shared meaning, and how their common aspects relate to educational outcomes[43].

In this section, we first examine the association between our measures of school accountability at school level. On a second stage, we apply factor analysis techniques to capture the underlying latent constructs from several possible combinations of our defined measures of school accountability. After identifying those factors, we finally use their associated latent variables, along with other student, school and school system characteristics to predict students' educational achievement, in similar specifications to those used in previous sections.

4.7.1 Correlation analysis

We decided to estimate correlations for observed data between our different measures of school accountability, namely those items previously mentioned: posting and tracking test score results and using academic results for benchmarking purposes when comparing with other schools and national standards. As we have available information for all those items only in year 2009, we estimate correlations for this year. We decided not to use imputed data on our measures of school accountability to construct them. Hence, later on, in our regression analysis, we will make use of three to four PISA waves.

The first results from our correlation analysis in Table 4.6 for year 2009 show there is a high correlation between all analysed accountability measures at school level. Especially strong are the associations between both benchmarking practices (Benchmarking I and II) and between those measures and reporting academic results to national authorities or to the public (what we name "results posted" and "results tracked"). Correlation results available for other PISA applications were very similar to figures in 2009.

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43 Also, and as discussed by Braga, Checchi & Meschi (2013), when measuring institutional characteristics, the case might be that several school system characteristics could be affecting the same outcome at the same time, affecting our regression estimates for single items. Although we partially aim to tackle this problem by adding several school system characteristics one at a time, and several at the same time in our regressions in the previous sections, the use of latent variables decreases the dimensionality of our regressors linked with school accountability, allowing us to include additional regressors at a country level simultaneously, which could provide us with relevant insights about the robustness of our estimates.

Table 4.6 School-level tetrachoric correlations matrix. School accountability measures (PISA 2009)

PISA 2009 (Observations= 17,284 schools)	**Results Posted**	**Results Tracked**	**Benchmarking I**	**Benchmarking II**
School Accountability-Results Posted	1.00			
School Accountability-Results Tracked	**0.37**	1.00		
School Accountability- Benchmarking I	**0.35**	**0.39**	1.00	
School Accountability- Benchmarking II	**0.39**	**0.40**	**0.84**	1.00

Note 1: Correlations in **bold** significant at 95% level.

Note 2: School Accountability- Results posted: Percentage of schools where achievement data are posted publicly (e.g. in the media); School Accountability- Results Tracked: Percentage of schools where achievement are tracked by an administrative authority. School Accountability- Benchmarking I: Percentage of schools where assessments are used to compare the school with other schools; School Accountability- Benchmarking II: Percentage of schools where assessments used to compare the school to <district or national> performance.

4.7.2 Factor analysis

As previously mentioned, our first exploratory analysis estimating correlations between different accountability measures, and our regressions results on single items, lead us to believe our measures of school accountability could be measures of different underlying factors related to different latent constructs. To assess this hypothesis, we perform a factor analysis utilizing our school accountability measures for each year separately, extracting those factors that we consider as better accounting for school accountability practices.

We take two approaches: initially, we produce a factor analysis for all available items together; then, we develop a separate factor analysis for different subgroups. Our results show that when we estimate our factor analysis with all items together, we extract only one factor. When we analyse factor loadings for that case, we see only two items taking more importance (see table 4.7)[44]. On the other hand, when we partition our items into two subgroups, we extract one factor per each subgroup; in this case, by construction, both items take the same factor loadings in their respective subgroup.

[44] Table 4.7 provides information on the extraction of factors. The second, third, and fourth columns indicate the factor order, the associated eigenvalue and the cumulative proportion of the overall variance explained by each factor. Column 5 specifies the correlation between each original item and the first factor extracted (the factor loading), as an indication of the contribution of each item to the constructed factors. Column 6 denotes the scores or coefficients used for each original item to construct the latent variable.

Table 4.7 Factor analysis results (PISA 2009)

Variables included	Factors (2)	Eigen Value (3)	Cumulative explained variance (4)	Factor Loadings (5)	Scores (6)	Number of Schools (7)	Number of Countries (8)	Number of PISA waves (9)
School Accountability-Results Posted	**1**	**0.48788**	**1.8928**	0.4939	0.3634	**18473**	**73**	**1**
School Accountability-Results Tracked	2	-0.23012	1	0.4939	0.3634			
School Accountability- Benchmarking I	**1**	**1.53859**	**1.0971**	0.8771	0.4774	**18473**	**73**	**1**
School Accountability- Benchmarking II	2	-0.13617	1	0.8771	0.4774			
School Accountability-Results Posted	**1**	**1.97152**	**1.07**	0.4649	0.1072	**18473**	**73**	**1**
School Accountability-Results Tracked	2	0.15722	1.1527	0.4923	0.1132			
School Accountability- Benchmarking I	3	-0.1225	1.0864	0.8769	0.4558			
School Accountability- Benchmarking II	4	-0.15951	1	0.8626	0.3986			
School Accountability-Results Posted	**1**	**0.98505**	**1.5293**	0.5712	0.3086	**18473**	**73**	**1**
School Accountability-Results Tracked	2	-0.15626	1.2867	0.5579	0.3216			
School Accountability- Benchmarking I	3	-0.18465	1	0.5895	0.3406			

Note 1: Factors extracted in **bold**.
Note 2: School Accountability- Results Posted: Percentage of schools where achievement data are posted publicly (e.g. in the media); School Accountability- Results Tracked: Percentage of schools where achievement are tracked by an administrative authority. School Accountability- Benchmarking I: Percentage of schools where assessments are used to compare the school with other schools; School Accountability- Benchmarking II: Percentage of schools where assessments are used to compare the school to <district or national> performance.

When analysing and interpreting these results, we chose as more preferable the approach where two specific subgroups of items are used to produce latent variables, over the use of the complete list of items in one group. This preference was due to two reasons: first, each subgroup seems to have a more straightforward qualitative significance, as the items used are relatively similar in their description and conceptual meaning (also showing different directions in their relationship with the assessed educational outcomes as single items. See Table 4.5 in the previous section). Second, and from Table 4.8, the association between the values we estimated for the latent variable resulting from a factor analysis for all items together (variable 3) is extremely high with those values from the latent variable for one of the estimated subgroups (related to the use of achievement results for internal purposes, variable 2), but not as high with the variable related to the other subgroup (related to posting results publicly and results tracking, variable 1)[45], suggesting that they respond to related but dissimilar categories. From Table 4.8, we see that the correlation of 0.35 between our two preferred variables (variables 1 and 2) remains important but still suggests the existence of two different underlying dimensions.

[45] The estimated correlation between variables 2 and 3 in Table 4.8 was as high as 0.98. On the other hand, the correlation between variable 3 and variable 1 is only 0.54.

Table 4.8 Correlation matrix for latent variables from factor analysis (PISA 2009)

PISA 2009 (Observations=18473 schools)	Latent Variable 1	Latent Variable 2	Latent Variable 3	Latent Variable 4
Latent Variable 1	-			
Latent Variable 2	**0.35**	-		
Latent Variable 3	**0.54**	**0.98**	-	
Latent Variable 4	**0.89**	**0.68**	**0.8188**	-
Variables included				
School Accountability-Results Posted	X		X	X
School Accountability-Results Tracked	X		X	X
School Accountability- Benchmarking I		X	X	X
School Accountability- Benchmarking II		X	X	

Note 1: All correlations in **bold** significant at 95% level

Note 2: School Accountability- Results posted: Percentage of schools where achievement data are posted publicly (e.g. in the media); School Accountability- Results Tracked: Percentage of schools where achievement are tracked by an administrative authority. School Accountability- Benchmarking I: Percentage of schools where assessments are used to compare the school with other schools; School Accountability- Benchmarking II: Percentage of schools where assessments used to compare the school to <district or national> performance.

We decided to name the two chosen variables (variables 1 and 2 in Table 4.8) according to the nature of the school practices involved in their constitutive items, as well as with their relationship with different conceptions of school accountability found in the current literature. Following OECD's approach (OECD, 2010b), we chose to name our latent variables: 1) Use of results for internal purposes (mostly Benchmarking) and 2) Use of results for external purposes (more specifically publishing results publicly and tracking them by national governments). Based on previous evidence from our analysis using single items, we claim that these two variables respond to different understandings of school accountability and could lead to different implications in schools, education communities and national policies.

4.7.3 Regression results

In this section, we will make use of the latent variables we constructed to study their association with overall academic achievement and inequality in outcomes. To do so we follow a similar approach to that of the previous sections, incorporating model specifications with additional time-varying country level controls in some of our specifications. As we do not have measures of accountability for all years to construct the latent variables, we are only able to work with three PISA applications for which we have complete data.

Our regression results on Table 4.9 show that these latent variables (which are a linear combination of the original items on school accountability) also have an impact on educational outcomes, and tend to be consistent in sign and statistical significance with some of our results for single items. On the one hand, the use of academic results for internal purposes is associated with increased average performance and reduced inequality. The effect size remains fairly constant after including other time-varying country level school system characteristics[46]. On the other hand, our results for the use of academic results for external purposes show less consistency across different specifications, although these practices do not seem to have any impact on average achievement in most of our specifications (we found that in general, the effect of external result on average outcomes becomes statistically insignificant in several cases). At the same time, and according to these figures, these practices could increase educational inequality, although this association fades after taking into account school admission policies, school funding or school property. These results contravene our figures when using single items instead of latent constructs, in which case the effect of those practices on inequality remains unchanged for most specifications (see Table 4.5).

[46] Even though we have few time-varying institutional characteristics at country level for these three PISA applications (both competition levels and admission policies are not present in the application in 2003).

Table 4.9 Regression results using latent variables from factor analysis

Dependent variable	(1) PVMATH	(2) PVMATH	(3) PVMATH	(4) PVMATH	(5) PVMATH	(6) PVMATH	(7) PVMATH	(9) PVMATH	(10) PVMATH	(11) PVMATH
Country level accountability measures and interactions with student SES (Index of Socioeconomic Status ESCS)										
School Accountability- Use of results for external purposes (Latent variable 1)	-3.018		-1.583	*-3.121*	**-6.799**	**-7.026**	*-4.684*			
	2.532		2.522	2.559	2.530	2.625	2.592			
Student ESCS X Use of results for external purposes (Latent variable 1)	**1.708**		0.343	0.618	-0.581	-0.622	-0.539			
	0.611		0.593	0.589	0.557	0.558	0.569			
School Accountability- Use of results for internal purposes (Latent variable 2)		**27.291**						**26.897**	**26.395**	**24.808**
		3.607						3.667	3.692	3.608
Student ESCS X - Use of results for internal purposes (Latent varriable 2)		**-3.426**						**-4.599**	**-4.077**	**-4.053**
		0.611						0.679	0.611	0.597
Country fixed effects	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Year fixed effects	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Student level sociodemographic characteristics	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
School level characteristics	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Other country level time-varying institutional characteristics	**No**	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
School Operation (Public)			**Yes**					**Yes**		
School Competition				**Yes**						
School Admission Policies I (Residential area)					**Yes**					
School Admission Policies II (Student past achievement)					**Yes**					
School Funding I - Average Proportion of Private Spending (Parental fees)						**Yes**			**Yes**	
School Funding II - Average Proportion of Public Spending (Government)							**Yes**			**Yes**
Constant	**224.447**	**198.871**	**217.118**	**413.782**	**222.279**	**223.932**	**228.519**	**199.584**	**201.623**	**210.191**
	20.6853	21.6224	20.5847	6.891	19.9228	19.6226	19.7968	21.8357	20.1112	20.7348
Observations	1,324,038	1,197,324	1,305,647	1,318,888	1,324,038	1,303,512	1,303,512	1,180,227	1,177,164	1,177,164
R-Squared	0.41	0.42	0.41	0.41	0.41	0.41	0.41	0.42	0.42	0.42
Number of countries	65	65	65	65	65	63	63	65	63	63
Number of PISA waves involved in the estimation	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
PISA Waves	**2006/09/12**	**2003/09/12**	**2006/09/12**	**2006/09/12**	**2006/09/12**	**2006/09/12**	**2006/09/12**	**2003/09/12**	**2003/09/12**	**2003/09/12**

Coefficients in **Bold** p<0.01, ***Bold italic*** p<0.05, *Italic*. Robust standard errors clustered at country level.

Note 1: Latent variable 1 is the result of the factor analysis applied to the following measures: i) School Accountability- Results posted: Percentage of schools where achievement data are posted publicly (e.g. in the media); ii) School Accountability- Results Tracked: Percentage of schools where achievement are tracked by an administrative authority. Latent variable 2 is the result of the factor analysis applied to the following measures: i) School Accountability- Benchmarking I: Percentage of schools where assessments are used to compare the school with other schools; ii) School Accountability- Benchmarking II: Percentage of schools where assessments used to compare the school to <district or national> performance.

Note 2: Admission Policies I: Percentage of schools using residential area as a criteria of student selection; Admission Policies II: Percentage of schools using prior achievement a a criteria for student selection; School Competition: Percentage of Schools declaring to be competing for students with other schools; School Funding I: Average percentage of school's total funding coming from parental fees; School Funding II: Average percentage of school's total funding provided from the

Note 3: All specifications include controls for students' age, gender, migration status, type of school attended, school funding scheme, school location, student teacher ratio, share of fully certified teachers, number of students at school, shortage of teachers in math, science and language, share of full-time teachers, and student socioeconomic status as measured by PISA ESCS index.

4.8 Conclusions and policy implications

By examining the results and findings of this study and comparing them to those of previous studies on the effect of accountability policies on educational outcomes, we draw the following conclusions.

First, from preceding literature in the subject, we acknowledge that the existence of national examinations and other institutional policies related to school accountability can trigger different practices at schools, as well as, for instance, motivate actions by parents and national governments. Those practices vary in their complexity and ultimate goals. In our study, we find that what we define as external and internal use of school educational results in standardized examinations could lead to different outcomes in terms of educational inequality and overall average achievement at schools in the subject of math. On the one hand, unlike other studies, we are unable to demonstrate that solely the publication of educational results leads to increased average results[47]. Furthermore, we find that tracking results by national authorities would have a negative impact on average achievement, whereas posting results publicly produces higher levels of inequality even after taking into account several relevant institutional characteristics.

Our results are also different to previous studies using PISA data, where the use of external exit exams[48], as well as other measures of school accountability were assessed. We find substantial differences with figures from some of the earlier studies[49]. Using panel data, we show that our empirical approach of following countries over time leads to different results than those of cross-sectional estimates used in many studies in the related literature. Under the assumptions of cross-sectional studies, our findings would imply a positive effect of school accountability practices on educational inequality, although according to our figures, this effect becomes negative for posting academic achievement results publicly, after taking into account unobserved fixed characteristics over time at country level. These results lead us to believe that previous studies' results and

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47 This finding is somehow contrary to most of the literature, although the measures used are commonly associated to the existence of standardized examinations as opposed to the publication of their results.
48 Something we do not directly address in the current work. See Schütz, West & Woessmann, 2007 and Woessmann, 2005.
49 For instance, unlike Schütz, West & Woessmann (2007), who use PISA 2003 data, we find a positive impact of some school-targeted accountability measures (namely use of results to compare with other schools, and use of results to compare with national standards), and inequity in examination results.

interpretations should be considered with caution, given the cross-sectional nature of the data used, which could lead to spurious associations.

Second, we found that the internal use of educational results has a positive impact on average outcomes in math, also leading to lower levels of inequality. The implications of this finding are relevant at a policy level. Many countries today aim to make standardized tests results public to inform parental school choice, but less attention is given to the internal use of those results to improve school practices. The fact that we find this association and no positive association between posting results and academic achievement after taking into account schools' admission policies or competition at schools, could imply that selective admission policies are somehow linked to the effectiveness of some accountability systems in educational outcomes. The association of these two institutional characteristics seems to be an interesting topic for further research, as accountability systems associated with increased competition amongst schools and more selective admission criteria could lead, for example, to both increased inequality and increased average outcomes. The association between those policies and academic and social segregation are also an interesting topic which arises from these results.

Third, we are unable to show consistency in our results when using different measures of school accountability to build latent constructs. Although we successfully associate different measures of internal use of educational results to a latent construct, this is not the case with the external use of academic results, where our figures are not coherent with single item estimates; hence, further exploration in this topic would be an interesting aim for future research. From these last results, however, we can give proof that our common understanding of school accountability obscures its important levels of complexity. Therefore, the concept of school accountability should not be simplified to mean only the use of educational results in schools, since the different ways in which results are used could make a big difference in average educational outcomes and inequity in education.

Fourth, the lessons obtained for the Chilean case are quite relevant. At a time when the National System of Quality for Education is being implemented, we see that the accountability system in the Chilean sector could lead to different educational outcomes. For the Chilean case, the role of the Agency for Quality in education could be crucial. For instance, instead of encouraging the publication of results to increase competition and parental choice, schools could start using academic results internally, to improve, for instance, their teaching practices.

Chapter 5

Discussion, Conclusions and Policy Implications

As discussed in Chapter one, inequality of educational opportunities still affects Chilean students during their schooling process. In this regard, it is possible to establish three important issues regarding access: low coverage in early childhood education, where access is less than 20% for low income families; student drop-outs during secondary education, mostly among disadvantaged populations; and access to higher education, where there is still an important gap in access according to student SES.

On the other hand, access to quality education is also not evenly distributed across schools and students from different social backgrounds. With regard to this, I identify three important aspects: 1) Early childhood education seems to disproportionally benefit those students from more affluent backgrounds and the quality and pertinence of public early childhood education is under scrutiny. 2) Students from better-off backgrounds show better educational outcomes than those from deprived backgrounds, even after taking into account their sociodemographic characteristics. Moreover, family characteristics play a more important role in explaining inequality of results in Chile than in most OECD countries. The socioeconomic gap in educational achievement is as big as 0.8 standard deviations in standardized test scores in primary school and 1.3 standard deviations in secondary schools for math. 3) The majority of students from low and lower-middle SES schools have access to low profile higher education institutions and academic programmes of arguable quality.

In this context, and although the potential drivers of educational inequality could be multi-faceted, the present thesis contributes to a better understanding of inequality of educational achievement in the Chilean context. The empirical chapters shed a light on three important aspects: teacher effects, secondary school quality and access to higher education, and school accountability as an institutional factor.

The first empirical chapter constitutes the first attempt to estimate teacher effects in all types of secondary schools in the Chilean context. We find evidence of important variation in teacher effects for the subjects of math and language across different types of schools according to their socioeconomic status. We find an important proportion of highly effective teachers and higher variability in teacher effectiveness in low SES schools and similar average teacher effectiveness between low and high SES schools. This finding reflects the fact that there is room for important improvement in equity. For example, if certain teachers in low SES secondary schools are capable of making such important progress with their students, then the mobility of the best teachers to lower income schools, or the improvement of current teachers' practices in those schools, could produce important gains in achievement for low SES students, lowering the socioeconomic gap importantly. According to our results, and as teacher effectiveness can improve outcomes by as much as 0.75 additional standard deviations in standardized tests in a two-year period, increasing the quality of teaching in low SES schools could reduce the gap in achievement significantly. Therefore, policies aimed at improving teacher effectiveness in low and lower-middle SES schools could have an important impact on levelling students' opportunities, as well as have the potential to be more cost-efficient than other policies currently under implementation.

The second empirical chapter sheds a light on the importance of school quality and other school and institutional factors explaining access to higher education. We found that secondary school quality, as measured by average learning achievement results, makes a big difference as a determinant of access to tertiary studies for low SES students. We also found that other school characteristics such as class size are directly associated with higher achievement in secondary schools and indirectly associated with higher chances of continuing tertiary studies. Moreover, we found that the vocational track has a negative effect both on academic achievement and on the probability of accessing higher education. Finally, our results show that shared high parental expectations at schools could play an important role in explaining access to higher education. We found that the association between these factors and higher (or lower) chances of accessing tertiary studies are substantial, especially for students in lower and lower-middle SES schools.

The previous findings inform important aspects of equity in education from a policy perspective. First, the fact that secondary school quality makes a difference for low SES students explains why it is important to offer quality education in this education cycle. Quality education not only increases competences and skills for adult life, but also increases expectations and preparedness for tertiary studies importantly. At the same time, the fact that academic suitability for tertiary studies is not completely defined by primary education outcomes encourages the idea that remedial programs and access to good quality secondary education could level up those students in disadvantage, and increase their chances to access tertiary studies.

Taking into account the large proportion of students from disadvantaged backgrounds undertaking the vocational track in Chilean schools, it is equally crucial to define a clear policy regarding this type of education. Vocational education not only seems to be increasing inequality in educational achievement affecting mainly low and lower-middle SES students, but also increases inequality in educational attainment. If no formal articulation exists between secondary education and tertiary education, then the existence of vocational schools is only justified if it allows students to gain competences that encourage them to be more productive and employable in adult life. Since secondary vocational studies should, ideally, lead to further technical post-secondary education, and as most secondary school students are currently entering the labour market with no additional qualifications, it is crucial to encourage increased participation in tertiary education for these students. At the same time, and as a matter of equity, entry barriers to academic programs at universities should be lowered for all talented low SES students, including those following the vocational track.

On a closely related matter, the current funding structure of the higher education system seems to be an important entry barrier for low SES students. As our research findings suggest, admission to higher education in the Chilean context is highly determined by accessibility to public funding, especially for low and middle SES students. In this regard, the current policy of free education up to the 5th decile of family income only for highly talented students (meeting certain academic criteria), and the limited access to credit for the rest of students, negatively affects equity, as students from low SES backgrounds show, on average, poorer academic results. The fact that funding for university access is only available for those students showing relatively high academic credentials, is not only unfair from an equity perspective, but also ineffective in increasing participation of low SES students in this type of institutions. Access must be wider and entry barriers must be substantially lowered for low SES students in order for their participation to be increased. Moreover, defining a specific path leading to technical tertiary studies with limited funding for those choosing the vocational track in tertiary education also encourages inequality in attainment and future income. Access to funding must be complete, so that there is no discrimination between choosing the academic or the vocational track.

As financial resources are scarce for tertiary education, an income contingent scheme that includes scholarships and maintenance grants for low SES students could encourage them to pursue tertiary studies. Giving access to full tuition funding, and ensuring the coverage of all eligible students from the financial risks of repayment (by defining a minimum income threshold) would benefit low SES students the most. This policy is not only more effective, but also more equitable, as it distributes resources for a larger number of students, increasing access for low SES students, in addition to providing incentives for risk-averse students to continue their studies.

On a different matter, one of the most interesting findings of this thesis suggests that parental expectations seem to play an important role in explaining access to higher education. Higher shared parental expectations at low SES schools are associated not only with higher academic achievement, but also with higher chances of undertaking tertiary studies. In this respect, local policies aiming to work with parents at schools, introducing them to the benefits of higher education, as well as the alternative paths and funding possibilities available for their children to access tertiary studies, could make a big difference in increasing low SES students' participation.

Moving on to the third empirical chapter of this thesis, we can draw relevant conclusions with regard to the effect of accountability practices in the Chilean context. From our results, and supporting previous research findings from national case studies, we found that those policies aiming to inform parents through school league tables or publication of academic results aiming to incentivize school competition and parental school choice, what we call external accountability, have no positive impact on students' national average academic results, nor improve equity in education. Moreover, they seem to have a negative impact with regard to equity in education. On the other hand, those school practices aiming to use students' results at schools for benchmarking purposes, what we call internal accountability, are linked to increased performance and lower inequity in academic achievement.

These results lead us to suggest the following policy implications for the Chilean case. First, and although there is no concrete national research available on this matter, we believe that accountability practices aiming to increase competition among schools under the current regulatory framework only incentivize the mobility of higher-middle and higher SES students to better performing schools, as their relative switching costs are lower. On the other hand, low SES students' parents tend to prioritize other criteria over academic achievement when choosing schools in the Chilean context, especially in primary schools. As a result, this policy incentivizes social segregation at schools and leaves those students in lower SES schools in a worse position, due to peer effects, lower shared parental expectations, etc.

On the other hand, the fact that our findings show that the use of educational results for benchmarking and other internal practices is positively associated with higher academic achievement and improvements in equity, leads us to believe that the use of examination results can help to inform internal practices at schools for educational improvement in the Chilean context. In this regard, there is certainly room for a more extensive use of academic results in standardized tests at Chilean schools. Although the national Agency of Quality has increased its presence in schools, more efforts are needed to involve head teachers and teachers in the use of SIMCE test results for educational improvement. The national test results provide schools with relevant information, which could be improved to become more intelligible, accessible and usable for teachers. Also, the fact that schools see this as a tool for improvement instead of as a tool of external evaluation might change their view about the test itself. Benchmarking practices also help head teachers and teachers to set higher expectations regarding their students, and to understand that, even in deprived areas, students have the potential to achieve high learning standards when their schools focus on improvement. The role of the national Agency of Quality in facilitating material and training at schools, in order to increase the usage of these results, seems to be a sensible policy.

On an indirectly linked matter, we also believe that the role of the Superintendence in regulating competition mechanisms between schools is of high importance. Schools students' selection, for instance, should be carefully supervised, as this practice plays an important part in increasing inequality in outcomes, mainly through academic and social segregation at schools.

This thesis shows that a focus on improving quality of teaching at low SES schools, widening access to higher education by effectively lowering entry barriers to students in those schools, and the correct use of information on students' learning outcomes could result in reduced education inequality in the Chilean education system. In a society where a fairer distribution of opportunities in life is a matter of urgency, taking measures in this direction is not only advisable from a policy perspective, but also a moral obligation towards those who live in disadvantage.

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Appendices

Appendix 2A: Descriptive statistics

Table 2A1. Descriptive statistics. Estimation samples versus all test takers in 10th grade (2006).

Student Level Descriptive Statistics in 10th grade	All students sitting SIMCE test in 10th grade			Estimation Sample			Reduced Sample (same teachers in both 9th and 10th grade)		
	N	Mean	SD	N	Mean	SD	N	Mean	SD
Mean test score Math 2006	237,600	252.3	65.0	190,981	258.3	64.7	83,468	264.4	63.8
Mean test score Language 2006	237,676	254.5	51.9	190,956	258.7	51.7	87,821	261.2	51.4
Lagged score Math 2004 (achievement in 8th grade)	197,860	261.9	49.3	190,981	262.1	49.3	83,468	264.9	49.0
Lagged score Language 2004 (achievement in 8th grade)	197,530	260.7	49.9	190,956	260.8	49.9	87,821	263.0	49.4
Student gender (male=1)	238,310	50%	0.5	191,432	49%	0.5	120,280	47%	0.5
Student age (in years)	238,310	15.4	2.4	191,432	15.2	2.2	120,280	15.2	2.4
Father education (in years)	184,571	11.2	3.9	151,053	11.3	3.9	96,697	11.3	3.9
Mother education (in years)	191,676	11.0	3.8	156,686	11.1	3.8	100,334	11.1	3.8
Monthly family income (usd)	190,199	665	774	155,499	680	785	99,563	674	775
Monthly parental fees (0-10 usd)	189,419	45%	0.50	155,059	43%	0.50	99,256	45%	0.50
Monthly parental fees (10-20 usd)	189,419	16%	0.37	155,059	16%	0.37	99,256	16%	0.37
Monthly parental fees (20-100 usd)	189,419	29%	0.45	155,059	30%	0.46	99,256	29%	0.45
Monthly parental fees (100 or more usd)	189,419	10%	0.3	155,059	11%	0.31	99,256	10%	0.31
Number of books at home	170,458	44.4	31.5	138,358	45.4	31.5	88,534	45.6	31.6
Parents expect student attends HE or more	185,102	71%	0.46	151,301	73%	0.44	97,060	74%	0.44
Student repeated course in the past	184,567	19%	0.39	151,112	9%	0.29	96,754	9%	0.28
Attended pre-school education	221,346	73%	0.44	178,784	75%	0.44	113,231	75%	0.43
Student attends academic course (not vocational)	238,310	68%	0.46	191,432	69%	0.46	120,280	71%	0.46

Table 2A1 (continuation)

Student's Shool and Class Level Descriptive statistics	All students sitting SIMCE test in 10th grade			Estimation Sample			Reduced Sample (same teachers in both 9th and 10th grade)		
	N	Mean	SD	N	Mean	SD	N	Mean	SD
Public school	238,310	48%	0.5	191,432	46%	0.5	120,280	47%	0.5
Voucher school	238,310	45%	0.5	191,432	46%	0.5	120,280	45%	0.5
Private unsubsidized school	238,310	7%	0.26	191,432	8%	0.26	120,280	7%	0.26
School Socioeconomic Status A	238,310	19%	0.39	191,432	18%	0.38	120,280	19%	0.39
School Socioeconomic Status B	238,310	40%	0.49	191,432	39%	0.49	120,280	37%	0.48
School Socioeconomic Status C	238,310	24%	0.43	191,432	25%	0.43	120,280	26%	0.44
School Socioeconomic Status D	238,310	10%	0.3	191,432	11%	0.31	120,280	11%	0.32
School Socioeconomic Status E	238,310	7%	0.25	191,432	7%	0.26	120,280	7%	0.25
Rural school (rural=1)	238,310	4%	0.2	191,432	4%	0.2	120,280	4%	0.21
School enrolment	238,310	806	595	191,432	813	602	120,280	757	555
School average prior score (8th level)	238,120	259.3	27.5	191,432	261.4	27.7	120,280	262.9	27.2
Pctge. of parents declaring schools selects	224,120	45%	0.33	181,313	47%	0.33	113,092	49%	0.33
Religious school (religious=1)	231,856	35%	0.48	186,939	37%	0.48	117,763	39%	0.49
Number of students in class	238,310	38.1	6.6	191,432	38.3	6.4	120,280	38.4	6.4
Number of 10th level classes per school	238,310	5.35	3.6	191,432	5.4	3.6	120,280	5.03	3.4
Class income	235,027	657.5	630.9	188,887	676.0	644.4	119,144	673.3	634.1
Class average prior score (8th grade)	237,941	258.7	30.0	191,432	261.3	30.1	120,280	263.4	29.6
Class average prior score standard deviation (8th grade)	237,939	39.7	5.5	191,424	39.7	6.4	120,275	39.6	6.2

Appendix 2B: Teacher effects by school SES

Table 2B1. Estimated teacher effects by school SES (Language)

	Number of observations	Mean	Avg. std. error	SD	Percentiles 10-90 Gap	Percentiles 25-75 Gap
Lower SES Schools (SES A)	33,443	0.07	0.08	0.13	0.32	0.17
Lower-middle SES Schools (SES B)	75,080	0.00	0.07	0.15	0.35	0.19
Middle SES Schools (SES C)	47,946	-0.03	0.07	0.15	0.34	0.17
Upper-middle SES Schools (SES D)	20,907	-0.02	0.08	0.16	0.34	0.19
Higher SES Schools (SES E)	13,580	-0.04	0.09	0.16	0.37	0.20
All Schools	190,956	0.00	0.07	0.15	0.36	0.18

	Number of teachers	Number of teachers different from avg. teacher	Number of teachers above avg. teacher	Proportion of teachers different from avg. teacher	Proportion of teachers above avg. teacher	Proportion of teachers below avg. teacher
Lower SES Schools (SES A)	747	183	156	24.5%	20.9%	3.6%
Lower-middle SES Schools (SES B)	1,328	373	192	28.1%	14.5%	13.6%
Middle SES Schools (SES C)	875	243	85	27.8%	9.7%	18.1%
Upper-middle SES Schools (SES D)	471	111	49	23.6%	10.4%	13.2%
Higher SES Schools (SES E)	423	89	23	21.0%	5.4%	15.6%
All Schools	3,844	999	505	26.0%	13.1%	12.9%

Notes: Teacher effects estimates from model a.6. Proportion of teachers different from average teacher estimated using confidence intervals with 95% of statistical significance.

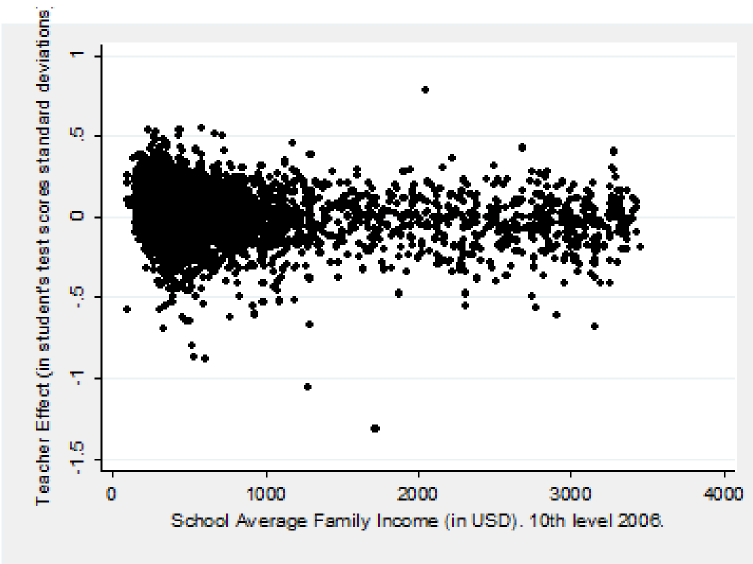

Figure 2B1. Estimated teacher effects versus school average family income (Language)

Table 2B2. Relationship between teacher effects, school SES and other class and school characteristics (Language)

	(1)	(2)	(3)	(4)	(5)	(6)
	Model a.4	Model a.6	Model a.4	Model a.6	Model a.4	Model a.6
School Socioeconomic Status B (SES B- Lower Middle SES)	-0.0566***	-0.0618***	-0.0551***	-0.0586***	-0.0456***	-0.0500***
	(0.00826)	(0.00688)	(0.00894)	(0.00726)	(0.00840)	(0.00700)
School Socioeconomic Status C (SES C- Middle SES)	-0.0863***	-0.0955***	-0.0853***	-0.0941***	-0.0703***	-0.0785***
	(0.00836)	(0.00708)	(0.00892)	(0.00773)	(0.00967)	(0.00752)
School Socioeconomic Status D (SES D- Higher Middle SES)	-0.0471***	-0.0850***	-0.0538***	-0.0886***	-0.0351***	-0.0667***
	(0.0104)	(0.00929)	(0.0127)	(0.00962)	(0.0128)	(0.0102)
School Socioeconomic Status E (SES E- Higher SES)	-0.0362***	-0.105***	-0.0683***	-0.119***	-0.0459***	-0.0918***
	(0.0101)	(0.00939)	(0.0119)	(0.00914)	(0.0117)	(0.0111)
Ln school enrollment			0.00865*	-0.00103	0.00866*	-5.39e-05
			(0.00473)	(0.00387)	(0.00490)	(0.00387)
Number of students in class			-0.00377***	-0.00132***	-0.00358***	-0.00112**
			(0.000491)	(0.000425)	(0.000497)	(0.000442)
Religious school (religious = 1)			0.0184***	0.00974	0.0223***	0.0136**
			(0.00685)	(0.00597)	(0.00681)	(0.00586)
Rural school			0.00216	0.0153	0.000764	0.0144
			(0.0116)	(0.0110)	(0.0117)	(0.0109)
Single sex school			0.0423***	0.0294***	0.0459***	0.0343***
			(0.00773)	(0.00630)	(0.00802)	(0.00640)
Proportion of parents declaring school selects students					-0.0542***	-0.0572***
					(0.00970)	(0.00771)
Class standard deviation of prior scores- Math (8th grade)					-0.000458*	-0.000357*
					(0.000242)	(0.000214)
Class standard deviation of prior scores- Language (8th grade)					-0.00148***	-0.000594***
					(0.000253)	(0.000221)
Constant	0.0517***	0.0650***	0.132***	0.115***	0.213***	0.151***
	(0.00612)	(0.00497)	(0.0284)	(0.0222)	(0.0344)	(0.0244)
Number of observations	190,956	190,956	190,956	190,956	190,956	190,956
R-Squared	0.0253	0.0506	0.0440	0.0580	0.0579	0.0724

Dependant variable: Estimated teacher effect from equation (1). Models a.4 and a.6 as detailed in Table 2.2.

Note: All specifications include schools SES classification. Columns 3 and 4 include other school and class controls, excepting school selectivity and students homogeneity in prior examinations as detailed in Table 2.2. Columns 5 and 6 also include the latter.

Excluded reference categories: School Socioeconomic Status A (Lower SES), Secular school, Urban school, Mixed school

Bootstrapped standard errors clustered at teacher level in parentheses . *** p < 0.01, ** p < 0.05, * p < 0.1. (200 replications)

Table 2B3. Teacher effects and school SES. Quantile regression results (Language)

	Model Specification 1			Model Specification 2			Model Specification 3		
	Percentile 10	Percentile 50	Percentile 90	Percentile 10	Percentile 50	Percentile 90	Percentile 10	Percentile 50	Percentile 90
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
School Socioeconomic Status B (SES B- Lower Middle SES)	-0.0898***	-0.0670***	-0.0516***	-0.0847***	-0.0601***	-0.0398***	-0.0825***	-0.0468***	-0.0292**
	(0.0100)	(0.00832)	(0.0148)	(0.0111)	(0.00719)	(0.0119)	(0.0115)	(0.00743)	(0.0114)
School Socioeconomic Status C (SES C- Middle SES)	-0.118***	-0.0929***	-0.0910***	-0.111***	-0.0875***	-0.0858***	-0.105***	-0.0674***	-0.0633***
	(0.0115)	(0.00668)	(0.0122)	(0.0151)	(0.0103)	(0.00905)	(0.0119)	(0.0107)	(0.0136)
School Socioeconomic Status D (SES D- Higher Middle SES)	-0.0985***	-0.0791***	-0.0730***	-0.0919***	-0.0779***	-0.0765***	-0.0779***	-0.0541***	-0.0475***
	(0.0136)	(0.00800)	(0.0182)	(0.0223)	(0.0106)	(0.0174)	(0.0190)	(0.00986)	(0.0182)
School Socioeconomic Status E (SES E- Higher SES)	-0.145***	-0.0990***	-0.0929***	-0.133***	-0.116***	-0.111***	-0.111***	-0.0869***	-0.0747***
	(0.0172)	(0.0112)	(0.0140)	(0.0197)	(0.0119)	(0.0163)	(0.0191)	(0.0102)	(0.0184)
Constant	-0.0856***	0.0676***	0.231***	-0.165***	0.157***	0.386***	-0.113***	0.190***	0.391***
	(0.00757)	(0.00498)	(0.0109)	(0.0416)	(0.0332)	(0.0276)	(0.0382)	(0.0272)	(0.0409)
Number of observations	190,956	190,956	190,956	190,956	190,956	190,956	190,956	190,956	190,956
	.	.	.	.	.	.	.	.	

Dependant variable: Estimated teacher effect from equation 1.

Note: All specifications include schools SES classification. Columns 4 to 6 include other school and class controls, excepting school selectivity and students homogeneity in prior examinations as detailed in Table 2.2. Columns 7 to 9 also include the latter.

Excluded reference categories: School Socioeconomic Status A (Lower SES), Secular school, Urban school, Mixed school

Bootstrapped standard errors clustered at teacher level in parentheses . *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. (200 replications)

Table 2B4.a Teacher effects quantile regressions. Full results (Math)

	Model Specification 1			Model Specification 2			Model Specification 3		
	Percentile 10	Percentile 50	Percentile 90	Percentile 10	Percentile 50	Percentile 90	Percentile 10	Percentile 50	Percentile 90
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
School Socioeconomic Status B (SES B- Lower Middle SES)	-0.0730***	-0.0354**	-0.0258	-0.0814***	-0.0307*	-0.0173	-0.0834***	-0.0342**	-0.0146
	(0.0155)	(0.0147)	(0.0206)	(0.0113)	(0.0157)	(0.0227)	(0.0127)	(0.0152)	(0.0271)
School Socioeconomic Status C (SES C- Middle SES)	-0.108***	-0.0842***	-0.0897***	-0.106***	-0.0795***	-0.0714***	-0.111***	-0.0856***	-0.0738**
	(0.0189)	(0.0152)	(0.0244)	(0.0145)	(0.0168)	(0.0221)	(0.0172)	(0.0149)	(0.0326)
School Socioeconomic Status D (SES D- Higher Middle SES)	-0.0313	-0.0632***	-0.0973***	-0.0133	-0.0613***	-0.0841***	-0.0386	-0.0754***	-0.0910***
	(0.0197)	(0.0168)	(0.0292)	(0.0207)	(0.0192)	(0.0266)	(0.0306)	(0.0211)	(0.0307)
School Socioeconomic Status E (SES E- Higher SES)	0.0429*	0.00356	-0.0613**	0.0638***	-0.00615	-0.0812***	0.0381	-0.0226	-0.0989***
	(0.0224)	(0.0192)	(0.0255)	(0.0213)	(0.0166)	(0.0255)	(0.0315)	(0.0200)	(0.0345)
Ln school enrolment				0.0118	-0.000426	-0.00997	0.00987	-0.00285	-0.0118
				(0.00855)	(0.00780)	(0.00955)	(0.0112)	(0.00766)	(0.0109)
Number of students in class				0.00153*	-0.000853	-0.00277**	0.00147	-0.000917	-0.00316***
				(0.000804)	(0.000984)	(0.00133)	(0.00122)	(0.000963)	(0.00120)
Religious school (religious = 1)				0.0158	0.00124	-0.0247	0.0136	-0.00423	-0.0191
				(0.0107)	(0.0116)	(0.0161)	(0.0109)	(0.0146)	(0.0171)
Rural school				0.0939***	0.0815**	0.0563**	0.0911***	0.0789***	0.0629*
				(0.0262)	(0.0341)	(0.0286)	(0.0179)	(0.0198)	(0.0343)
Single sex school				0.0357**	0.0544***	0.0795***	0.0364**	0.0478***	0.0733***
				(0.0160)	(0.0119)	(0.0257)	(0.0154)	(0.0119)	(0.0266)
Proportion of parents declaring school selects students							0.0240	0.0193	0.0117
							(0.0239)	(0.0212)	(0.0255)
Class standard deviation of prior scores- Math (8th grade)							-0.000972**	-0.000937***	-0.00111*
							(0.000426)	(0.000349)	(0.000588)
Class standard deviation of prior scores- Language (8th grade)							-0.00132**	-0.00134***	-0.000691
							(0.000591)	(0.000360)	(0.000697)
Constant	-0.199***	0.0462***	0.311***	-0.346***	0.0683	0.470***	-0.246***	0.175***	0.559***
	(0.00824)	(0.0123)	(0.0192)	(0.0607)	(0.0440)	(0.0599)	(0.0720)	(0.0472)	(0.0771)
Number of observations	190,981	190,981	190,981	190,981	190,981	190,981	190,981	190,981	190,981

Dependant variable: Estimated teacher effect from equation 1.
Note: All specifications include schools SES classification. Columns 4 to 6 include other school and class controls, excepting school selectivity and students homogeneity in prior examinations as detailed in Table 2.2. Columns 7 to 9 also include the latter.
Excluded reference categories: School Socioeconomic Status A (Lower SES), Secular school, Urban school, Mixed school.
Bootstrapped standard errors clustered at teacher level in parentheses . *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. (200 replications)

Table 2B4.b Teacher effects quantile regressions. Full results (Language)

	Model Specification 1			Model Specification 2			Model Specification 3		
	Percentile 10	Percentile 50	Percentile 90	Percentile 10	Percentile 50	Percentile 90	Percentile 10	Percentile 50	Percentile 90
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
School Socioeconomic Status B (SES B- Lower Middle SES)	-0.0898***	-0.0670***	-0.0516***	-0.0847***	-0.0601***	-0.0398***	-0.0825***	-0.0468***	-0.0292**
	(0.0100)	(0.00832)	(0.0148)	(0.0111)	(0.00719)	(0.0119)	(0.0115)	(0.00743)	(0.0114)
School Socioeconomic Status C (SES C- Middle SES)	-0.118***	-0.0929***	-0.0910***	-0.111***	-0.0875***	-0.0858***	-0.105***	-0.0674***	-0.0633***
	(0.0115)	(0.00668)	(0.0122)	(0.0151)	(0.0103)	(0.00905)	(0.0119)	(0.0107)	(0.0136)
School Socioeconomic Status D (SES D- Higher Middle SES)	-0.0985***	-0.0791***	-0.0730***	-0.0919***	-0.0779***	-0.0765***	-0.0779***	-0.0541***	-0.0475***
	(0.0136)	(0.00800)	(0.0182)	(0.0223)	(0.0106)	(0.0174)	(0.0190)	(0.00986)	(0.0182)
School Socioeconomic Status E (SES E- Higher SES)	-0.145***	-0.0990***	-0.0929***	-0.133***	-0.116***	-0.111***	-0.111***	-0.0869***	-0.0747***
	(0.0172)	(0.0112)	(0.0140)	(0.0197)	(0.0119)	(0.0163)	(0.0191)	(0.0102)	(0.0184)
Ln School Enrollment				0.0115**	-0.00516	-0.00776	0.00871	-0.00351	-0.00645
				(0.00566)	(0.00432)	(0.00729)	(0.00561)	(0.00418)	(0.00582)
Number of students in class				-0.000140	-0.00172***	-0.00296***	0.000574	-0.00147***	-0.00253***
				(0.000636)	(0.000620)	(0.000952)	(0.000594)	(0.000474)	(0.000801)
Religious School (religious = 1)				0.0106	0.00868	-0.00615	0.0150*	0.0106*	0.00280
				(0.0108)	(0.00610)	(0.00845)	(0.00765)	(0.00605)	(0.00945)
Rural School				0.0223	0.0170	0.0262*	0.0215*	0.00906	0.0245
				(0.0189)	(0.0123)	(0.0151)	(0.0121)	(0.00971)	(0.0212)
Single-sex school				0.0189	0.0285***	0.0299**	0.0188	0.0308***	0.0377***
				(0.0184)	(0.0103)	(0.0135)	(0.0166)	(0.00675)	(0.00892)
Proportion of parents declaring school selects students							-0.0537***	-0.0559***	-0.0753***
							(0.0124)	(0.00930)	(0.0135)
Class standard deviation of prior scores- Math (8th grade)							-0.000180	-0.000501*	-4.74e-05
							(0.000274)	(0.000277)	(0.000275)
Class standard deviation of prior scores- Spanish (8th grade)							-0.000911**	-0.000583***	-0.000294
							(0.000380)	(0.000225)	(0.000293)
Constant	-0.0856***	0.0676***	0.231***	-0.165***	0.157***	0.386***	-0.113***	0.190***	0.391***
	(0.00757)	(0.00498)	(0.0109)	(0.0416)	(0.0332)	(0.0276)	(0.0382)	(0.0272)	(0.0409)
Number of observations	190,956	190,956	190,956	190,956	190,956	190,956	190,956	190,956	190,956
	.	.	.	.	.	.	.	.	

Dependant variable: Estimated Teacher Effect from equation (1).

Note. All specifications include schools SES classification. Columns 3 to 6 include other school and class controls, excepting school selectivity and students homogeneity in prior examinations. Columns 7 to 9 also include the latter.

Excluded reference categories: School Socioeconomic Status A (Lower SES), Secular school, Urban school, Mixed school.

Bootstrapped standard errors clustered at teacher level in parentheses . *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. (200 replications)

Appendix 2C: Sensitivity analysis - Teacher value-added estimation

Table 2C1. Teacher value-added estimates and estimation sample per subject. Teachers' original and reduced sample.

Average Teacher effect (in score standard deviations)

	Model a.1	Model a.2	Model a.3	Model a.4	Model a.5	Model a.6
All Teachers						
Math						
Teacher effects Non-Shrunken	0.36	0.35	0.28	0.26	0.23	0.24
Teacher effects Shrunken	0.34	0.33	0.26	0.24	0.21	0.21
Language						
Teacher effects Non-Shrunken	0.30	0.29	0.24	0.21	0.19	0.19
Teacher effects Shrunken	0.27	0.26	0.20	0.18	0.15	0.15

Estimation Sample	***Math***	***Language***
Number of teachers	3,746	3,845
Observations	190,989	190,965
Average students per teacher	51.0	49.7
SD Average students per teacher	36.1	34.4
Min number of students per teacher	10	10
Max number of students per teacher	363	286
Average number of classes per teacher	1.9	1.8
Average Number of schools per teach	1.04	1.03

	Model a.1	Model a.2	Model a.3	Model a.4	Model a.5	Model a.6
2005-2006 Teachers						
Math						
Teacher effects Non-Shrunken	0.38	0.37	0.30	0.28	0.25	0.26
Teacher effects Shrunken	0.33	0.33	0.27	0.25	0.22	0.22
Language						
Teacher effects Non-Shrunken	0.32	0.31	0.26	0.29	0.21	0.27
Teacher effects Shrunken	0.27	0.26	0.21	0.25	0.16	0.22

Estimation Sample	***Math***	***Language***
Number of teachers	2,147	2,309
Observations	83,468	87,821
Average students per teacher	38.9	38.03
SD Average students per teacher	27.0	25.6
Min number of students per teacher	10	10
Max number of students per teacher	348	207
Average number of classes per teacher	1.7	1.6
Average Number of schools per teach	1.03	1.02

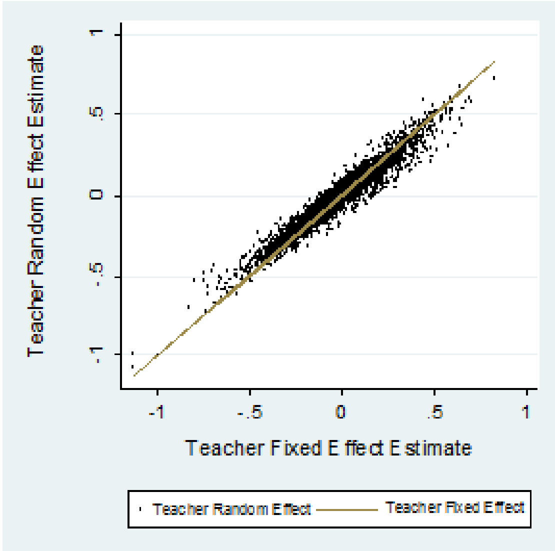

Figure 2C1. Teachers' fixed versus random effects estimates (Math)

Table 2C2. Sargan-Hansen test results. Teacher random versus fixed effects estimates

MODEL	Model a.1	Model a.2	Model a.3	Model a.4	Model a.5	Model a.6
Estimated Teacher effects-Whole Sample						
Random effects-Math	0.23	0.22	0.21	0.21	0.21	0.21
Fixed effects-Math (shrunken)	0.34	0.33	0.26	0.24	0.21	0.21
Random effects-Spanish	0.18	0.17	0.17	0.17	0.16	0.16
Fixed effects-Spanish (shrunken)	0.27	0.26	0.20	0.18	0.15	0.15
Sargen-Hansen test-Whole Sample						
Math						
Degrees of freedom	1	13	20	30	24	34
Chi squatred	5,002.12	4,306.12	1,619.02	902.04	157.60	190.25
P-value	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Language						
Degrees of freedom	1	13	20	30	24	34
Chi squatred	5,274.29	3,839.22	1,632.10	798.32	165.93	137.84
P-value	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001

Table 2C3. Intra-class correlation per subject. Teachers' fixed vs. random effects estimates.

MODEL	Model a.1	Model a.2	Model a.3	Model a.4	Model a.5	Model a.6
Intraclass correlation- Teacher Fixed Effects Estimates						
Math						
N observations= 190,981						
Pho	0.33	0.32	0.22	0.19	0.16	0.17
Language						
N observations= 190,956						
Pho	0.22	0.21	0.15	0.12	0.10	0.10
Intraclass correlation- Teacher Random Effects Estimates						
Math						
N observations= 190,981						
Pho	0.15	0.14	0.13	0.13	0.13	0.13
Language						
N observations= 190,956						
Pho	0.08	0.07	0.07	0.07	0.07	0.07

Appendix 2D: Teacher effects and the socioeconomic gap

Table 2D1. Teacher effects and the socioeconomic gap in academic achievement in 10th grade (Language)

	Socioeconomic GAP in 10th grade (in test scores standard deviations)	Average Teacher effect difference (model a.4)		Average Teacher effect difference (model a.6)		Pctg. of the socioeconomic GAP explained by teacher effects difference (Model a.4)		Pctg. of the socioeconomic GAP explained by teacher effects difference (Model a.6)	
	(1)	(2)		(3)		(4)		(5)	
Lower SES (reference category, SES A)	-	-		-		-		-	
Lower-middle SES (SES B)	0.24	**-0.05**	*0.01*	**-0.05**	*0.01*	**-19.0%**	*3.2%*	**-20.8%**	*2.6%*
Middle SES (SES C)	0.75	**-0.07**	*0.01*	**-0.08**	*0.01*	**-9.4%**	*1.1%*	**-10.5%**	*0.9%*
Upper-middle SES (SES D)	1.20	**-0.04**	*0.01*	**-0.07**	*0.01*	**-2.9%**	*0.9%*	**-5.6%**	*0.7%*
Higher SES (SES E)	1.50	**-0.05**	*0.01*	**-0.09**	*0.01*	**-3.1%**	*0.7%*	**-6.1%**	*0.6%*
Lower-Middle SES (reference category, SES B	-	-		-		-		-	
Middle SES (SES C)	0.51	**-0.02**	*0.01*	**-0.03**	*0.01*	**-4.8%**	*1.5%*	**-5.6%**	*1.2%*
Upper-middle SES (SES D)	0.96	0.01	*0.01*	**-0.02**	*0.01*	1.1%	*1.0%*	**-1.7%**	*0.9%*
Higher SES (SES E)	1.26	**0.00**	*0.01*	**-0.04**	*0.01*	**0.0%**	*0.8%*	**-3.3%**	*0.7%*
Middle SES (reference category, SES C)	-	-	-	-	-	-		-	
Upper-middle SES (SES D)	0.45	**0.04**	*0.01*	**0.01**	*0.01*	**7.8%**	*2.3%*	**2.6%**	*1.9%*
Higher SES (SES E)	0.75	**0.02**	*0.01*	**-0.01**	*0.01*	**3.3%**	*1.4%*	**-1.8%**	*1.2%*
Upper-Middle SES (reference category, SES I	-	-	-	-	-	-		-	
Higher SES (SES E)	0.30	**-0.01**	*0.01*	**-0.03**	*0.01*	**-3.6%**	*3.9%*	**-8.4%**	*3.5%*

All coefficients in **bold** significant at 95% level. Standard errors in *italic*.

Note: School Socieconomic Status attainment GAP (in student test scores standard deviations)

Appendix 3A: Access to higher education. Period 1990-2013

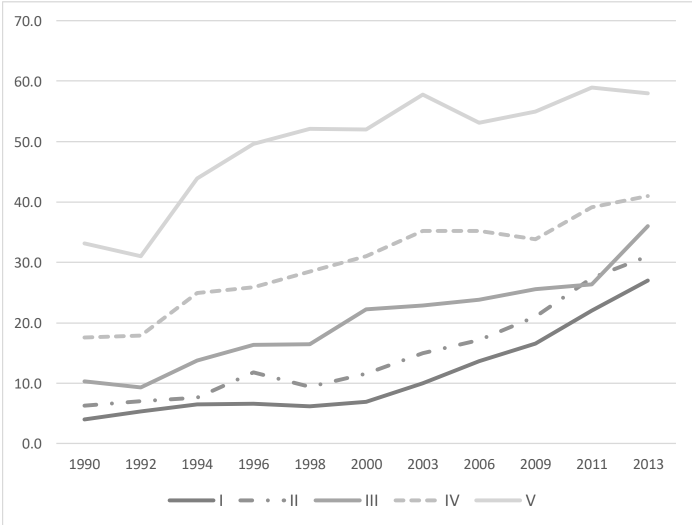

Figure 3A1. Higher education net enrolment rate by income quintile. 1990-2013

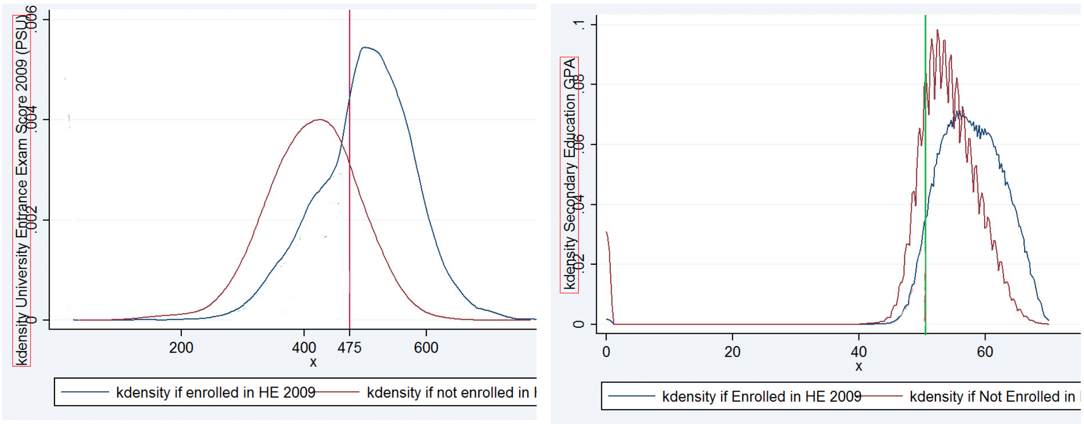

Figure 3A2. Distribution of students attending higher education according to GPA score and PSU test results in 2009. 2008 cohort.

Appendix 3B: Estimation sample and regressions full results

Table 3B1. Sample descriptive statistics by school SES

	All schools			Lower SES Schools (SES A)			Lower-Middle SES Schools (SES B)			Middle SES Schools (SES C)			Higher-Middle SES Schools (SES D)			Higher SES Schools (SES E)		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
School and Class Level Descriptive Statistics																		
School's proportion of students sitting University Entrance Examination in 09	2,422	0.87	0.2	466	0.69	0.3	659	0.79	0.2	578	0.95	0.1	383	0.98	0.1	336	0.98	0.1
School's proportion of students eligible for public funding in 09	2,422	0.42	0.3	466	0.09	0.1	659	0.21	0.2	578	0.50	0.2	383	0.71	0.2	336	0.83	0.2
School average University Entry Examination score (PSU 09)	2,408	445.7	120.9	456	316.3	78.3	656	371.0	76.4	577	477.2	61.0	383	542.7	58.7	336	602.2	64.9
Student's school average SIMCE 06 (10th grade)	2,417	264.6	38.5	466	226.3	19.0	659	243.3	24.9	577	271.3	25.2	383	294.4	25.9	332	314.6	25.3
Student's school average SIMCE 04 (8th grade)	2,418	265.7	29.9	466	234.4	14.2	659	248.3	17.5	576	272.0	17.8	383	289.5	18.6	334	305.0	20.8
School's proportion of repeaters before 8th grade	2,419	0.09	0.1	466	0.17	0.1	659	0.11	0.1	577	0.05	0.1	383	0.05	0.1	334	0.06	0.1
School's average parental expectations on their children's lenght of schooling (in years)	2,419	15.4	1.1	466	13.9	0.7	659	15.0	0.6	577	16.1	0.4	383	16.4	0.2	334	16.5	0.1
School's average father's schooling (in years)	2,412	11.5	3.2	466	7.7	1.0	659	9.5	1.0	575	12.0	1.2	380	14.5	1.1	332	16.7	1.2
School's average mother's schooling (in years)	2,410	11.1	3.0	466	7.6	1.0	659	9.3	0.9	574	11.7	1.1	380	13.9	1.1	331	15.8	1.1
School's proportion of mothers with higher education degree	2,417	0.40	0.3	465	0.08	0.1	658	0.21	0.1	577	0.45	0.1	383	0.68	0.1	334	0.83	0.1
School's average number of people at home	2,419	5.0	0.6	466	5.2	0.8	659	5.1	0.5	577	4.8	0.4	383	4.6	0.4	334	5.0	0.8
School's average family income	2,419	1,090	1,063	466	351	73	659	478	121	577	787	201	383	1,488	463	334	3,394	824
School enrolment in 12th grade 2008	2,422	74.2	72.6	466	64.2	56.5	659	104.3	87.0	578	78.5	78.4	383	54.0	57.5	336	44.9	34.4
Class size in 12th grade	2,422	24.6	9.9	466	20.9	9.1	659	25.8	10.7	578	27.7	9.1	383	25.2	9.5	336	21.4	8.4
School type public in 12th grade	2,422	0.31	0.5	466	0.66	0.5	659	0.52	0.5	578	0.14	0.4	383	0.03	0.2	336	-	-
School type private subsidized in 12th grade	2,422	0.54	0.5	466	0.34	0.5	659	0.47	0.5	578	0.86	0.4	383	0.83	0.4	336	0.06	0.2
School type private in 12th grade	2,422	0.15	0.4	466	-	-	659	-	0.1	578	-	-	383	0.14	0.4	336	0.94	0.2
School SES A in 10th grade (lower SES)	2,422	0.19	0.4	466	1.00	-	659	-	-	578	-	-	383	-	-	336	-	-
School SES B in 10th grade (lower-middle SES)	2,422	0.27	0.5	466	-	-	659	1.00	-	578	-	-	383	-	-	336	-	-
School SES C in 10th grade (middle SES)	2,422	0.24	0.4	466	-	-	659	-	-	578	1.00	-	383	-	-	336	-	-
School SES D in 10th grade (higher-middle SES)	2,422	0.16	0.4	466	-	-	659	-	-	578	-	-	383	1.00	-	336	-	-
School SES E in 10th grade (higher SES)	2,422	0.14	0.4	466	-	-	659	-	-	578	-	-	383	-	-	336	1.00	-

Table 3B2. Determinants of access to higher education by student's school SES. 2008 cohort (full results)

Average marginal effects *	ALL SCHOOLS			SES A SCHOOLS (LOWER SES)			SES B SCHOOLS (LOWER-MIDDLE SES)			SES C SCHOOLS (MIDDLE SES)			SES D SCHOOLS (UPPER-MIDDLE SES)			SES E SCHOOLS (HIGHER SES)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Individual-Level Determinants																		
Student did not sit University Entry Examination (1 or 0)			-0.152***			-0.209***			-0.207***			-0.123***			-0.0670***			-0.0491***
			(0.00286)			(0.00716)			(0.00515)			(0.00607)			(0.00676)			(0.00762)
Student eligible for HE Public Funding (1 or 0)			0.0551***			0.0908***			0.0831***			0.0428***			0.000932			1
			(0.00339)			(0.0126)			(0.00680)			(0.00471)			(0.00425)			(0.00527)
Student GPA (1.0 to 7.0)			0.0166***			0.0295***			0.0307***			0.00710***			-0.00172			-0.00253
			(0.00155)			(0.00695)			(0.00330)			(0.00197)			(0.00166)			(0.00182)
Student SIMCE test score in 8th grade	0.0619***	0.0629***	0.00589***	0.105***	0.106***	0.00826	0.0845***	0.0850***	0.00907***	0.0401***	0.0402***	0.00198	0.0106***	0.0106***	-0.000655	0.0120***	0.0120***	0.00331
	(0.00108)	(0.00130)	(0.00162)	(0.00371)	(0.00350)	(0.00525)	(0.00246)	(0.00299)	(0.00303)	(0.00196)	(0.00195)	(0.00258)	(0.00143)	(0.00146)	(0.00241)	(0.00191)	(0.00213)	(0.00240)
Student SIMCE test score in 10th grade			0.0231***			0.0423***			0.0301***			0.0138***			0.00336			0.00446*
			(0.00184)			(0.00535)			(0.00355)			(0.00312)			(0.00237)			(0.00250)
Student University Entry Examination average score			0.0645***			0.0989***			0.0875***			0.0452***			0.0247***			0.0206***
			(0.00142)			(0.00418)			(0.00268)			(0.00225)			(0.00250)			(0.00290)
Gender (1 or 0)	0.0295***	0.0284***	0.0208***	0.0731***	0.0728***	0.0507***	0.0302***	0.0296***	0.0206***	0.0153***	0.0142***	0.0116***	0.0103***	0.0101***	0.0109***	0.0143***	0.0142***	0.0155***
	(0.00309)	(0.00240)	(0.00269)	(0.00758)	(0.00862)	(0.00722)	(0.00597)	(0.00582)	(0.00542)	(0.00409)	(0.00416)	(0.00399)	(0.00373)	(0.00340)	(0.00304)	(0.00271)	(0.00327)	(0.00285)
Family income (in USD)	0.0353***	0.0357***	0.0298***	0.0575***	0.0582***	0.0487***	0.0877***	0.0882***	0.0753***	0.0216***	0.0216***	0.0195***	0.00438***	0.00435***	0.00367**	-4.48e-05	-5.06e-05	-7.18e-05
	(0.00294)	(0.00276)	(0.00272)	(0.0123)	(0.00967)	(0.0107)	(0.00760)	(0.00766)	(0.00677)	(0.00470)	(0.00409)	(0.00383)	(0.00152)	(0.00155)	(0.00162)	(0.00129)	(0.00126)	(0.00118)
Number of people at home	-0.0164***	-0.0162***	-0.0134***	-0.0200***	-0.0198***	-0.0159***	-0.0241***	-0.0240***	-0.0196***	-0.0141***	-0.0139***	-0.0120***	-0.00155	-0.00155	-0.00155	0.00216	0.00216	0.00194
	(0.00106)	(0.00105)	(0.000985)	(0.00340)	(0.00288)	(0.00297)	(0.00227)	(0.00215)	(0.00185)	(0.00192)	(0.00157)	(0.00153)	(0.00221)	(0.00210)	(0.00212)	(0.00160)	(0.00204)	(0.00176)
Parents' schooling (in years)	0.0358***	0.0360***	0.0264***	0.0592***	0.0595***	0.0405***	0.0486***	0.0491***	0.0364***	0.0232***	0.0234***	0.0184***	0.00144	0.00143	0.000766	-9.56e-05	-5.82e-06	-0.000462
	(0.00154)	(0.00154)	(0.00150)	(0.00536)	(0.00446)	(0.00411)	(0.00271)	(0.00387)	(0.00302)	(0.00246)	(0.00255)	(0.00239)	(0.00190)	(0.00228)	(0.00192)	(0.00278)	(0.00311)	(0.00265)
Number of books at home	0.00708***	0.00741***	0.00264**	0.0223***	0.0229***	0.0139***	0.0124***	0.0132***	0.00519**	0.000527	0.000815	-0.00128	0.000108	0.000135	-2.57e-05	-0.00166	-0.00168*	-0.00178*
	(0.00126)	(0.00126)	(0.00123)	(0.00438)	(0.00581)	(0.00514)	(0.00283)	(0.00213)	(0.00227)	(0.00163)	(0.00173)	(0.00175)	(0.00139)	(0.00147)	(0.00131)	(0.00106)	(0.00101)	(0.00108)
Parental fees (in USD)	-0.000494	0.000658	0.00255	-0.0178	-0.0177	-0.00348	0.0193***	0.0202***	0.0260***	0.0100*	0.0106*	0.00907*	-0.00238	-0.00228	-0.00277	0.00111	0.00121	0.000883
	(0.00301)	(0.00345)	(0.00315)	(0.0152)	(0.0146)	(0.0118)	(0.00740)	(0.00747)	(0.00764)	(0.00534)	(0.00589)	(0.00525)	(0.00234)	(0.00221)	(0.00211)	(0.00135)	(0.00142)	(0.00139)
Student's parents schooling expectations (in years)	0.0445***	0.0446***	0.0337***	0.0599***	0.0601***	0.0436***	0.0632***	0.0634***	0.0474***	0.0294***	0.0296***	0.0243***	0.00514	0.00516*	0.00386	0.00333	0.00339	0.00369
	(0.00108)	(0.00107)	(0.00113)	(0.00335)	(0.00310)	(0.00286)	(0.00218)	(0.00261)	(0.00221)	(0.00242)	(0.00176)	(0.00195)	(0.00334)	(0.00289)	(0.00325)	(0.0151)	(0.0113)	(0.00635)
Student attended pre-school education (1 or 0)	0.0133***	0.0142***	0.0154***	0.00966	0.0113	0.0128*	0.0234***	0.0246***	0.0271***	0.00598	0.00674	0.00920**	-1.75e-05	-2.90e-06	0.00119	0.000494	0.000847	0.00182
	(0.00270)	(0.00219)	(0.00252)	(0.00692)	(0.00828)	(0.00713)	(0.00484)	(0.00567)	(0.00485)	(0.00406)	(0.00437)	(0.00398)	(0.00432)	(0.00424)	(0.00379)	(0.00825)	(0.00649)	(0.00632)
Student repated course once or more before 8th grade (1 or 0)	-0.0440***	-0.0438***	-0.0209***	-0.0718***	-0.0720***	-0.0359***	-0.0617***	-0.0616***	-0.0298***	-0.0233***	-0.0233***	-0.00809	-0.00602	-0.00600	0.00103	-0.00200	-0.00189	0.00272
	(0.00331)	(0.00337)	(0.00315)	(0.00973)	(0.00905)	(0.00829)	(0.00743)	(0.00683)	(0.00609)	(0.00703)	(0.00675)	(0.00611)	(0.00765)	(0.00809)	(0.00714)	(0.00631)	(0.00555)	(0.00605)
Student Switched school in 8th grade	-0.0164***	-0.0142***	-0.00418	-0.0223*	-0.0240**	-0.00718	-0.0247***	-0.0221***	-0.00293	-0.00921**	-0.00780*	-0.00492	-0.00573**	-0.00600***	-0.00474*	-4.79e-05	-0.000157	-3.81e-05
	(0.00337)	(0.00313)	(0.00312)	(0.0118)	(0.00944)	(0.00990)	(0.00760)	(0.00711)	(0.00664)	(0.00435)	(0.00436)	(0.00402)	(0.00223)	(0.00198)	(0.00267)	(0.00423)	(0.00397)	(0.00369)
Student attended rural school in 8th grade (1 or 0)	-0.0231***	-0.0237***	-0.0167***	-0.0415***	-0.0403***	-0.0279***	-0.0261***	-0.0268***	-0.0192***	-0.00603	-0.00873	-0.0129	-0.00529	-0.00585	-0.00879	0.00174	0.00176	0.000276
	(0.00327)	(0.00394)	(0.00348)	(0.00700)	(0.00669)	(0.00747)	(0.00737)	(0.00658)	(0.00735)	(0.00954)	(0.00732)	(0.00905)	(0.0134)	(0.0134)	(0.0104)	(0.0134)	(0.0160)	(0.0116)

Table 3B2 (continuation)

Average marginal effects *	ALL SCHOOLS			SES A SCHOOLS (LOWER SES)			SES B SCHOOLS (LOWER-MIDDLE SES)			SES C SCHOOLS (MIDDLE SES)			SES D SCHOOLS (UPPER-MIDDLE SES)			SES E SCHOOLS (HIGHER SES)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
School-Level Determinants																		
School's University Entry Examination average score	0.0344***	0.0201***	-0.00342	0.0360***	0.0243**	0.000454	0.0532***	0.0282***	-0.00753	0.0322***	0.0124	-0.0172*	0.00885	0.00406	-0.0139**	0.0262***	0.0232***	0.00609
	(0.00494)	(0.00487)	(0.00461)	(0.0115)	(0.0120)	(0.0113)	(0.00791)	(0.00975)	(0.00990)	(0.00967)	(0.00937)	(0.00902)	(0.00656)	(0.00602)	(0.00693)	(0.00525)	(0.00576)	(0.00573)
School SIMCE test score in 8th grade	0.0127**	-0.00254	0.0130**	0.00114	-0.0114	0.0101	0.0188*	0.000374	0.0277**	0.00147	-0.00820	0.00603	0.00154	-1.25e-05	0.00758	-0.0184***	-0.0186***	-0.0135***
	(0.00551)	(0.00524)	(0.00559)	(0.0151)	(0.0188)	(0.0151)	(0.0112)	(0.0109)	(0.0118)	(0.00942)	(0.00878)	(0.00886)	(0.00519)	(0.00503)	(0.00551)	(0.00388)	(0.00530)	(0.00502)
School Enrollment in 12th grade	-0.00325	-0.00300	0.00159	-0.00186	0.00178	0.0162**	-0.00502	-0.00577*	0.000849	0.00197	0.00177	0.00423	0.00220	0.00262	0.00321*	0.000452	0.00256	0.00324
	(0.00257)	(0.00209)	(0.00244)	(0.00983)	(0.00725)	(0.00803)	(0.00405)	(0.00347)	(0.00395)	(0.00371)	(0.00359)	(0.00342)	(0.00283)	(0.00307)	(0.00190)	(0.00593)	(0.00575)	(0.00548)
Class size in 12th grade	0.0134***	0.0136***	0.00515***	0.0223***	0.0222***	0.00401	0.0203***	0.0208***	0.00894***	0.00588**	0.00570**	0.00176	0.00138	0.000974	0.000136	0.00250	0.00186	0.00187
	(0.00199)	(0.00203)	(0.00145)	(0.00564)	(0.00417)	(0.00433)	(0.00352)	(0.00378)	(0.00239)	(0.00274)	(0.00287)	(0.00286)	(0.00228)	(0.00169)	(0.00181)	(0.00248)	(0.00260)	(0.00211)
Vocational course in 12th grade (1 or 0)	-0.108***	-0.0932***	-0.0579***	-0.181***	-0.170***	-0.0927***	-0.141***	-0.119***	-0.0783***	-0.0530***	-0.0442***	-0.0276***	-0.0216	-0.0245	-0.0165			
	(0.00433)	(0.00485)	(0.00420)	(0.00988)	(0.0103)	(0.00963)	(0.00807)	(0.00868)	(0.00916)	(0.00771)	(0.00762)	(0.00670)	(0.0243)	(0.0265)	(0.0291)			
School type public in 12th grade (1 or 0)-Ref. Voucher school	-0.00793**	-0.00644	-0.00553	0.00302	0.00199	0.00816	-0.00394	-0.00444	-0.00648	-0.0122	-0.00914	-0.00557	-0.0170**	-0.0162**	-0.0162**			
	(0.00405)	(0.00422)	(0.00387)	(0.0126)	(0.00979)	(0.0129)	(0.00829)	(0.00409)	(0.00682)	(0.00802)	(0.00652)	(0.00682)	(0.00738)	(0.00702)	(0.00667)			
School type private in 12th grade (1 or 0)	-0.102***	-0.0680***	-0.0971***				0.0582**	0.0690***	0.181***				-0.00485	-0.00116	-0.00143	0.00422	0.00616	0.00696
	(0.0225)	(0.0225)	(0.0206)				(0.0265)	(0.0215)	(0.0250)				(0.00888)	(0.00778)	(0.00797)	(0.00649)	(0.00680)	(0.00679)
School average student's parents schooling expectations (years)	0.0257***	0.0250***	0.0289***	0.0294***	0.0259***	0.0371***	0.0409***	0.0347***	0.0375***	0.0333***	0.0239**	0.0195**	-0.00612	-0.00692	-0.00673	-0.00453	-0.00437	-0.00729
	(0.00410)	(0.00393)	(0.00375)	(0.0108)	(0.00906)	(0.0106)	(0.00937)	-0.00802	(0.0104)	(0.0108)	(0.0101)	(0.00953)	(0.0116)	(0.0139)	(0.0153)	(0.0193)	(0.0144)	(0.0138)
Observations	162,449	162,449	162,449	26,904	26,904	26,904	62,195	62,195	62,195	41,017	41,017	41,017	19,019	19,019	19,019	13,314	13,314	13,314
N of Clusters	2416	2416	2416	466	466	466	659	659	659	576	576	576	383	383	383	332	332	332
Pseudo R2			0.2919			0.1465			0.1351			0.1288			0.031			0.059

Bootstrapped standard errors clustered at school level in parentheses (200 replications). *** p<0.01, ** p<0.05, * p<0.1. All non-dummy regressors standardized.

Appendix 3C: Structure of the Chilean education system

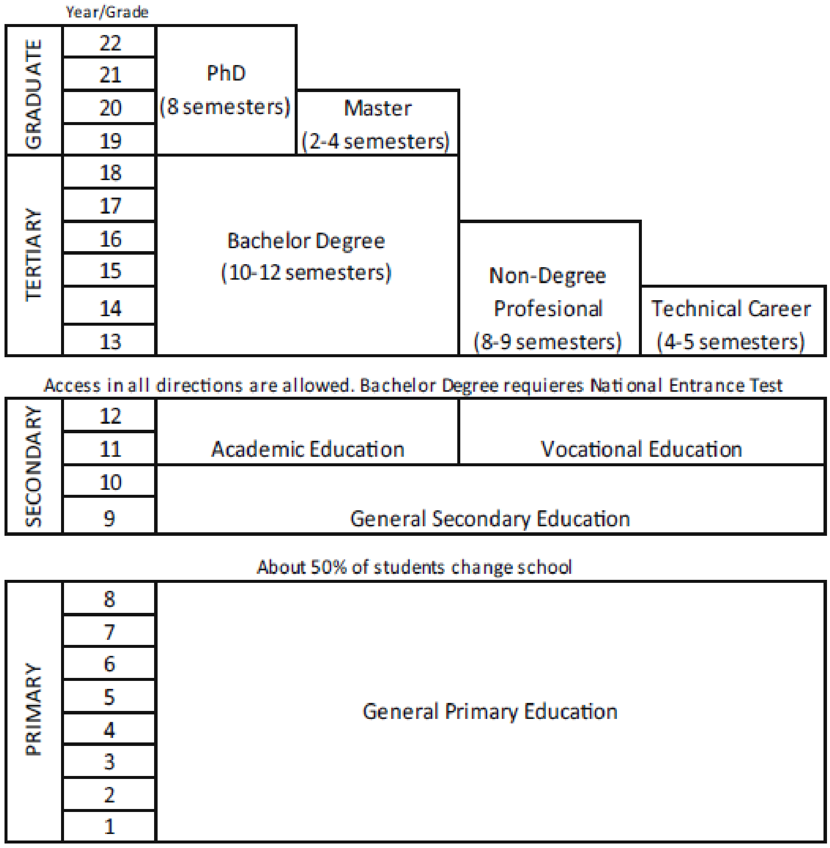

Figure 3C1. Structure of the Chilean education system. *Source: Farías and Sevilla (2015)*

Table 3C1. Individual and school level SES descriptive statistics. 8th grade cohort (2004) vs. estimation sample in 12th grade (2008).

	All SIMCE takers in 8th Grade 2004			Enrollment in12th Grade 2008 with SIMCE scores in 2004 and 2006 (2008 cohort)			Difference (in standard deviations)
	N	Mean	SD	N	Mean	SD	
Student Level							
SIMCE 04 Examination Average Score (8th grade)	267,489	252.5	47.3	162,449	266.3	45.1	0.29
SIMCE 06 Examination Average Score (10th grade)	196,560	258.3	54.0	162,449	265.3	52.9	0.13
University Entry Examination Average scores (PSU 09)	150,133	452.3	178.4	135,990	458.4	175.3	0.03
Gender in 8th grade	267,489	0.50	0.5	162,449	0.53	0.5	0.06
Family Income (in USD)	244,538	767.4	953.5	150,996	868.9	1,056.7	0.11
Parents' schooling (in years)	203,618	9.9	3.7	122,949	10.5	3.7	0.15
Number of books at home	249,095	47.4	54.9	153,379	53.6	57.8	0.11
Parental fees (in USD)	244,874	34.3	75.1	151,232	41.1	85.0	0.09
Student's parents schooling expectations (in years)	240,648	15.0	2.0	148,458	15.4	1.8	0.18
Student attended pre-school education	173,238	0.62	0.5	110,236	0.63	0.5	0.02
Student repated course once or more before 8th grade	250,068	0.15	0.4	154,084	0.07	0.3	(0.22)
Student's School Average SIMCE 04 (8th grade)	267,489	252.4	28.6	162,449	266.1	27.5	0.48
Student's School Average SIMCE 06 (10th grade)	267,463	250.7	34.3	162,449	265.3	35.3	0.43
Student attended Rural school in 8th grade	267,489	0.12	0.3	162,449	0.11	0.3	(0.03)

Table 3C1 (continuation)

	All SIMCE takers in 8th Grade 2004			Enrollment in12th Grade 2008 with SIMCE scores in 2004 and 2006 (2008 cohort)			Difference (in standard deviations)
	N	Mean	SD	N	Mean	SD	
School and Class Level							
Student's School Average SIMCE 04 (8th grade)	267,489	252.4	28.6	162,449	266.1	27.5	0.48
Student's School Average SIMCE 06 (10th grade)	267,463	250.7	34.3	162,449	265.3	35.3	0.43
School Type Public in 8th grade	267,489	0.54	0.5	162,449	0.50	0.5	(0.08)
School Type Private Subsidized in 8th grade	267,489	0.38	0.5	162,449	0.41	0.5	0.06
School Type Private in 8th grade	267,489	0.07	0.3	162,449	0.09	0.3	0.08
School SES A in 8th grade (lower income)	267,394	0.10	0.3	162,397	0.08	0.3	(0.07)
School SES B in 8th grade (lower middle income)	267,394	0.34	0.5	162,397	0.30	0.5	(0.08)
School SES C in 8th grade (middle income)	267,394	0.34	0.5	162,397	0.35	0.5	0.02
School SES D in 8th grade (upper middle income)	267,394	0.15	0.4	162,397	0.18	0.4	0.08
School SES E in 8th grade (higher income)	267,394	0.06	0.3	162,397	0.09	0.3	0.12

Appendix 4A: Accountability measures per country by PISA application

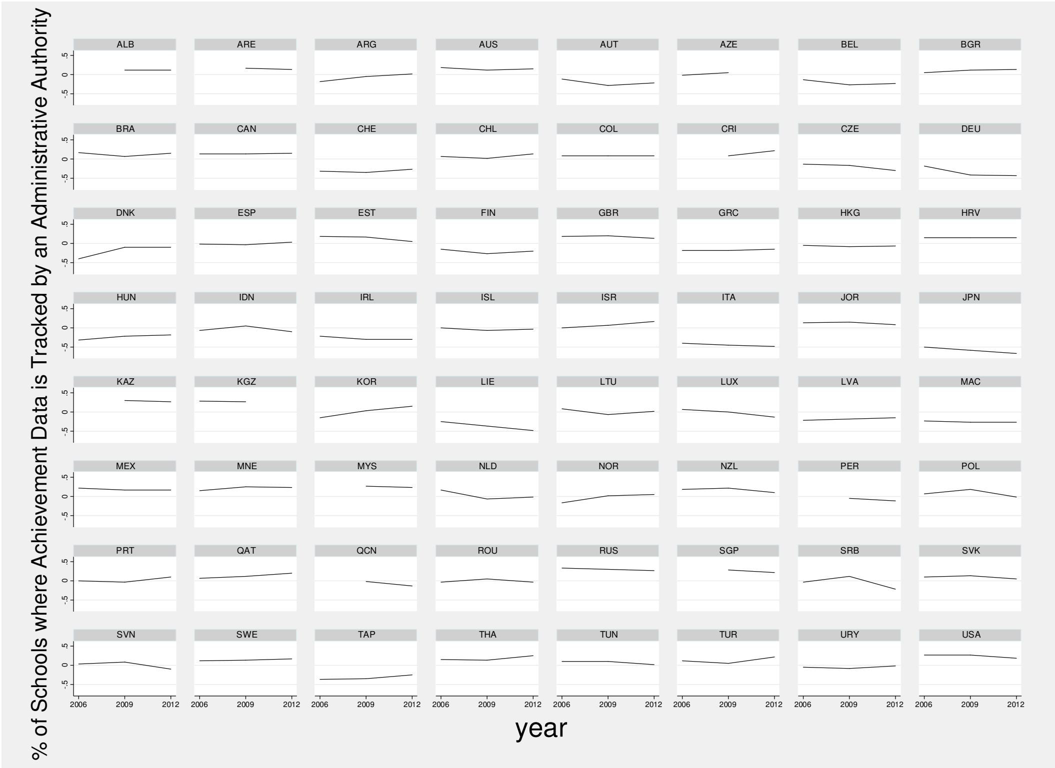

Figure 4A1. Percentage of schools at country level where academic results are tracked by an administrative authority (years 2006-2012).

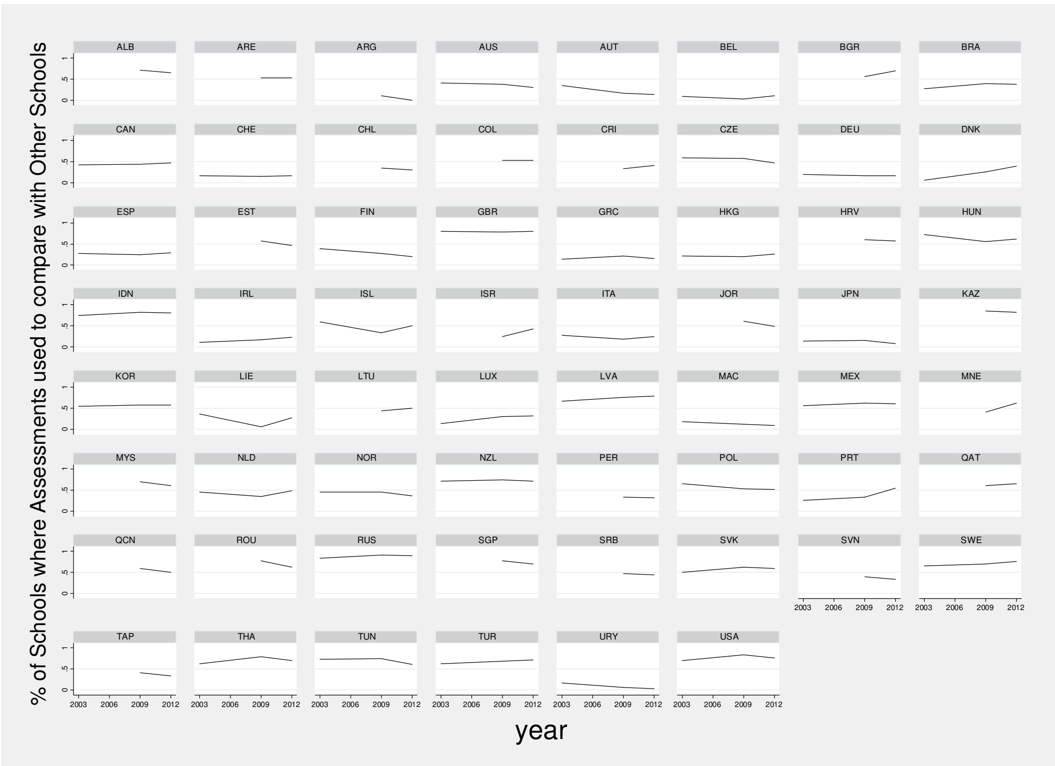

Figure 4A2. Percentage of schools at country level where results are used to compare with other schools (years 2003-2012).

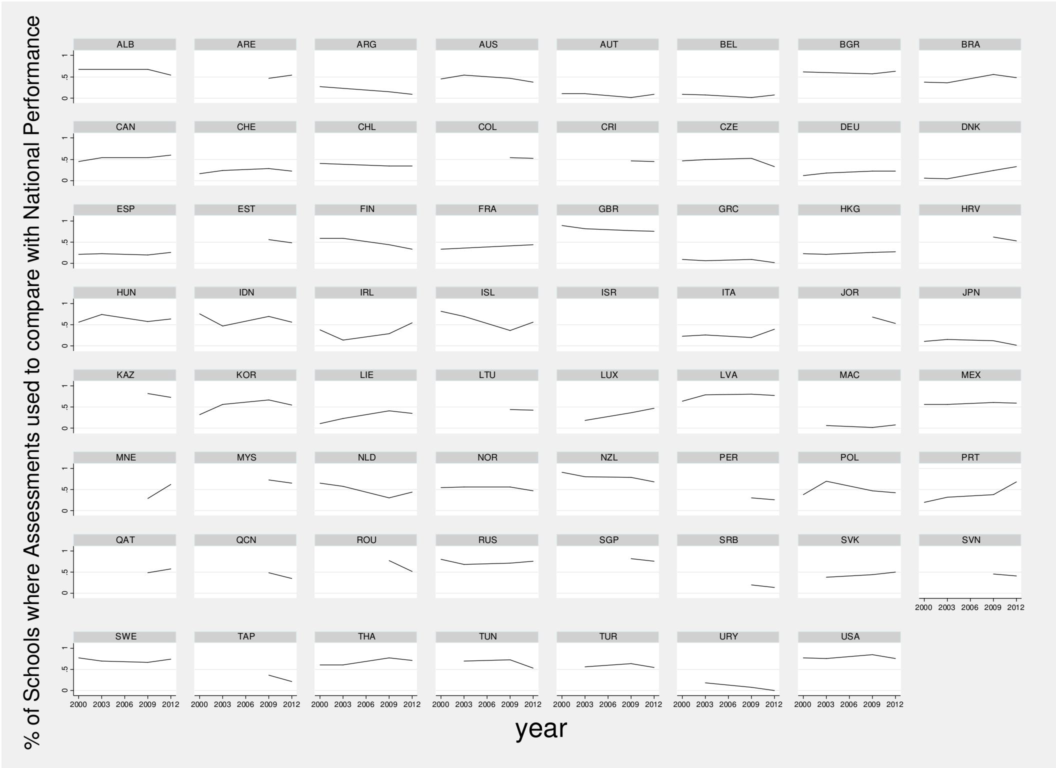

Figure 4A3. Percentage of schools at country level where achievement results are used to compare with national performance (years 2000-2012).

Appendix 4B: School accountability regressions. Cross-sectional estimates

Table 4B1. Effect of accountability in educational achievement. Cross-sectional estimates.

Dependent variable	(1) PVMATH	(2) PVMATH	(3) PVMATH	(4) PVMATH	(5) PVMATH
Country level accountability measures and interactions with student SES (Index of Socioeconomic Status ESCS)					
School Accountability- Results posted	2.703				
	1.812				
Student ESCS X Results posted	**-11.641**				
	1.315				
School Accountability- Results Tracked		***-53.552***			
		1.806			
Student ESCS X Results Tracked		**-9.400**			
		1.516			
School Accountability- Benchmarking I			**-30.938**		
			1.757		
Student ESCS X Benchmarking I			**-23.952**		
			1.457		
School Accountability- Benchmarking II				**-17.328**	**-17.254**
				2.288	2.470
Student ESCS X Benchmarking II				**-26.319**	**-26.806**
				1.573	1.570
Country fixed effects	**No**	**No**	**No**	**No**	**No**
Year fixed effects	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Student level sociodemographic characteristics	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
School level characteristics	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Other country level accountability-related covariates (admissions, etc)	**No**	**No**	**No**	**No**	**No**
Imputed covariates on school accountability	**No**	**No**	**No**	**No**	**No**
Constant	**279.560**	**279.907**	**283.756**	**276.655**	**365.350**
	12.6066	12.2725	11.6990	13.6817	11.2137
Observations	1,323,701	1,324,038	1,197,324	1,197,324	1,310,803
R-Squared	0.23	0.26	0.26	0.25	0.25
Number of countries	65	65	65	65	65
Number of PISA waves involved in the estimation	**3**	**3**	**3**	**3**	**4**
PISA Waves	**2006/09/12**	**2006/09/12**	**2003/09/12**	**2003/09/12**	**2000/03/09/1**

Coefficients in **Bold** p<0.01, ***Bold italic*** p<0.05, *Italic* p<0.1. Robust standard errors clustered at country level.

Note 1: School Accountability- Results posted: Percentage of schools where achievement data are posted publicly (e.g. in the media); School Accountability- Results Tracked: Percentage of schools where achievement are tracked by an administrative authority; School Accountability- Benchmarking I: Percentage of schools where assessments are used to compare the school with other schools; School Accountability- Benchmarking II: Percentage of schools where assessments used to compare the school to <district or national> performance.

Note 2: All specifications include controls for students' age, gender, migration status, type of school attended, school funding scheme, school location, student teacher ratio, share of fully certified teachers, number of students at school, shortage of teachers in math, science and language, share of full-time teachers, and student socioeconomic status as measured by PISA ESCS index.

Appendix 4C: Robustness checks on school accountability regressions. Additional time-varying country level controls

Table 4C1. Robustness checks for other measures of accountability

Dependent variable	(1) PVMATH	(2) PVMATH	(3) PVMATH	(4) PVMATH	(5) PVMATH	(6) PVMATH	(7) PVMATH	(8) PVMATH	(9) PVMATH	(10) PVMATH	(11) PVMATH	(12) PVMATH	(13) PVMATH
Country level accountability measures and interactions with SES (Index of Socioeconomic Status ESCS)													
School Accountability- Results Tracked	***-16.417***	**-19.828**	**-19.675**	**-30.109**	**-23.753**	**-19.317**	**-32.115**	**-27.754**					
	6.564	7.038	7.035	6.969	6.972	7.035	6.990	6.829					
Student ESCS X Results Tracked	**-3.442**	***-10.215***	***-8.371***	**-11.999**	**-6.688**	**-7.782**	**-9.196**	**-9.371**					
	1.467	1.371	1.368	1.264	1.357	1.365	1.277	1.296					
School Accountability- Benchmarking II									**62.909**	**62.786**	**64.493**	**65.881**	**74.241**
									5.661	5.703	5.397	5.681	5.328
Student ESCS X Benchmarking II									**-7.700**	**-8.630**	**-9.551**	**-9.682**	**-10.667**
									1.565	1.598	1.509	1.541	1.565
Other country level time-varying institutional characteristics													
School Operation (Public)		Yes						Yes		Yes			Yes
School Competition			Yes				Yes	Yes					
School Admission Policies I (Residential area)				Yes			Yes	Yes					
School Admission Policies II (Student past achievement)				Yes			Yes	Yes					
School Funding - Average Proportion of Private Spending (Parental fees)					Yes		Yes	Yes			Yes		Yes
School Funding - Average Proportion of Public Spending (Government)						Yes						Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Student level sociodemographic characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
School characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other country level accountability-related covariates (admissions, etc)	No	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Imputed covariates on school accountability	No	No	No	No	No	No	No	No	No	No	No	No	No
Constant	**199.681**	**195.116**	**212.746**	**201.270**	**202.304**	**207.947**	**206.576**	**201.549**	**285.742**	**284.375**	**286.914**	**290.221**	**291.230**
	12.6700	13.1109	12.9435	12.8681	13.0223	12.9575	12.9821	13.1886	11.5152	11.7296	11.2217	11.2545	11.3895
Observations	1,324,038	1,305,647	1,318,888	1,324,038	1,303,512	1,303,512	1,298,362	1,279,971	1,310,803	1,274,565	1,290,643	1,290,643	1,254,405
R-squared	0.396	0.397	0.397	0.397	0.399	0.399	0.401	0.402	0.389	0.388	0.392	0.392	0.391
Number of countries	65	65	65	65	63	63	63	63	65	65	65	65	65
Number of PISA waves involved in the estimation	3	3	3	3	3	3	3	3	4	4	4	4	4
PISA Waves	2006/09/12	2006/09/12	2006/09/12	2006/09/12	2006/09/12	2006/09/12	2006/09/12	2006/09/12	2000/03/09/12	2000/03/09/12	2000/03/09/12	2000/03/09/12	2000/03/09/12

Coefficients in **Bold** p<0.01, ***Bold italic*** p<0.05, *Italic* p<0.1. Robust standard errors clustered at country level.

Note 1: School Accountability- Results posted: Percentage of schools where achievement data are posted publicly (e.g. in the media); School Accountability- Results Tracked: Percentage of schools where achievement are tracked by an administrative authority. School Accountability- Benchmarking I: Percentage of schools where assessments are used to compare the school with other schools; School Accountability- Benchmarking II: Percentage of schools where assessments used to compare the school to <district or national> performance.

Note 2: Admission Policies I: Percentage of schools using residencial area as a criteria of student selection; Admission Policies II: Percentage of schools using prior achievement a a criteria for student selection; School Competition: Percentage of Schools declaring to be competing for students with other schools; School Funding I: Average percentage of school's total funding coming from parental fees; School Funding II: Average percentage of school's total funding provided from the government.

Note 3: All specifications include controls for students' age, gender, migration status, type of school attended, school funding scheme, school location, student teacher ratio, share of fullt certified terachers, number of students at school, shortage of teachers in math, science and language, share of full time teachers, and student socioeconomic status as measured by PISA ESCS index.

Appendix 4D: Robustness checks on school accountability regressions. Missing data on school accountability measures.

As mentioned in section 5.1.2, since we do not have information available for all our accountability measures for all PISA applications, we decided to impute our measures of accountability for those PISA waves where the respective items were not present, by using similar information available for two or more PISA waves. To do so, we make use of all the available information related to school practices, school accountability and other school level characteristics available in the different PISA waves, to impute information on our school accountability measures at school level for years 2000, 2003 and/or 2006 (depending on the measure of interest). In table 4D1 we can see a list of the imputed items on school accountability and the years imputed.

Table 4D1. Imputed data in school accountability

School Questionnaire Items-School Accountability Practices	**Original vs. Imputed Data***				
	PISA 2000	PISA 2003	PISA 2006	PISA 2009	PISA 2012
In your school, are assesments of students in <national modal grade for 15-year old> used for any of the following purposes? (Yes/No)					
Q01 Assessments - National Performance (To compare the school to <district or national> performance)	O	O	I	O	O
Q02 Assessments - School's Progress (To monitor the school's progress from year to year)	O	O	I	O	O
Q03 Assessments - School's Progress (To monitor the school's progress from year to year)	O	O	I	O	O
In your school, Are achievement data used in any of the following <accountability procedures>? (Yes/No)					
Q01 Achievement - Posted Publicly (Achievement data are posted publicly. e.g. in the	I	I	O	O	O
Q02 Achievement - Tracked by autorithy (Achievement data are tracked over time by an administrative authority)	I	I	O	O	O

* Original Data (O), Imputed data (I)

We decided to use multiple imputation techniques to impute data on school accountability measures, as well as on other variables at school level with incomplete information. We make use of the chained equations technique[50] (incorporating logistic regressions to forecast binary outcomes and linear regressions when the outcome is continuous) in our imputation model, to estimate the probability that a school shows a specific school accountability practice, forecasting the binary outcome per school. A

[50] We use Stata *mi* command following the chained equations methods which allows sequential imputation of imputed variables according to their initial level of completeness. The chained equations technique fills in missing values in multiple variables iteratively by using chained equations, a sequence of univariate imputation methods, starting with those variables with more information available and ending with those with the least information available.

similar procedure was followed for continuous outcomes. Below, in table 4D2, a list with descriptive statistics for the imputed variables can be found, as well as figures for the original records per variable.

Table 4D2. Imputed vs non-imputed data. Multiple imputation.

		Non Imputed Data			Imputed Data		
School Level Characteristics	***Type***	N	Mean	SD	N	Mean	SD
School operation (Publicly Operated=1)	Binary	248,661	0.83	0.38	471,930	0.80	0.40
School Funding (Share of budget paid by government)	Binary	249,619	0.81	0.29	428,373	0.80	0.31
School Funding (Share of budget paid by fees)	Binary	223,925	0.15	0.27	411,766	0.17	0.30
School Location (Small town=1) Ref cat: Village or Rural Area	Binary	259,425	0.22	0.42	471,356	0.20	0.40
School Location (Town=1)	Binary	259,425	0.32	0.47	471,356	0.30	0.46
School Location (City=1)	Binary	259,425	0.22	0.42	471,356	0.26	0.44
School Location (Large City=1)	Binary	259,425	0.11	0.32	471,356	0.14	0.35
Student teacher ratio	Continous	216,679	18.41	63.34	458,727	16.45	65.75
Number of students	Continous	276,165	876.42	646.99	480,174	867.32	694.63
Share of fully certified teachers	Continous	201,196	0.90	1.65	394,253	1.37	5.87
Shortage of math teachers=1, 0 otherwise	Binary	264,416	0.47	0.50	466,551	0.38	0.49
Shortage of science teachers=1, 0 otherwise	Binary	263,369	0.47	0.50	466,029	0.38	0.49
Shortage of language teachers=1, 0 otherwise	Binary	263,624	0.41	0.49	466,552	0.34	0.47
Share of full time teachers	Continous	215,189	0.88	0.19	442,412	0.86	0.21

In order to impute these variables, we make use of information at individual, country and school level[51].

Later on, we use our imputed values to build up a country level measure of school accountability, similar to the approach used for years with complete data, by estimating the proportion of schools showing those practices at a country level.

In the following figures we show time trends for our measures of school accountability, including those PISA waves where data was imputed. Results are discussed following each figure.

[51] More specifically, in our preferred imputation method we included aggregated measures of student characteristics at school level (ESCS, age, gender), school accountability measures when present (results posted, results tracked, benchmarking with other schools, benchmarking with national performance, following school's academic progress from year to year) and other school characteristics (school admission policies, school competition, school operation (public or private), funding structure, location, student teacher ratio, number of students, share of full time teachers, share of fully certified teachers, shortage of math, language or science teachers.

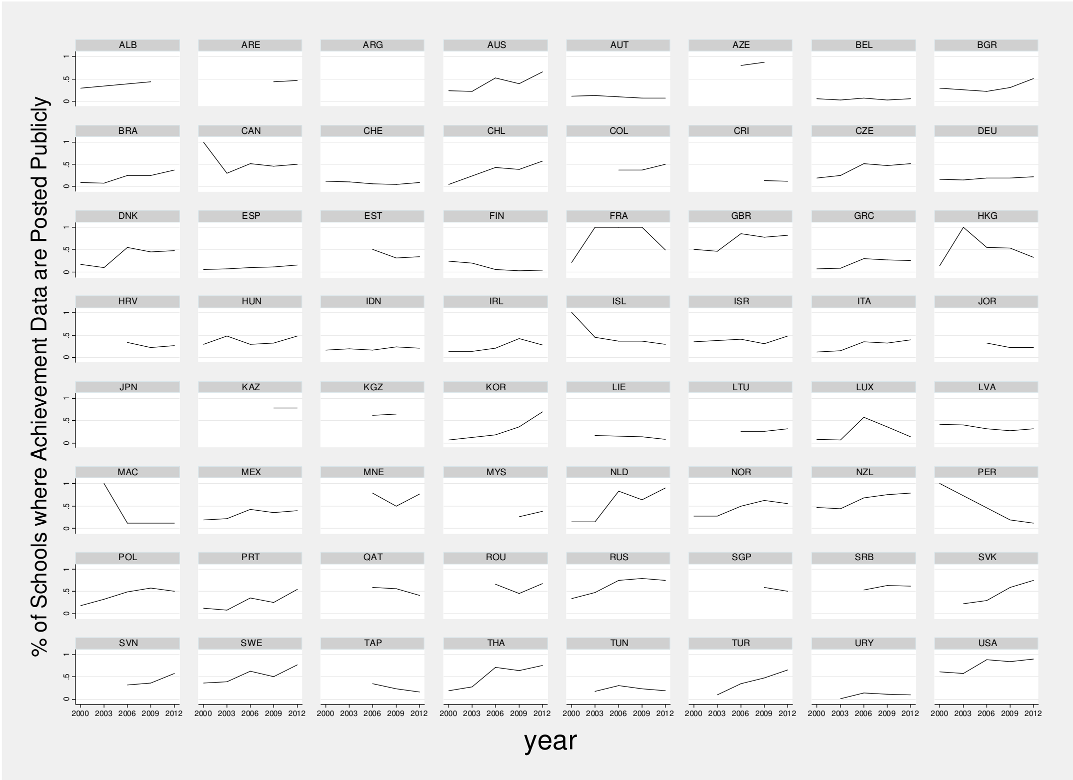

Figure 4D1. Percentage of schools at country level where academic results are posted publicly-including imputation (years imputed: 2000 and 2003). Countries with 2 or more PISA applications. All values in 2000 and 2003 imputed.

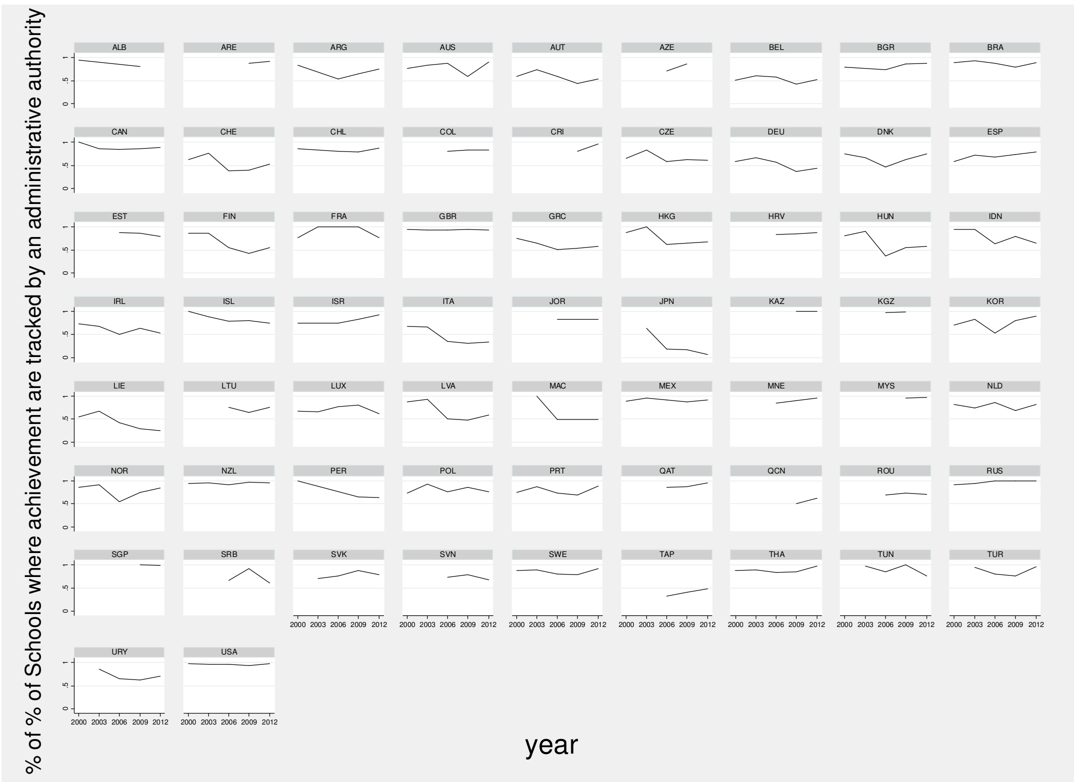

Figure 4D2. Percentage of schools at country level where academic results are tracked-including imputation (years imputed: 2000 and 2003).

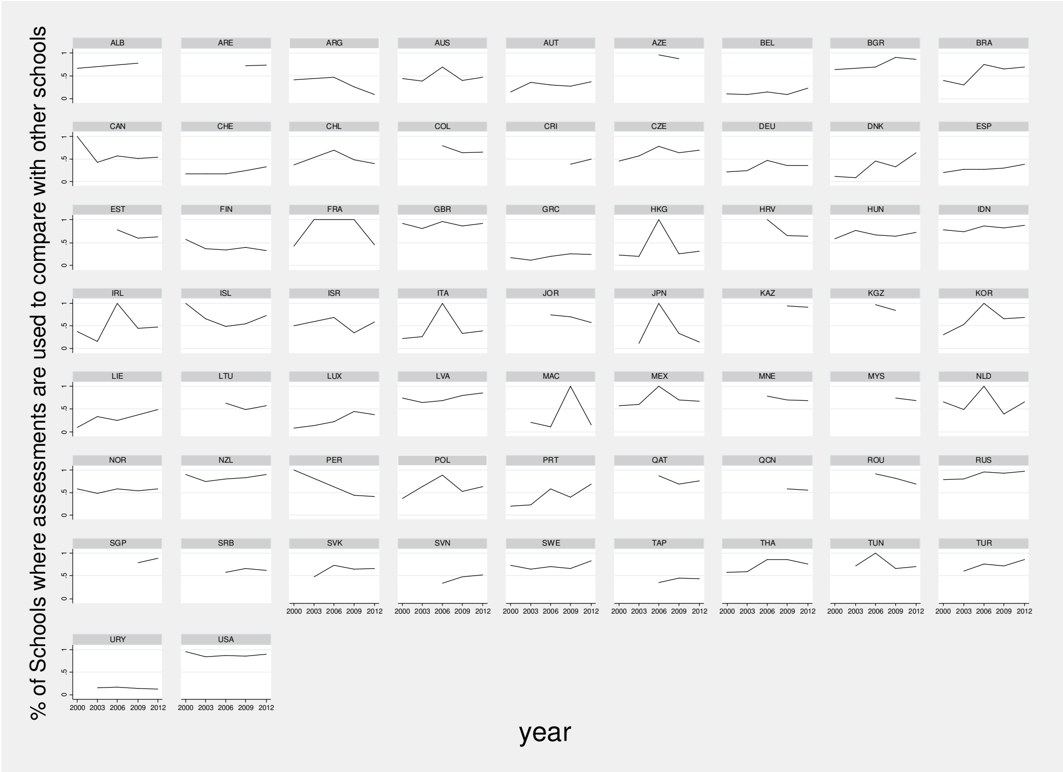

Figure 4D3. Percentage of schools at country level where results are used to compare the school with other schools-including imputation (years imputed: 2000 and 2006).

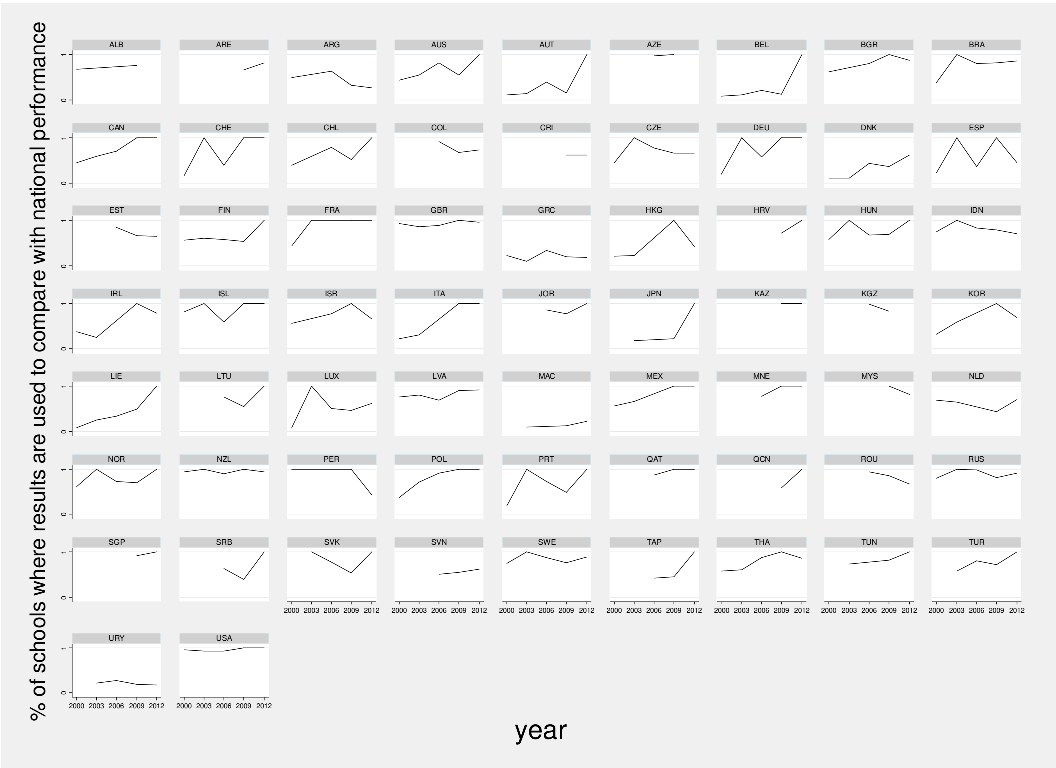

Figure 4D4. Percentage of schools at country level where results are used to compare with national performance-including imputation (years imputed: 2006).

Table 4D3. Panel estimates of the effect of school accountability in educational outcomes including imputed data

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Dependent Variable	PVMATH	PVMATH	PVMATH	PVMATH	PVMATH	PVMATH	PVMATH	PVMATH	PVMATH	PVMATH	PVMATH	PVMATH
Country level Accountability measures and interactions with student SES (Index of Socioeconomic Status ESCS)												
School Accountability- Results posted	**13.262**					**13.652**	**-18.587**					
	4.538					3.503	2.599					
Student ESCS X Results posted	**11.158**					**5.888**	**3.684**					
	1.419					1.242	1.171					
School Accountability- Results Tracked		***-16.417***						-6.314	**-21.101**			
		6.564						5.081	4.381			
Student ESCS X Results Tracked		**-3.442**						1.299	***3.334***			
		1.467						1.389	1.459			
School Accountability- Benchmarking I			58.587							**15.560**	**15.297**	
			9.570							3.829	3.720	
Student ESCS X Benchmarking I			**-9.427**							**-8.518**	**-7.783**	
			1.434							1.149	1.207	
School Accountability- Benchmarking II				**47.710**	**62.909**							**31.859**
				6.399	5.661							3.802
Student ESCS X Benchmarking II				**-6.770**	**-7.700**							**-7.374**
				1.466	1.565							1.335
Country fixed effects	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Year fixed effects	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Student level sociodemographic characteristics	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
School characteristics	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Other country level accountability-related covariates (admissions, etc)	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**
Imputed covariates on school accountability	**No**	**No**	**No**	**No**	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Constant	**196.390**	**199.681**	**173.766**	**201.624**	**285.742**	**220.673**	**286.659**	**221.220**	**295.720**	**225.004**	**291.510**	**294.020**
	12.5719	12.6700	12.2701	21.9060	11.5152	20.9000	10.4881	20.8600	10.5600	21.4800	10.7270	11.4500
Observations	1,323,701	1,324,038	1,197,324	1,197,324	1,310,803	1,600,632	1,717,965	1,600,632	1,718,476	1,600,632	1,718,476	1,626,495
R-squared (pending)	0.40	0.40	0.39	0.39	0.39	0.42	0.42	0.42	0.43	0.39	0.38	0.39
N_countries	65	65	65	65	65	64	65	64	65	65	65	65
Number of PISA waves involved in the estimation	**3**	**3**	**3**	**3**	**4**	**4**	**5**	**4**	**5**	**4**	**5**	**5**
PISA Waves	**2006/09/12**	**2006/09/12**	**2003/09/12**	**2003/09/12**	**2000/03/09/12**	**2006/09/12**	**2006/09/12**	**2006/09/12**	**2006/09/12**	**2003/09/12**	**2003/09/12**	**2000-2012**
Years with imputed covariates in accountability covariates						**2003**	**2000-2003**	**2003**	**2000-2003**	**2006**	**2000-2006**	**2006**

Coefficients in **Bold** p<0.01, ***Bold italic*** p<0.05, *Italic* p<0.1. Robust standard errors clustered at country level.

Note 1: School Accountability- Results Posted: Percentage of schools where achievement data are posted publicly (e.g. in the media); School Accountability- Results Tracked: Percentage of schools where achievement are tracked by an administrative authority; School Accountability- Benchmarking I: Percentage of schools where assessments are used to compare the school with other schools; School Accountability- Benchmarking II: Percentage of schools where assessments used to compare the school to <district or national> performance.

Note 2: All specifications include controls for students' age, gender, migration status, type of school attended, school funding scheme, school location, student teacher ratio, share of fully certified teachers, number of students at school, shortage of teachers in math, science and language, share of full-time teachers, and student socioeconomic status as measured by PISA ESCS index.