ISCTE Business School
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PISA 2015: STUDENT ACHIEVEMENT IN NORWAY

A comparison between native and immigrant students

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Abstract

Student achievement is often considered a product of student background, school variables, and institutional setting. Literature also indicates that these educational inputs have varying effects on students. This dissertation performs an in-depth analysis of student achievement in Norway, using the data from PISA 2015, to see which educational inputs contributed to the fact that Norway performed better than the OECD average. The persisting achievement gap between native and immigrant students was also thoroughly researched. Student achievement was measured through two main channels: 1) characteristic effects, and 2) return effects, and these were elaborated using descriptive statistics, t-tests, educational production functions, and Blinder-Oaxaca decompositions. Results indicate that home possessions such as cultural items and books at home, student motivation and expectations, and parental background had significant positive impacts on student achievement, while significant negative effects were found for wealth items, study time outside of class, emotional support, student anxiety, and absenteeism. The school variables were not found very relevant for student achievement. Furthermore, immigrant students experienced significantly worse endowments, particularly for language, home possessions, and parental background, and this, together with experiencing worse returns than native students, helped to explain the negative differences between the groups.

Keywords: Student achievement, ethnic group differences, Norway, PISA 2015
JEL Classification: C10, I24

Resumo

O desempenho dos alunos é frequentemente considerado um produto da formação do aluno, recursos escolares e do ambiente institucional. A literatura também indica que esses fatores têm efeitos variados nos alunos. Esta dissertação realiza uma análise aprofundada do desempenho dos alunos na Noruega, usando os dados do PISA 2015, para ver quais fatores educacionais contribuíram para o fato de a Noruega ter tido um melhor resultado do que a média da OCDE. A lacuna persistente entre estudantes nativos e imigrantes também foi investigado. O desempenho dos alunos foi medido através de dois canais principais: 1) efeitos característicos, e 2) efeitos de retorno, e estes foram elaborados usando estatística descritiva, testes t, funções de produção educacional e decomposições de Blinder-Oaxaca. Os resultados indicam que bens domésticos como posses culturais e livros em casa, motivação e expectativas dos alunos, e o trabalho e a educação dos pais tiveram um impacto significativamente positivo no desempenho do aluno, enquanto efeitos negativos foram encontrados para posses de riqueza, tempo de estudo fora da aula, apoio emocional dos pais, ansiedade estudantil e absenteísmo. Por outro lado, as características das escolas não parecem ter um efeito importante para o desempenho dos alunos. Além disso, estudantes imigrantes tinham dotações significativamente piores, particularmente para linguagem, posses em casa, e o trabalho e a educação dos pais, e isso, juntamente com piores retornos do que os estudantes nativos, ajudou a explicar as diferenças negativas entre os grupos.

Palavras-chave: Desempenho dos alunos, diferenças entre grupos étnicos, Noruega, PISA 2015
Classificação JEL: C10, I24

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To be able to live life, be happy and help others.

To my family and friends that inspires, challenges and enriches my life.

To all the people around the world that strives to make a positive difference.

To nature that provides us with all we need.

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To Gonçalo that have given me valuable advice for my dissertation.

To my professors and colleagues that have inspired and helped me get where I am.

This dissertation, with all its contents, is my responsibility alone.

Contents

List of Tables

List of Figures

List of Abbreviations

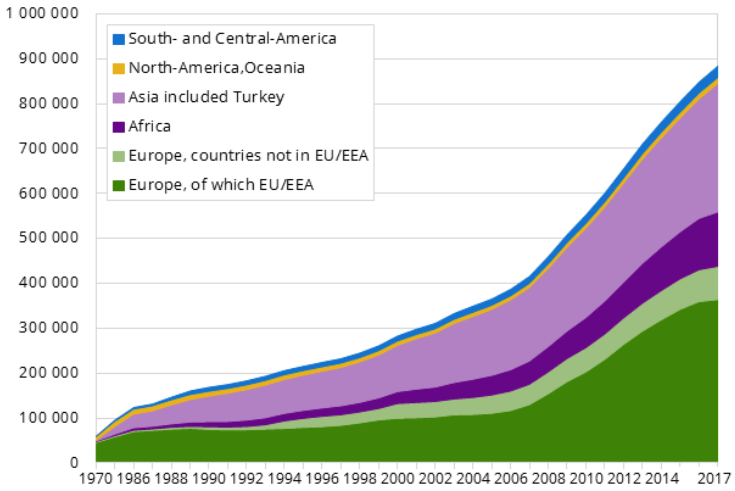
2PLM	Two-parameter-logistic model
BRR	Balanced Repeated Replication
Coeff.	Estimated coefficient
Diff	Mean difference
EPF	Educational production function
ESCS	PISA index of economic, social and cultural status
ICT	Information and Communication Technology
ISCED	International Standard Classification of Education
ISCO	International Standard Classification of Occupations
ISEI	International Socio-Economic Index of occupational status
N	Number of Observations
NPM	New Public Management
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary Least Squares
PIRLS	Progress in International Reading Literacy Study
PISA	Programme for International Student Assessment
PPS	Probability Proportional to Size
S.D.	Standard deviation
S.E.	Standard error
SSB	Statistics Norway
TIMMS	Trends in International Mathematics and Science Study

1 Introduction

Education is considered a fundamental social channel and plays a key role in the well-being and sustainability of a population. It helps both individuals and nations to develop knowledge and skills required to ensure better jobs and lives, and thus prosperity, as well as social inclusion and cohesion. A population's happiness can also be considered a measure of social progress and, with this in mind, Norway was recently (2017) rewarded as the world's happiest country[1]. Since education plays a major role in social formation, it is therefore reasonable to expect equity in Norwegian students' achievement, and thus, small differences between native and immigrant students in Norway.

Early 2017, 16,8% of the Norwegian population were immigrants, and Norway has during the last decade experienced strong migration flows and the number of immigrants has doubled during the last ten years (see figure 1.1[2]). With this increasing migration flow, Norway's ability to preserve and promote social cohesion depends highly on its ability to integrate immigrants (OECD, 2018).

Figure 1.1: Immigrants by country, Norway 1970-2017



Migration flows pose challenges for societies, but also represent opportunities through diversity, as immigrants bring new culture, knowledge, and traditions that can enrich the host society.

[1] World Happiness Report (2017), url: http://worldhappiness.report/ed/2017/. (Accessed on 23 February 2018)

[2] Statistics Norway, SSB (2017), Immigrants and Norwegian-born to immigrant parents, 1 January 2017, url: https://www.ssb.no/en/befolkning/statistikker/innvbef/aar/2017-03-02. (Accessed on 25 February 2018)

However, these opportunities need to be unlocked through effective social policies and education. In its essence, an education system shapes the future of its participants since it conditions a person's participation in the labour market and integration into society. According to recent data (2014), Norway was one of the OECD countries with the highest educational spending per student (OECD)[3] on primary and secondary education. Government expenditure on education aims to pay off through labour and production, and thus it is very important to analyse whether the Norwegian example is successful or not. Not only whether it is successful in terms of student achievement, but also for the integration and social formation of the population.

The existence of wide international studies, that include large representative samples of students, such as OECD's Programme for International Student Assessment (PISA), Trends in International Mathematics and Science Study (TIMMS) and Progress in International Reading Literacy Study (PIRLS) are examples of international datasets that allow researchers to study academic achievement. They also collect vast amounts of contextual background information for students and schools which furtherly provide a strong foundation for analysis. PISA assesses 15-year-old students in three key areas: science, mathematics, and reading.

I will in this dissertation use the data from PISA 2015 to investigate student achievement in Norway, more specifically which factors are conducive and adverse for students, and compare how these processes are manifested between native and immigrant students by comparing their performance on PISA. Student achievement is in this context referred to by the students' PISA test scores. Empirical work suggests that language barriers, socio-economic disadvantage, peer effects and cultural differences are some of the main factors that create differences and adverse learning conditions for immigrants students (Ammermueller, 2007b; Brunello and Rocco, 2013; Jensen and Rasmussen, 2011; Makarova and Birman, 2015; OECD, 2018; Rangvid, 2007; Schnepf, 2007).

I found that native students performed significantly better than immigrant students in all the three PISA main domains. This difference was found across all percentiles of the score distribution, but smaller differences were found for the three lowest percentiles (1%, 5%, and 10%). Furthermore, results indicated that distinguishing second-generation immigrants from first-generation immigrants was reasonable. Immigrants were found to experience worse endowments, and particularly first-generation immigrants, for most of the variables, but particularly language, home

[3]OECD (2018), Education spending (indicator). doi: 10.1787/ca274bac-en. (Accessed on 20 April 2018)

possessions, parental background, and school environment. Furthermore, student variables such as socio-economic status, motivation and expectations, and parental background were found most important to explain student achievement. Additionally, socio-economic status and parental background were also found important in explaining differences between native and immigrant students. Lastly, for the Blinder-Oaxaca decompositions, substantial proportions of the estimated gaps between native and immigrant students were explained by the characteristic or return effect. Furthermore, the predictors used in this dissertation, in particular, the student and parent variables, helped to explain the differences between native and immigrant students.

This dissertation is organised into seven sections. This section introduces the main framework and idea of this study. Section 2 is a literature review that elaborates more on the Norwegian context and student achievement. Section 3 formalises the research proposal of this dissertation. Section 4 explains the sampling methodology and complexity of the PISA data. Section 5 describes which specific procedures were employed in this dissertation as well as a more elaborated description of modified variables. Section 6 presents the results that I obtained. Section 7 highlights and concludes the main findings of this dissertation.

2 Literature review

This literature review is divided into two main sections: 2.1 Framework and 2.2 Student Achievement. The first section explains and gives a perspective of the Norwegian education system, while the second section is divided into several subsections that discuss student achievement, more specifically what contributes to a student's achievement, how education systems relate to each other, how achievement gaps between native and immigrant students can arise, and research methodologies that have previously been employed in similar analyses. Lastly, a third section 2.3 is included which briefly discusses the cost and efficiency of educational inputs.

2.1 Framework

This section provides a description for the Norwegian education system and some explanations about its evolution. Firstly, 633 029 students were registered in the compulsory school system in 2017. Compulsory schooling is free in Norway and is primarily public with 96,2% of total enrolment (Statistics Norway)[4]. Students start at the age of 6 and attend compulsory school for 10 years, regularly split into 7 years of primary school and 3 years of secondary school. This implies that PISA normally assesses students attending their last year of compulsory education.

In economic terms, educational expenditure on primary and secondary school in Norway was 2,06 % and 2,42% of GDP in 2014, equivalent to 13 104 US dollars/student in primary school and 15 149 US dollars/student in secondary school. The only country with higher expenditure (US dollars/student) on both school levels was Luxembourg, while countries such as Germany had 8 546 $/student in primary and 11 684 $/student in secondary, and United States with the respective expenditure of 11 319 $/student and 12 995 $/student. In contrast, Mexico only spent 2 896 $/student and 3 219 $/student on the same education levels (OECD)[5].

The Norwegian parliament (the Storting) and the Government define the goals and decide the budgetary framework for education. A common educational standard is ensured through national curricula, regulation, and legislation. Furthermore, the National Education Office ensures, in coop-

[4]Statistics Norway, SSB (2017), Pupils in primary and secondary school, url: https://www.ssb.no/en/utdanning/statistikker/utgrs. (Accessed on 20 February 2018)

[5]OECD (2018), Education spending (indicator), doi: 10.1787/ca274bac-en. (Accessed on 19 February 2018)

eration with municipal and county authorities, that appropriate schooling is provided. The municipalities are responsible for running schools at compulsory educational level.

> "The aim is for Norway to have high-quality schools that equip individuals and society with the tools they need in order to add value and to build a prosperous and sustainable future. The Norwegian school system is based on the principles of equality and adapted learning for everyone within an inclusive environment. All students should develop key skills, and in the course of their education they should both face challenges and experience a sense of achievement."[6]

The quote above was taken from the front page of the website for the Norwegian government on education topics for primary and secondary education. It is emphasised that the educational system strives for equality and inclusion. Educational policies are aimed to create both equal and equitable opportunities and conditions for all social groups. Møller et al. (2005) decomposed this Norwegian equality concept into two aspects: 1) providing equal access to education by meeting financial and economic differences, and 2) assuring equity by meeting the diversity in individual learning abilities with necessary attention and resource allocation. To achieve this, and by being predominantly public, recent legislature in the educational system has implied liberalisation. Møller and Skedsmo (2013) discussed how the Norwegian education system has been modernised through the New Public Management (NPM) reforms that started in the 1990s. These policies aimed at reducing public expenditure and bureaucracy by fostering competition of public services, including deregulation, decentralisation, and organisational flexibility.

International educational surveys, such as PISA, TIMMS, and PIRLS, were important triggers for the modernisation of the Norwegian education system and lifted the debate on education through their potential for international comparison. Norway performed under the OECD average during the first PISA surveys (2000-2006) and worse than most of its neighbouring Nordic countries on all/some of the main domains. The poor results led to intense political discussions. Møller and Skedsmo (2013) argued that with the publication of PISA findings, accountability and school leadership became more important. Furthermore, that being listed among the "lower performing" countries during the first PISA assessments, could have started a further development of education

[6]Norwegian Government (2018), Primary and Secondary Education, https://www.regjeringen.no/en/topics/education/school/id1408/. (Accessed on 02 February 2018)

reforms such as the implementation of national tests (in Norwegian, math, and English) in 2004, as a system of quality control. A consolidation and confirmation of this can be learned through the *Report No. 30 to the Storting (2003-2004)* which often is recognised as one of the turning points for the Norwegian education system. Partially as a response to the publications of the recent international education surveys, it contained research and a thorough evaluation of the compulsory school system. Furthermore, it led to an important Norwegian education reform, *The Knowledge Promotion* ("Kunnskapsløftet"), which among several other things renewed the national curriculum, increased local autonomy, added more classes in core subjects, and set higher emphasis on teacher quality and education. With this, Nilsen (2010) discussed in his paper how the new neo-liberal ideology, reflected through the NPM reforms, could contradict central focus areas such as inclusion and diversity for the Norwegian education system. However, Arnesen and Lundahl (2006) concluded that, despite liberalisation, social-inclusive aspects were still strong in Norway (Nordic countries).

It is important to notice that the poor and worsening PISA results through 2000-2006 involved students that were either completely or partially exempted from the education reforms. The results have continuously improved since PISA 2009 and current results are clear: Norwegian students performed better than the OECD average in all three PISA main domains in 2015.

2.2 Student achievement

With a better performance than the OECD average, it becomes important to discuss what made it possible and which factors contributed to this achievement. Secondly, does it vary between native and immigrant students and what create gaps in student achievement? And does an educational system work similarly across countries? These questions are addressed in this section as well as the main research methodologies used in previous studies.

Educational effects

Which factors can explain variation in student achievement? And how can they be classified? This type of analysis got its benchmark when James Coleman and his colleagues published *"Equality of Educational Opportunity"* (Coleman et al., 1966), often denoted *The Coleman Report*. They found that variation in academic achievement in American schools mostly came from external contex-

tual factors and socio-economic indicators, rather than school-specific variables. Ammermueller (2007b), Fuchs and Wößmann (2007), Hanushek and Luque (2003) and Wößmann (2003) also found student background to be the most decisive factor for academic achievement.

In line with Willms (2010) recent research, Dar and Resh (1986) found that classroom composition was more effective than school composition and that the intellectual composition in classrooms positively affected academic achievement. It was also found that compositional quality and personal ability interacted in a way that low-resource students were more sensitive than high-resource quality students to compositional quality. This could imply a trade-off in mixing high- and low-resource students. Similarly, Caldas and Bankston (1997) studied how peer effects affected academic achievement, i.e the influence of the socio-economic profile of classes and schools. They found that attending a school with classmates coming from families with higher socioeconomic status tended to positively raise the students' academic achievement, independently of one's own background, race or characteristics. Perry and McConney (2010) found similar results for Australia.

Apart from student background, school variables are also expected to affect academic achievement. However, the effects are inconclusive. Hanushek and Wößmann (2017) stated little confidence on school inputs on educational production. Gundlach et al. (2001) also found evidence suggesting that resource expansions over time, in most countries of the OECD, were not significantly important for academic achievement. For the US, Hanushek and Luque (2003) confirmed this by demonstrating that school resources were not significantly important for student outcomes. On the other hand, Krueger (2003) found evidence of a relationship between class size and student achievement, in particular, small positive effects of smaller classes on achievement, and similarly, Hedges et al. (1994) showed a positive relationship between resource inputs and school outcomes. By including teachers as school resources, Darling-Hammond (2000) found that teacher "quality" was a powerful predictor of student achievement, while Egalite et al. (2015) analysed the student achievement effect of own-race teachers and found small, positive effects. Consequently, it seems that school resources have an intricate and complex relationship with student performance and Robinson (2007) discusses this widely in her book.

A student's achievement is also affected by its belonging school system and how the institutional setting constitutes the learning environment of the students. Wößmann (2016) found that

a significant part of international differences was explained due to institutional features. External exit exams and increased competition from private sector positively affected student achievement, while school autonomy was found to be positive in developed countries, but negative for developing countries. The same effects of school autonomy were also found in Hanushek et al. (2013) research. Fuchs and Wößmann (2007) found roughly 25% of international differences to be due to institutional variation. Lavy (2015) findings also showed that instructional time had a significant, positive effect on student achievement. However, the results were heterogeneous as he found that the effects were higher for immigrants, girls, and students that had lower socio-economic status.

Thus, the literature suggests that socio-economic status has been an important explanatory variable and that it mainly contribute through two channels: 1) directly through own student background, and 2) through its composition within schools/classes. School variables and institutional setting are also central to student achievement, but results have been ambiguous.

Individuality of educational systems

Education systems vary amongst countries. Is there a construct of an "ideal" system or does it depend on its context? Heyneman and Loxley (1983) conducted a study with 29 different countries to see how family background and school quality affected academic achievement, and how the level of economic development in a country conditioned the relative strength between the two individual effects, of family inputs and school resource quality, on student achievement. They reported that lower-income countries had weaker family effects and greater effects coming from teacher and school quality. Their results implied that the success of an education system not only depended on certain inputs but also on its context. However, both Baker et al. (2002) and Bouhlila (2015) found that the Heyneman-Loxley effect has declined over time and no longer was applicable in the same way. Baker et al. (2002) also found that there was a positive relationship between GDP per capita and mean national student achievement (in mathematics and science). More recent studies have researched the cross-country variation of student achievement (Fuchs and Wößmann, 2007; Hanushek and Wößmann, 2017; Wößmann, 2016) and suggest that country-specific elements are important. School systems and institutional settings were found to be important components for student achievement.

With this, literature arguably shows a weak existence of an HL effect, while institutional setting

and cross-country differences have been found more important in the explanation of variation in student achievement. The idea of a successful, universal education system seems controversial and focus should rather be put on each individual system.

Student achievement gaps

What causes gaps in academic achievement between native and immigrant students? Most contemporary theories fall into two general theories: 1) how cultural aspects promote/discourage academic achievement, and 2) how the structural position of ethnic groups affects children's (school, peer and parent) environments. Ethnic groups have different cultural orientations which can be beneficial or negative for educational achievements (DiMaggio, 1982; Makarova and Birman, 2015; Warikoo and Carter, 2009). Meanwhile, there is literature that traces the structural position of ethnic groups and proposes that class differences are manifested through varying parental practices, socioeconomic status, and schooling opportunities (Ammermueller, 2007b; Kao and Thompson, 2003; Wößmann, 2016).

Rangvid (2007) researched the underlying sources for the existence of racial/ethnic gaps in academic achievement in Copenhagen, Denmark. Her results suggested that immigrant students attended schools with at least as favourable conditions as native students and that performance gaps might come through lower academic expectations, encouragement, and pressure combined with adverse peer effects.

Another consideration is that students typically attend schools close to their home, implying that schools located in less affluent neighbourhoods followingly are expected to have a more disadvantaged student composition. Jargowsky (2009) explains how schools of these neighbourhoods are attended by immigrant students with limited language proficiency and by native students with a relatively poor parental background.

Brunello and Rocco (2013) found in their cross-country study evidence suggesting that a doubling of the share of immigrants students in a school could reduce average school performance of natives by 1 - 3,4 % (depending on the group of natives). They also found that the estimated negative effect of immigrant pupils was stronger in countries with higher school segregation, furthermore, that the impact of desegregation policies was small. In Israel, Gould et al. (2009) found that the negative effect of immigrants on natives was larger for native students from a more disad-

vantaged socio-economic background and that those effects were generally nonlinear. Nonlinear, meaning that the composition effects were stronger at lower levels of immigrant concentration, and, hence, proposing a plausible mitigation by increasing immigrant composition. Hanushek et al. (2009) studied ethnic composition and found that academic achievement of Texas students, in particular, black students, were adversely affected by a higher percentage of black schoolmates. In comparison, the enrolment of Hispanic students had a lower impact on achievement. On the other hand, Ohinata and van Ours (2013) did not find strong evidence for negative effects caused by the presence of immigrant students in the Netherlands, while Schnepf (2007) found mixed evidence on effects of immigrant concentration in her cross-country analysis.

With this, student achievement gaps seem to be created through differences in socio-economic status, peer effects and school/class ethnic composition. The effects also seem to imply different effects with respect to the distribution of the students' level of socio-economic status and how this is composed through schools and classes.

Research methodology

This subsection discusses different methodologies that have been applied in similar empirical work that have used data from PISA or similar studies.

Student achievement can be interpreted as a function of educational factors, ideally with all current and prior inputs. These educational production functions (EPFs) have often been used to see how various inputs affect student achievement. Furthermore, some important aspects have been highlighted through Todd and Wolpin (2003) findings and many authors have incorporated these considerations into their methodology. Many researchers have used the PISA data to estimate ordinary least square (OLS) regression models as educational production functions[7]:

$$Student\ achievement = f(student\ background,\ school\ factors,\ other\ variables) \qquad (1)$$

The authors took advantage of the information available in the PISA data. Student background

[7]For examples, see: Ammermueller, 2007a; Ammermueller, 2007b; Baker et al., 2002; Caldas and Bankston, 1997, Dar and Resh, 1986; Egalite et al., 2015; Fuchs and Wößmann, 2007; Gould et al., 2009; Hanushek and Luque, 2003; Hanushek et al., 2009; Hanushek et al., 2013; Hanushek and Wößmann, 2017; Jensen and Rasmussen, 2011; Rangvid, 2007; Wößmann, 2003.

has often been transformed into socio-economic status which followingly was decomposed into parental education and occupation, and home possessions. School variables were usually translated into inputs such as teacher quality, student-teacher ratio, availability of information and communication technology (ICT) resources, and others. Some authors also included variables for institutional setting (e.g. Wößmann, 2003) such as school autonomy, examination methods and decision-making processes to explain the variation in student achievement. However, evidence of institutional effects on educational performance is scarce and is more relevant when comparing institutional differences between countries (Fuchs and Wößmann, 2007; Hanushek et al., 2013; Wößmann, 2016).

Others have investigated student performance gaps, like Rangvid (2007), who used a data-set from a replicate PISA study for Copenhagen schools and analysed the test score gaps between native and immigrant students in Denmark by entering immigrant status as a dummy variable. Jensen and Rasmussen (2011) combined the PISA 2000 data for Denmark with another special Danish PISA study from 2005, and used an instrumental variable for immigrant concentration in school to identify causal effects on student outcomes, while Ohinata and van Ours (2013) used data from previous PIRLS and TIMMS studies for the Netherlands to identify spill-over effects by using the percentage of first-generation immigrants students in each class. Schnepf (2007) used data from TIMMS (1995 and 1999), PIRLS (2001) and PISA (2003) and researched immigrants' educational disadvantage through several models, conditional on 1) language at home, 2) socio-economic background, and 3) school segregation.

Decomposition methods, such as the Blinder-Oaxaca (Blinder, 1973; Oaxaca, 1973) or the John-Murphy-Pierce method (Juhn et al., 1993), has allowed researchers to analyse how much different educational factors explain test score gaps. Several researchers have employed decomposition methods to the PISA data to explain test score gaps between ethnic groups (Ammermueller, 2007a; Ammermueller, 2007b). Martins and Veiga (2010) used the PISA 2003 data and exercised three different decompositions to assess how socio-economic factors related inequality in mathematics achievement among 15 EU countries. Finally, Lounkaew (2013) used the Oaxaca-Blinder method on the PISA 2009 data to analyse educational achievement between urban and rural groups in Thailand.

2.3 Efficiency and costs

Costs related to various educational inputs and their efficiency are not researched in this thesis. However, these are important considerations for policy-makers and should be addressed together with the topics covered above. In general, Nordic countries are characterised by relatively high levels of expenditure on education and Bogetoft et al. (2015) calculated input efficiency scores for these countries. They found Finland to be the most efficient country, while Norway was found quite insufficient. Verhoeven et al. (2007) researched efficiency of education in the G7 countries and found that inefficiency was caused by lower student-teacher ratios, higher wage spending, and resource procurement, while greater autonomy seemed to raise efficiency. Afonso and St. Aubyn (2006) researched the education expenditure efficiency by comparing the PISA 2003 results with resources employed. Norway was originally ranked as the 16th most efficient country of the total 25 OECD countries included in the analysis, but as the most inefficient country when adjusting for GDP and educational attainment. Note that efficiency scores were only based on actual resources employed and should be considered with their respective impact on student achievement.

3 Hypothesis

I want with this dissertation address important aspects of education dynamics for Norwegian students, in particular, native and immigrant students, using the data for PISA 2015. The assessment tests 15-year-old students in their ability to solve complex problems and concepts and covers three major domains: science, math, and reading. In addition to student performance and test scores, the rich PISA data has information about student background and school characteristics.

The following figure (figure 3.1) shows how native and immigrant students have performed on PISA from 2000 to 2015 in Norway[8]. The graphs show that student achievement have steadily increased during the last assessments. However, despite having an overall increase in student achievement across all groups, differences between native students and both immigrant categories persist and remain significantly big. This is an important consideration for Norwegian student achievement and I will in this dissertation try to answer the following questions:

Q1: Which factors are important for student achievement in Norway?

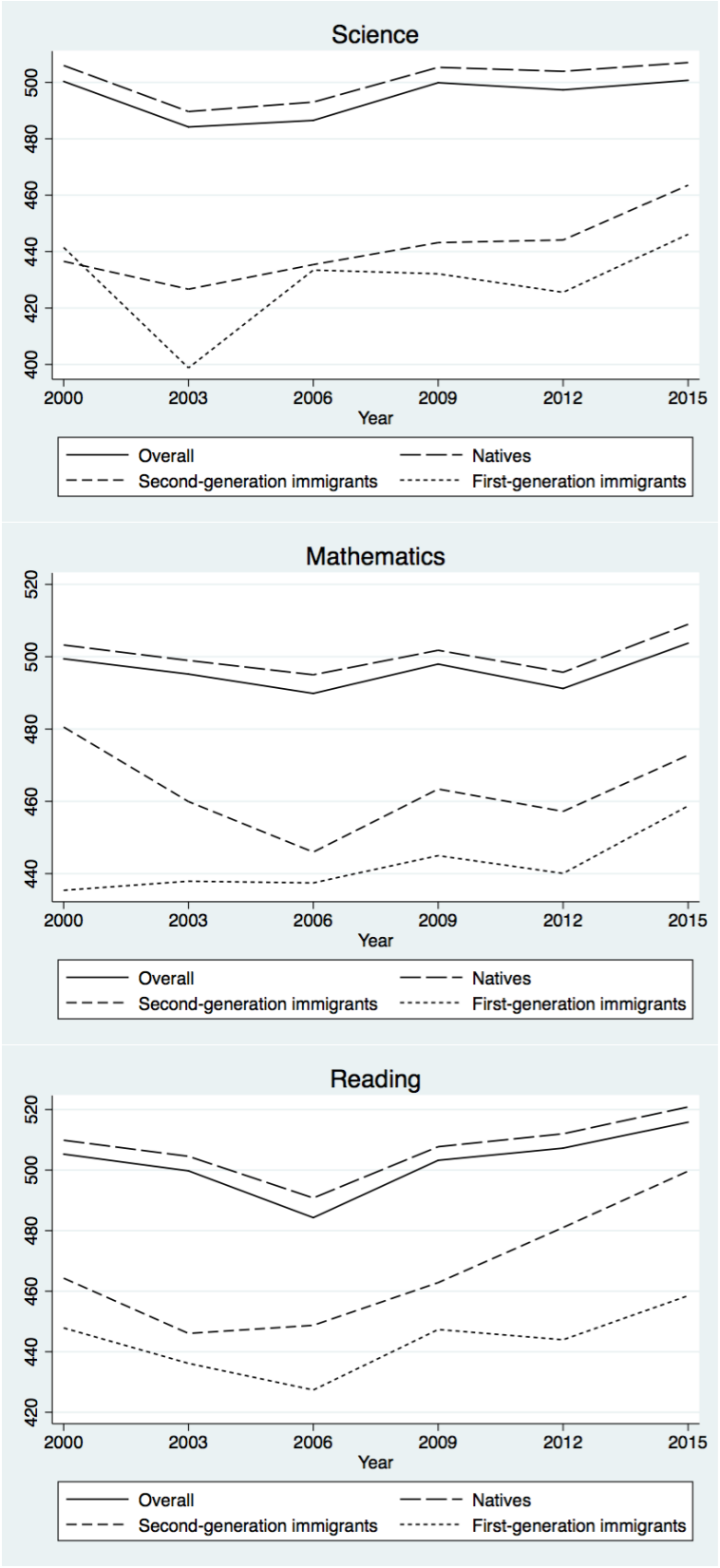
Q2: Which factors are important for explaining differences in achievement between native and immigrant students?

The first question was naturally chosen to provide insights about the different factors and educational inputs that were important for Norwegian students. Not only is this important for the Norwegian education system, but it may also serve as indicators on which inputs other countries should emphasise in their respective education systems. This information is also important for the second question which was motivated by the three graphs, in figure 3.1, that shows a gap between native and immigrant students from 2000-2015, and thus, intends to find explanations for the test score gap between native and immigrant students. This may be due to different endowments or returns to the educational inputs found in the first question.

Thus, the final aim of this dissertation is to explain student achievement in Norway, and then use these findings to find policies that both can increase student achievement while reducing the achievement gap between native and immigrant students.

[8]The data was obtained from OECD, available at http://www.oecd.org/pisa/data/. Mean test scores were then calculated using the BRR methodology and sampling weights. See section 5.1 for further details.

Figure 3.1: Test scores, PISA 2000-2015



These questions will be elaborated through the available information from the student and school questionnaire. Variables were grouped into four categories: 1) descriptive variables, 2) student variables, 3) parent variables, and 4) school variables. The two research questions above will be answered as best can by employing the following methods:

- Descriptive statistics: Investigating how the students among the different ethnic groups are endowed within the four variable groups, and use these variables to find explanatory relations.
- T-tests: Mean score differences across, and between, ethnic groups are researched by separating each subgroup by a characteristic. A t-test, with null-hypothesis, that the difference is equal to zero, was employed. This allowed me to see the unconditional effects of particular characteristics.
- Educational production functions: Using the explanatory variables to estimate multivariate regression models that include native, first- and second-generation immigrant students to analyse the effects of various educational inputs variables on student achievement.
- Blinder-Oaxaca decomposition method: Analyse the test score gap between native and immigrant students by group means to see how differences in characteristics and returns to the educational inputs affected student achievement, and followingly, the total test score gap.

These methods intend to find the determinants of student achievement and gaps between natives and immigrants. Descriptive statistics allowed me to see how the Norwegian sample, and its subgroups, were endowed with a wide set of variables. The t-tests provided unconditioned indications on how various variables affected student achievement, both across and between the ethnic groups. Moreover, given the endowments found, the educational production functions allowed me to see how the various educational inputs affected student achievement. This, together with plausible differences in endowments, permitted me to do a rigorous comparison between the natives and immigrants. Lastly, the decomposition method was employed to consolidate the results obtained in the two previous methods, as it allowed me to see how the test score gap between natives and immigrants was decomposed into three effects: 1) characteristics effect, 2) return effect and 3) interaction effect. The first effect allowed me to see how immigrants, given their estimated returns, would perform if they had the same endowments as natives, while the return effect allowed me to see how immigrants, given their endowments, would perform if they experienced the same returns as natives. The latter effect accounted for differences that existed simultaneously in both endow-

ments and returns. A two-fold decomposition also allowed to me to see how the different predictors helped explaining the differences between the ethnic groups.

Several hypotheses were developed for both research questions. The four following main hypotheses, one for each of the variable groups, was developed for the first research question:

1a. Descriptive variables:

H1a: "Demographic differences, i.e. descriptive variables such as gender, community size, and school size, are expected to only have a small impact on student achievement, while language spoken at home, and specifically speaking Norwegian at home, is expected to be conducive for student achievement."

Norway is recognised for its egalitarian principles as well as being a socially developed country. Demographic differences, such as gender, community size, and school size are therefore expected to be rather insignificant for educational quality. Meanwhile, speaking the local language of a country can generally be assumed conducive for achievement purposes in the respective country.

1b. Student variables:

H1b: "Student-related variables are expected to have a significant impact on student achievement. Socio-economic status, study time outside of class and student motivation are expected to be particularly positive on the students' test scores."

Socio-economic status is frequently confirmed as an important determinant for student achievement (OECD, 2018; Perry and McConney, 2010; Schnepf, 2007). Study time should also be positively associated with the students' performance on PISA as it should increase the knowledge of the students. Student motivation, which in this dissertation is measured through educational expectation, occupational expectation, ambition/competitiveness and no absenteeism are expected to be conducive factors that enhances the students' performance.

1c. Parent variables:

H1c: "Parental education and occupation are expected to have a significant positive impact on student achievement."

Parental status, in terms of education and occupation, is normally integrated into socio-economic status, and thus, is expected to be positive for student achievement. Furthermore, Jargowsky (2009) argued that parental status was an important determinant on where fami-

lies settled, and as students often are enrolled in schools close to their neighbourhoods, it can also be expected to affect the peer composition of their children(s) school and class. Another positive impact can be that parents with higher education and/or occupation emphasise their children's education and achievement more than parents with lower levels.

1d. School variables:

H1d: "The school variables are expected to have marginal effects on student achievement."

The PISA 2015 study only included variables related to its sample. However, student achievement should ideally be considered as a result of both previous and current inputs, but due to lack of historical data, a contemporaneous approach was implemented. The included school variables (e.g. staff capacity and learning environment) should be considered time-invariant as changes in these type of variables often occur gradually, rather than radically. Additionally, Norwegian schools were predominantly public and had little autonomy, which consolidates this dynamic. This implies that the current school variables should only have a marginal effect on student achievement. Jerrim et al. (2017) and Todd and Wolpin (2003) also highlighted this particular limitation on the PISA data in their research.

Not only student achievement is studied in this dissertation, but also the achievement gap between native and immigrant students. The characteristic effect and return effect was used to explain the differences in achievement and the following main hypotheses were considered for the second research question:

2a. Characteristic effect:

H2a1: "The endowments of language at home, and student and parent variables are expected to explain differences between native and immigrant students, particularly socio-economic status."

Empirical work suggests that language barriers and socio-economic differences are important factors to explain immigrants students' underachievement (Ammermueller, 2007b; OECD, 2018; Schnepf, 2007). Thus, it can be expected that in Norway, as in other countries, that immigrants face language barriers and socio-economic disadvantage.

H2a2: "The endowments of descriptive and school variables, except language at home, are not expected to explain differences between native and immigrant students."

Norway is recognised as a successful egalitarian society and was in 2017 awarded as "The

World's Happiest Country". Meanwhile, it is experiencing positive rankings on various inequality measures, like the Gini-coefficient (FRED, OECD, and World Bank) and Migrant Integration Policy Index (MIPEX)[9]. Additionally, schools are primarily public, and thus, significant differences in endowments, and particularly adverse characteristics through descriptive and/or school variables, are not expected to explain differences between native and immigrant students.

2b. Return effect:

H2b1: "Native students are expected to have better returns than immigrant students."

Education can be interpreted as part of an integration process, and thus, given that native students are expected to be more familiar with the cultural and social processes in Norway, it can be expected that native students take better advantage of their resources than what immigrant students do.

The results obtained in this dissertation are compared towards these hypotheses in section 6.4.

[9] See (https://fred.stlouisfed.org/series/SIPOVGININOR), (http://www.oecd.org/social/income-distribution-database.htm) and (https://data.worldbank.org/indicator/SI.POV.GINI?locations=NO) and MIPEX (http://www.mipex.eu/norway) for rankings and more details.

4 Data

The OECD Programme for International Student Assessment (PISA) 2015 aims to measure how 15-year-old students are prepared to meet the challenges of today's society[10]. PISA assesses not only whether students can reproduce knowledge, but also their ability to apply knowledge in new situations, as it emphasises problem-solving skills, concept understanding, and autonomy. It is a triennial survey, with its first assessment completed in 2000, where each study have focused on one of the major domains: science, reading or mathematics[11]. In 2015 (and 2006) the main focus was science. PISA data ranging back to 2000 is publicly available at OECD's website, where also technical reports, data manuals, and other official documentation can be downloaded[12].

PISA 2015 was conducted in 35 OECD countries plus 37 partner countries and economies with approximately a total of 540 000 completed assessments. The 2015 assessment was the first time computer-based tests were implemented as the main mode and paper-based alternatives were only used in cases of inadequate ICT resources[13]. All assessments in Norway were done by computer. Test items were a mixture of multiple-choice items and questions requiring students to construct their own responses. Test scores were standardized with an international mean of 500 and standard deviation of 100. Additional information was obtained through 1) a student questionnaire with various background information about each student (e.g. family, home and school), and 2) a school questionnaire, responded by the school principals, collecting information about organisational and educational characteristics of each school.

4.1 PISA design

Test items were thoroughly developed before being included in the final PISA assessment. The PISA 2015 tests were based on a variant of matrix sampling which implied the use of different item

[10] Further information about PISA 2015, such as achievement goals, development methods, and underlying theory, is available at http://www.oecd.org/edu/pisa-2015-assessment-and-analytical-framework-9789264281820-en.htm.

[11] A detailed and complete description of the implementation of the PISA surveys can be found in the technical reports. For PISA 2015, it is available at http://www.oecd.org/pisa/data/2015-technical-report/.

[12] Available at http://www.oecd.org/pisa/data/.

[13] A mode effect study was conducted to evaluate the reliability between computer- and paper-based assessments. Item parameters were found consistent across countries and time. Moreover, a high correlation (0,94) was found between the item parameters from the two different modes (OECD, 2017).

sets and assessment modes as each student were given a subset of items from the total item pool. The complete set of items were organised into different, linked test forms where each student was assigned one booklet. A student was only considered a respondent when answering at least half of the test items given. The test forms were therefore kept relatively short to minimise the students' response burden and thus to prevent fatigue. Furtherly, OECD (2017) argue that the implementation of this particular test form construct also was important since PISA neither provided feedback nor consequences for the test takers. Lastly, decreasing the necessity of school resources by limiting the test forms could eventually also lead to a higher acceptance rate at the school level.

Sampling design

A two-stage stratified sampling technique was employed for drawing the student sample[14]. The target population consisted of 15-year-old students attending educational institutions in seventh grade or higher. This definition was slightly adapted to fit the age structure better and implied that the international target population was defined as all students between 15 years and 3 completed months to 16 years and 2 completed months at the assessment's beginning. A variation of up to one month was permitted.

The first-stage sampling unit, schools, were sampled systematically from a national list of all the PISA-eligible schools with probabilities proportional to their respective size. This sampling methodology is referred to as probability proportional to size (PPS) sampling and a school's student enrolment was used as size. PPS was employed since schools were expected to differ in size as urban areas could be expected to have higher enrolment numbers than rural areas. The second-stage sampling unit were students within the sampled schools. A target cluster size was employed and implied that a set number of PISA-eligible students, 42 for computer-based assessments and 35 for paper-based, were randomly selected. Additionally, each student was assigned a weight that was defined by the reciprocal of the student's sample selection probability.

Some quality standards were employed to ensure an accurate and convenient coverage of the target population. Eligibility standards and principles of exclusion were consistently applied to both schools and students. Exclusions could either take place at school level or within-school level (individual students), and the overall exclusion rate for a country was required to be kept below 5%

[14] A complete explanation of the PISA sampling design can be found in OECD (2017), chapter 4.

of the target population. The specific restrictions that were employed can be found in OECD (2017), p. 67-70. Furthermore, to ensure accurate coverage of the target population, a minimum of 150 schools were selected from each country and a predetermined number of students, the target cluster size, was randomly selected within each school. If the number of students or schools available were smaller than the minimum requirement, all schools and/or students were selected. This implied a minimum sample size of 5 250 in computer-based countries (e.g. Norway) and 4 500 in paper-based countries. The whole population was sampled if the available sample was less than this size.

Assessment structure

PISA 2015 employed a variant of matrix sampling which implied that students were assigned different subsets of items where only a few items overlapped. A student's number of correct responses was therefore inappropriate to represent its abilities. This was overcome by the implementation of item response theory (IRT) scaling which modelled regularities in the response patterns of the students to describe and estimate their performance and proficiency.

All the prior PISA cycles (2000-2012) used the Rasch model and the partial credit model (Masters, 1982) to estimate item parameters. The Rasch model is a psychometric model that provides the probability that an individual responds correctly to a particular item, given its location on a reference dimension. A respondent's answers depend on its ability, θ, and item difficulty, β_i, and the probability that an individual responds correctly to a particular item, $x_i = 1$, is defined as:

$$P(x_i = 1 \mid \theta, \beta_i) = \frac{exp(\theta - \beta_i)}{1 + exp(\theta - \beta_i)} \tag{2}$$

The probability of a correct response is strictly decreasing in β and increasing in θ. A special case, if $\theta = \beta$, induces that the expected probability of a correct response is equal to 0,50. This implies that item difficulty can be interpreted as the ability level where the probability of a correct or incorrect response is equal. The partial credit model is an extension of the Rasch model and was used on polytomous items with more than two response categories. However, these models were criticised for their applicability in the PISA context (Goldstein, 2004; Kreiner and Christensen, 2014; Oliveri and von Davier, 2011).

PISA 2015 introduced a new hybrid model that combined best practices (Adams et al., 2007;

Glas and Jehangir, 2014; Mislevy and Verhelst, 1990; von Davier and Carstensen, 2007) with the two previously used models. Two additional models were implemented: 1) the two-parameter logistic model (2PLM) (Birnbaum, 1968) for dichotomous scored responses (correct or incorrect), and 2) the generalised partial credit model (Muraki, 1992) for items with more than two response categories. A combined Rasch model/partial credit model and two-parameter logistic model/generalised partial credit model was applied, and this new model was used for items that showed poor fit to the older model (OECD, 2017)[15].

The 2PLM also assumes that the probability of a correct response depends on the difference between a respondent's ability θ and item difficulty β_i, but 2PML also allows for an additional item discrimination parameter, α_i, that characterises its sensitivity to proficiency (OECD, 2017). As a function of these parameters, the probability of answering correct is defined as:

$$P\big(x_i = 1 \mid \theta, \beta_i, \alpha_i\big) = \frac{exp\big(D\alpha_i(\theta - \beta_i)\big)}{1 + exp\big(D\alpha_i(\theta - \beta_i)\big)} \tag{3}$$

where D is a constant which often is presumed either 1,0 or 1,7 (OECD, 2017, p. 142). The same function applies for θ and β as in the Rasch model, so a student with a higher ability is more likely to answer correctly, while more difficult items reduce the probability of a correct reponse[16].

An important assumption that applies to these models is conditional independence which imply that the item response probabilities only depended on an individual's ability, θ, and the item parameters, α and β. Followingly, the 2PLM implicitly assumes unidimensionality, which means that it is only a student's ability, θ, that accounts for performance across all items. Factors such as the survey conditions and dependence between item responses were therefore not considered. The

[15]Several model checks were applied to the new hybrid IRT model to ensure that it fitted the observed data. The overall item fit was found satisfying for each domain with small numbers of items misfitting for science (3,9%), mathematics (1,8%) and reading (2,5%). These checks are furtherly elaborated in OECD (2017), chapter 9.

[16]The generalised partial credit model was used for items with more than two response categories. The benefit of using that model was that it is applicable for items i with $m_i + 1$ ordered categories while it appropriately reduced to the two-parameter-logistic model when applied to dichotomous responses. It is formulated as follows:

$$P\big(x_i = k \mid \theta, \beta_i, \alpha_i, d_i\big) = \frac{exp\big\{\sum_{r=0}^{k} D\alpha_i(\theta - \beta_i + d_{ir})\big\}}{\sum_{u=0}^{m_i} exp\big\{\sum_{r=0}^{u} D\alpha_i(\theta - \beta_i + d_{ir})\big\}} \tag{4}$$

where d_i is the category threshold parameter. See Muraki (1992) for further details.

joint probability of a particular reponse pattern is in 2PLM, for n items ($x = x_i, ..., x_n$), defined as:

$$P\big(x \mid \theta, \beta, \alpha\big) = \prod_{i=1}^{n} P_i(\theta)^{x_i}(1 - P_i(\theta))^{1-x_i} \tag{5}$$

where $P_i(\theta)$ is a function of a student's ability, θ, that determines the probability of answering correct (or incorrect) on any given item i. The response pattern can be replaced by the actual scored data which followingly transforms equation 5 into a likelihood function that is maximised with respect to the item parameters. This transformation implied that students were assumed to provide their answers independently and that the students' abilities could be sampled from a distribution $f(\theta)$ (OECD, 2017). For a total of J students, the likelihood function was characterised as:

$$P\big(x \mid \beta, \alpha\big) = \prod_{j=1}^{J} \int \Big(\prod_{i=1}^{n} P_i(\theta)^{x_{ij}}(1 - P_i(\theta))^{1-x_{ij}} \Big) f(\theta) d(\theta) \tag{6}$$

The purpose of using this IRT scaling was to obtain the item parameter estimates for α and β to facilitate the estimation of the students' abilities, θ (OECD, 2017).

Plausible values

The PISA 2015 design did not directly provide comparable student scores because of the matrix sampling methodology, and thus, the students' proficiency levels in the tested domains were unobserved. OECD employed a plausible value methodology to measure student achievement. A commonly used definition is:

> "The simplest way to describe plausible values is to say that plausible values are a representation of the range of abilities that a student might reasonably have. [...] Instead of directly estimating a student's ability, θ, a probability distribution for a student's θ is estimated. [...] Plausible values are random draws from this (estimated) distribution for a student's θ." (Adams and Wu, 2002)[17].

[17] Plausible values can be considered as the better alternative in resolving the uncertainty of the students' unobserved proficiency values, θ. The variability among the plausible values is arguably a way to reflect the uncertainty of not observing a student's ability. Furthermore, it is important to emphasise that plausible values are not substitutes for the test scores of the students, but rather intermediary computations that incorporate their responses to the test items and background information (OECD, 2017).

OECD implemented a population model that first used the IRT model (derived in the previous subsection) to estimate the item parameters that were followingly used in a latent regression model that incorporated the effects of the students' backgrounds to obtain the students' proficiency distributions[18]. Followingly, the population model incorporated both test responses and variables answered through the student questionnaire. The estimation procedure was carried out as follows:

1. *Item calibration:* The students' responses and scored values were used in the IRT model derived in the previous section ("Assessment structure") to obtain the item parameter estimates (α and β) for the test items.
2. *Population modelling:* The population model assumed that the item parameters obtained in step 1 were fixed. These estimates were employed in a latent regression model that fitted the data to obtain regression weights (Γ) and a residual variance-covariance matrix (Σ). An expectation-maximization algorithm (Mislevy, 1985) was employed to estimate Γ and Σ[19].
3. *Plausible value computation:* 10 plausible values were drawn for all students using the estimated item parameters, Γ, and Σ (Little and Rubin, 2002; Schafer, 1997; von Davier et al., 2009).

The usage of all 10 plausible values is also communicated as the best estimate for a student's ability because a more accurate and proper variability for the students' performance is obtained when applying and repeating analyses on each of the 10 plausible values (OECD, 2017).

4.2 Data description

The 2015 PISA dataset for Norway originally contained 5456 observations/students spread over 239 schools. One school and 195 observations were dropped due to missing values for ethnic group status. The final data sample contained 5261 students. This was split between 2631 female and 2630 male students, and 4609 native students, 332 second-generation immigrant students, and 320 first-generation immigrant students. There was missing information about school type for 872 of the sampled students, but by the available data, 98,15% were enrolled in public schools, while

[18]The covariances between the skill domains (science, mathematics, and reading) were also used to improve the accuracy of the estimated proficiency distributions.

[19]A more detailed explanation of the latent regression model can be found in OECD (2017), chapter 9.

1,85% were enrolled in a private school, which is close to the 2017 ratios presented in the literature review. Each observation was assigned unique identifiers, student-id (*cntstuid*) and school-id (*cntschid*), and these were used to combine the datasets for the student and school questionnaire.

Educational levels are in this dissertation referred to by the International Standard Classification of Education (ISCED) 1997[20]. The ISCED levels were classified through the following enumeration:

0) ISCED 0: None / Pre-primary education
1) ISCED 1: Primary education
2) ISCED 2: Lower secondary education
3) ISCED 3B or 3C: Vocational or pre-vocational upper secondary schooling
4) ISCED 3A and/or 4: General upper secondary and/or non-tertiary post-secondary schooling
5) ISCED 5B: Vocational tertiary education
6) ISCED 5A and/or 6: Theoretically oriented tertiary and/or post-graduate education

Occupational status in the PISA data was coded to four-digit ISCO codes and then mapped to the International Socio-Economic Index of occupational status (ISEI) (Ganzeboom et al., 1992). ISEI values were also used throughout this dissertation.

Table 4.1 summarizes all the original OECD variables that were used in this dissertation and includes variable descriptions, original variable name and description, descriptive statistics (minimum and maximum value, and the number of observations (N)), and belonging questionnaire (QST). All the variables that are starting with either *stxxx* (student questionnaire) or *scxxx* (school questionnaire) assume values that correspond directly with the alternatives in the respective questionnaires.[21] The other variables (e.g. *immig*, *langn*, and *schsize*) are specific OECD derived variables[22].

[20]The complete documentation and explanation of ISCED 1997 is available at UNESCO, http://www.unesco.org/education/information/nfsunesco/doc/isced_1997.htm, and its suggested translation and equivalence to the Norwegian education system can be found at http://gpseducation.oecd.org/Content/MapOfEducationSystem/NOR/NOR_1997_EN.pdf.

[21]The questionnaires can be downloaded at http://www.oecd.org/pisa/data/2015database/.

[22]A complete description of the scaling procedures and construct validation of context questionnaire data can be found in OECD (2017), chapter 16.

Table 4.1: Variable description for all used variables, PISA 2015

Variable	Data (OECD)	Min	Max	Description	N	QST
Test scores:						
Science	*pv1scie-pv10scie*	175	810	Quantitative	5261	STU
Mathematics	*pv1math-pv10math*	182	793	Quantitative	5261	STU
Reading	*pv1read-pv10read*	54	827	Quantitative	5261	STU
Descriptive:						
Ethnic group category	*immig*	1	3	Native (1), 2nd-generation immigrant (2), and 1st-generation immigrant (3)	5261	STU
Gender	*st004d01t*	1	2	Female (1) and male (2)	5261	STU
Language at home[a]	*langn*	264	840	264 = Danish, 494 = Swedish, 523 = Norwegian, 540 = Sami, and 840 = Other language	5259	STU
Community size	*sc001q01ta*	1	4	Village: < 3 000 (1), small town: < 15 000 (2), town: < 100 000 (3), and city: < 1 000 000 (4)	4659	SCH
School size	*schsize*	28	925	Quantitative	4446	SCH
Student:						
Socio-economic status (ESCS)[b]	*escs*	-6,60	3,57	Index	5231	STU
- Home possessions	*homepos*	-8,75	5,14	Index	5260	STU
· Cultural items	*cultposs*	-1,71	2,62	Index	5180	STU
· Educational resources	*hedres*	-4,37	1,18	Index	5250	STU
· ICT resources	*ictres*	-3,27	3,50	Index	5253	STU
· Wealth items	*wealth*	-6,97	4,09	Index	5258	STU
· Books at home	*st013q01ta*	1	6	0-10 (1), 11-25 (2), 26-100 (3), 101-200 (4), 201-500 (5) and 500+ books (6)	5226	STU
Study hours outside of class						
- Science	*st071q01na*	0	30	Quantitative	4590	STU
- Mathematics	*st071q02na*	0	30	Quantitative	4611	STU
Subjective perceptions						
- Emotional support from parent(s)	*emosups*	-3,08	1,10	Index	5240	STU
- Educational expectation	*st111q01ta*	1	6	ISCED 2 (1), ISCED 3B/C (2), ISCED 3A (3), ISCED 4 (4), ISCED 5A (5), and ISCED 5A/6 (6)	5231	STU

Table 4.1 (*continued*)

Variable	Data (OECD)	Min	Max	Description	N	QST
- Educational anxiety	*anxtest*	-2,51	2,55	Index	5234	STU
- Ambition/competitiveness	*motivat*	-3,09	1,85	Index	5224	STU
- Occupational expectation	*bsmj*	16	89	Quantitative, ISEI scores	4260	STU
- Student preference/characteristic						
· Prefer working as part of a team	*st082q01na*	1	4	Strongly disagree (1), ..., strongly agree (4)	5205	STU
· A good listener	*st082q02na*	1	4	Strongly disagree (1), ..., strongly agree (4)	5195	STU
· Enjoy seeing success of others	*st082q03na*	1	4	Strongly disagree (1), ..., strongly agree (4)	5189	STU
· Feel like an outsider	*st034q01ta*	1	4	Strongly agree (1), ..., strongly disagree (4)	5210	STU
· Feel like I belong at school	*st034q03ta*	1	4	Strongly agree (1), ..., strongly disagree (4)	5176	STU
Class skipped	*st062q02ta*	1	4	Never (1), 1-2 times (2), 3-4 times (3), and 5+ times (4) last two weeks	5170	STU
Ate breakfast before school	*st076q01na*	1	2	Yes (1), no (2), on the most recent school day	5031	STU
Parent:						
Parents' highest education	*hisced*	0	6	ISCED 0 (0) - ... - ISCED 6 (6)	5162	STU
Mother's highest education	*misced*	0	6	ISCED 0 (0) - ... - ISCED 6 (6)	5136	STU
Father's highest education	*fisced*	0	6	ISCED 0 (0) - ... - ISCED 6 (6)	5034	STU
Parental occupational status						
- Mother	*bmmj1*	12	89	Quantitative, ISEI scores	4736	STU
- Father	*bfmj2*	12	89	Quantitative, ISEI scores	4650	STU
School:						
Proportion certified teacher staff	*proatce*	0	1	Proportion	3904	SCH
Class size	*clsize*	13	33	Quantitative	4589	SCH
Student-teacher ratio	*stratio*	1,5	15,9	Quantitative	4212	SCH
Class division by ability	*sc042q01ta*	1	3	For all subjects (1), for some subjects (2), and not for any subjects (3)	4222	SCH
Within class-division by ability	*sc042q02ta*	1	3	For all subjects (1), for some subjects (2), and not for any subjects (3)	4212	SCH
Report achievement data publicly	*sc036q01ta*	1	2	Yes (1), no (2)	4219	SCH
School climate						
- Staff capacity hinders education	*staffshort*	-1,68	1,51	Index	4418	SCH

Table 4.1 (*continued*)

Variable	Data (OECD)	Min	Max	Description	N	QST
- Student behaviour hinders education	*stubeha*	-2,39	3,89	Index	4261	SCH
- Teacher behaviour hinders education	*teachbeha*	-2,12	2,77	Index	4261	SCH

Index variables are increasing, and thus, higher values imply a better state of the respective variable (except for the *school climate* variables which were opposite).

[a] A codebook for country-specific variables is available at http://www.oecd.org/pisa/data/2015database/Codebook_CMB.xlsx.

[b] Parental education and occupation are also variables that were integrated into the *escs* construct.

The PISA dataset separates ethnic groups by the variable *immig*, and these groups were defined in OECD (2017) as 1) *natives* (students with at least one parent born in the country), 2) *second-generation immigrants* (those born in the country of assessment but whose parent(s) were born in another country), and 3) *first-generation immigrants* (both the student and parent(s) where born outside the country of assessment). These definitions were also used throughout this dissertation. Followingly, *immigrant* students are referred to as a joint category of these two immigrant categories.

The PISA index of economic, social and cultural status (ESCS), hereinafter referred to as "socio-economic status (ESCS)", as in Table 4.1, is a composite score built up by household possessions, in addition to parental education and occupation (OECD, 2017, p. 339-342). These household possessions (*homepos*), which furtherly were decomposed into cultural items (*cultposs*), educational resources (*hedres*), ICT resources (*ictres*) and wealth items (*wealth*), are all constructs made up by students responses on the availability of 16 different household items (*ST011*) and the reported amount of certain possessions and books at home (*ST012*, *ST013*)[23]. The intention of these variables was to serve as proxies for family wealth.

The variables found under the category "Subjective perceptions" are grouped since the student responses were based on the student's own emotions and perceptions. Care should therefore be considered when interpreting results related to the respective variables. A further elaboration of the indices for test anxiety (*anxtest*), student motivation (*motivat*), and emotional support (*emosups*) can be found in OECD (2017), p. 315 and 317. The answering format for the three variables, upon which the indices were constructed, was a four-point Likert scale.

The school variable, proportion certified teacher staff *proatce*, was obtained by dividing the number of fully certified teachers by the total number of teachers. Similarly, student-teacher ratio (*stratio*) was obtained by dividing enrolled students by the total number of teachers. The indices for school climate were built by several items where a principal responded his/her perception of staff quality and learning environments, and to what distinct these factors hindered educational purposes. The construction of these indices are furtherly elaborated in OECD (2017), p. 326-327. These were also reversed for analysis (see variable modifications in Table 5.1).

[23]See Table A.1 (in Annex A) for an overview of which specific items that OECD used to construct the index *homepos* for home possessions, and the subindices *cultposs*, *hedres*, *ictres* and *wealth*.

5 Methodology

This chapter elaborates the methods employed in this dissertation. The first section includes an explanation of the customised procedures used to acquire unbiased and consistent population estimates. The last section goes into further detail on the model specifications, more specifically the assumptions and implications of using educational production functions, which (and where) variable modifications were employed, and an explanation of both the econometric model and decomposition method used in this dissertation. Simple t-tests were also used to obtain results in some sections of this dissertation.

5.1 Sampling variance

The PISA sample was acquired through a two-stage sampling method. As normal statistical packages assume simple random sampling methods I needed to adjust statistical methods to account for this. Both OECD (2009) and OECD (2017) emphasise the importance of adjusting methodology due to the complexity of the sample design.

The PISA dataset clusters students by schools, and even though students were sampled randomly (with different sampling probabilities), survey weights were required to analyse the PISA data. These weights had to be incorporated to ensure that each student represented the correct number of students in the whole population. Furthermore, this corrected for the clustered data design which could have implied an interdependence between the error terms of students from the same schools. This methodology enables researchers to calculate appropriate sampling errors and to make valid population estimates and inferences (Jerrim et al., 2017; OECD, 2009; OECD, 2017). Some authors have been criticised for not properly adjusting methods to the complexity of the PISA sample and test design (Cattaneo et al., 2017; Lavy, 2015; Rivkin and Schiman, 2015). Furthermore, Jerrim et al. (2017) conducted a complete analysis of methodologies when using PISA data for empirical work and emphasised the importance of adjusting statistical methods due to the complex PISA sample. Todd and Wolpin (2003) also commented on this but discussed more technical specifications when using educational production functions.

The implemented methodology made further computations necessary. A standard statistical

package, *repest*[24] (Avvisati and Keslair, 2014) in Stata, enabled estimation with weighted replicate samples and plausible values, and thus reduced computational burden. The approach used to calculate correct sampling variances is known as balanced repeated replication (BRR), more specifically Fay's method (OECD, 2009; OECD, 2017; Rust and Rao, 1996; Wolter, 2007).

Simply said, the replication approach acquires variance estimates by using large numbers of different sampling weights. For PISA, it was decided to include 80 replicate estimates, and thus, 80 replicate weights too. As any replication method, the statistic of interest, φ, was computed based on the sample itself, but also for each replicate. Following the BRR-method, the replicate estimates were then compared towards the sample estimate, to obtain the variance in the following way:

$$\sigma^2_{(\hat{\varphi})} = \frac{1}{G(1-k)^2}\sum_{i=1}^{G}(\hat{\varphi}_i - \hat{\varphi})^2 = \frac{1}{20}\sum_{i=1}^{80}(\hat{\varphi}_i - \hat{\varphi})^2 \tag{7}$$

where G represents the number of replicates and k is a deflating factor which was set equal to 0,5 (OECD, 2009, p. 72-74). OECD (2017) argues that using this particular BRR-methodology obtains a more "true" sampling error of the initial population parameter of interest, and thus, providing more accurate and correct variability.

5.2 Model specifications

Student achievement can be modelled using educational production functions (EPFs). These functions look at academic achievement as an end to a production process by estimating the effects of various inputs. All current and prior inputs should ideally be included in the model to determine the correct production function, but due to data limitations and lack of historical data, missing data often become problematic. The PISA datasets include rich, contemporary longitudinal information on students and schools, but there is no information on prior achievement and previous inputs on educational production. Hence, early childhood inputs were treated as unobserved characteristics.

Todd and Wolpin (2003) discuss in their paper various techniques that can be employed to tackle this specification problem. Firstly, I chose not to use proxy variables in this study to maintain the original data and reduce potential bias. Furthermore, this study takes a contemporaneous specifi-

[24] Francesco Avvisati and François Keslair, 2014. REPEST: Stata module to run estimations with weighted replicate samples and plausible values, Statistical Software Components S457918, Boston College Department of Economics, revised 23 Mar 2017.

cation strategy that relates the PISA test scores to measures on several descriptive characteristics, student background, parental background and school/institutional characteristics. This approach, in addition to the assumptions that apply to linear regression and ordinary least squares, includes the following assumptions:

1. Inputs are constant/time invariant, implying that current inputs are representative for previous inputs, and thus, only contemporaneous inputs are relevant for current student achievement.
2. Contemporaneous inputs are not related to students ability.

The contemporaneous approach was primarily adopted due to data limitations on historical inputs. Furthermore, considering the variability of inputs through time, institutional changes can be expected to occur gradually rather than radically. Hence, education systems can be considered time-invariant, or at least rather similar, during a student's enrolment in compulsory schooling.

Variable modifications

This section includes the modifications that were employed on the original PISA data and Table 5.1 displays the specific variable modifications that were applied throughout this dissertation[25].

Table 5.1: Variable modifications, categorical variables

Variable description	**Modification (else =0)**	**Data (OECD)**
Immigrant category		
- Second-generation immigrant	=1 (immig=2)	*immig*
- First-generation immigrant	=1 (immig=3)	*immig*
Descriptive:		
Female	=1 (st004d01t=1)	*st004d01t*
Speak Norwegian at home	=1 (langn=523)	*langn*
Community size		
- Village	=1 (sc001q01ta=1)	*sc001q01ta*
- Small town	=1 (sc001q01ta=2)	*sc001q01ta*
- Town	=1 (sc001q01ta=3)	*sc001q01ta*
- City	=1 (sc001q01ta>=4)	*sc001q01ta*
Student:		
Socio-economic status (ESCS)		
- Home possessions		
· Books at home		
- More than 200 books	=1 (st013q01ta>=5)	*st013q01ta*

[25]Further details on the original PISA data can be found in Table 4.1.

Table 5.1 (*continued*)

Variable description	**Modification (else =0)**	**Data (OECD)**
- Between 100 and 200 books	=1 (st013q01ta>3 or <5)	*st013q01ta*
- Less/equal than 100 books	=1 (st013q01ta<=3)	*st013q01ta*
Subjective perceptions		
- Expect to complete tertiary education	=1 (st111q01ta=5 or =6)	*st111q01ta*
- Student preference/characteristic		
· Prefer working as part of a team	=1 (st082q01na=3 or =4)	*st082q021na*
· A good listener	=1 (st082q02na=3 or =4)	*st082q02na*
· Enjoy seeing success of others	=1 (st082q03na=3 or =4)	*st082q03na*
· Feel like an outsider	=1 (st034q01ta=1 or =2)	*st034q01ta*
· Feel like I belong at school	=1 (st034q03ta=1 or =2)	*st034q03ta*
No class skipped	=1 (st062q02ta=1)	*st062q02ta*
Ate breakfast before school	=1 (st076q01na=1)	*st076q01na*
Parent:		
Parental education		
- Don't have compulsory schooling		
· Mother	=1 (misced<=2)	*misced*
· Father	=1 (fisced<=2)	*fisced*
- Parent have tertiary education		
· Mother	=1 (misced>=5)	*misced*
· Father	=1 (fisced>=5)	*fisced*
School:		
No class division by ability	=1 (sc042q01ta=3)	*sc042q01ta*
No within class-division by ability	=1 (sc042q02ta=3)	*sc042q02ta*
Report achievement data publicly	=1 (sc036q01ta=1)	*sc036q01ta*
School climate		
- Staff capacity	=1 (staffshort*-1)	*staffshort*
- Student behaviour	=1 (stubeha*-1)	*stubeha*
- Teacher behaviour	=1 (teachbeha*-1)	*teachbeha*

Econometric model

Plausible values were used to represent the students' test scores and these were followingly set as dependent variables in the econometric model. The following educational production function was estimated:

$$T_{is} = \alpha + \beta_0 I_{2is} + \beta_1 I_{1is} + \beta_2 D_{is} + \beta_3 S_{is} + \beta_4 P_{is} + \beta_5 R_s + \varepsilon_{is} \tag{8}$$

where T_{is} is the test score for student i in school s. I_{2is} and I_{1is} represent a dummy variable for the two respective immigrant categories: first the dummy for second-generation immigrant, and then first-generation immigrant. The production function was furtherly split into four groups: 1) D_{is},

descriptive variables, 2) S_{is}, student variables, 3) P_{is} parent variables, and 4) R_s, a set of school variables. α was the constant term and ε_{is} the error term. The error term captured all the omitted variables. Convenient categories were selected as reference categories. Finally, observations with missing value(s) for any of the explanatory independent variables were always omitted from the econometric models.

All the estimated econometric models were derived from equation 8 and included both a constant and error term. The base model only included the two immigrant category variables. This allowed me to see how the immigrant categories affected student achievement independently of other explanatory variables. All the following models included these immigrant dummies but were furtherly extended. The sub-group models were estimated individually on each of the four variable groups (descriptive, student, parent and school variables). This allowed me to see how the different variable groups affected the magnitude of the estimated immigrant coefficients as well as individual coefficients for the predictors within each group. The final model was estimated as in equation 8 and included all variables, and thus, controlled for subgroups and variable dependencies.

Decomposition method

The Blinder-Oaxaca decomposition method was employed in this dissertation (Blinder, 1973; Oaxaca, 1973). It is commonly used to study outcome variables by mean differences between groups. In this case, test scores were used as the outcome variable (T) while the explanatory variables were used as predictors (a given vector X). The ethnic groups were used as comparing groups.

The Stata command *oaxaca*[26] was employed, and standard errors for the decomposition results were reported according to Jann (2008). Before the decomposition, individual educational production functions were estimated for native and immigrant students, using sampling weights and the BRR-method, to obtain mean score estimates, and thus, the estimated score gap.

The total test score gap was defined as:

$$\Delta T = \bar{T}_i - \bar{T}_j,\ i,\ j \in [1,2,3]\ and\ i \neq j \tag{9}$$

where the bars denote means and the subscripts "i" and "j" represent the two comparing groups.

[26]Ben Jann, 2008. "OAXACA: Stata module to compute the Blinder-Oaxaca decomposition", Statistical Software Components S456936, Boston College Department of Economics, revised 25 Aug 2011.

The groups take value 1 for native, 2 for second-generation immigrants, and 3 for first-generation immigrants. $\bar{T}_i$ and $\bar{T}_j$ were obtained through separate linear regressions and assumed that required assumptions for OLS were fulfilled.

The Blinder-Oaxaca method allowed the estimated gap to be decomposed into three effects: 1) a characteristic, 2) a return, and 3) an interaction effect, and was defined as:

$$\Delta T = \underbrace{(\bar{X}_i - \bar{X}_j)'\hat{\beta}_j}_{\text{Characteristic effect}} + \underbrace{\bar{X}_j'(\hat{\beta}_i - \hat{\beta}_j)}_{\text{Return effect}} + \underbrace{(\bar{X}_i - \bar{X}_j)'(\hat{\beta}_i - \hat{\beta}_j)}_{\text{Interaction effect}}, \; i, \; j \in [1,2,3] \; \textit{and} \; i \neq j \tag{10}$$

where X was vectors with all the explanatory variables. The effects were compared towards group j, so the first component in the decomposition was the characteristic effect which measured how group j, given their estimated returns, $\hat{\beta}_j$, would score differently if they had the same characteristics as group i. The return effect, seen in the second component, showed how group j would perform, given their characteristic endowment, $\bar{X}_j'$, if they experienced the same returns as group i. The interaction term applied when differences between the groups, in both endowments and coefficients, existed simultaneously. Furthermore, besides observing the three effects, the decomposition method allowed me to obtain the individual effects of the predictors (Jann, 2008).

Another popular decomposition alternative includes a twofold decomposition where the first component of the gap is decomposed into a part that explains the gap between the groups by differences in the predictors. The second component is usually referred to as the unexplained part (Jann, 2008). Using the gap obtained in equation 9, the gap was in this case defined as:

$$\Delta T = \underbrace{(\bar{X}_i - \bar{X}_j)'\beta^*}_{\text{Explained part}} + \underbrace{\bar{X}_i'(\hat{\beta}_i - \beta^*) + \bar{X}_j'(\beta^* - \hat{\beta}_j)}_{\text{Unexplained part}}, \; i, \; j \in [1,2,3] \; \textit{and} \; i \neq j \tag{11}$$

where β^* was a nondiscriminatory coefficient vector. β^* was determined using the *pooled* option (Jann, 2008) which implied that the final econometric models, in section 6.2.3, were only estimated for the two comparing groups, i and j, and thus, excluding the omitted category from the sample. Furthermore, this option implied that the nondiscriminatory vector was estimated as one of the alternatives considered in Oaxaca and Ransom (1994), and thus, β^* laid somewhere between the estimated coefficients of group i and j.

6 Results

This chapter is divided into four main sections: 1) Preliminary analysis, 2) Educational production functions, 3) Decomposition methods and 4) Summary. The first section, 6.1, is divided into four parts, where the first part provides descriptive statistics for relevant variables and the second part shows the difference between immigrant and native students across different percentiles. The third and fourth subsection employs t-tests to assess differences in PISA scores across groups defined by various variable specifications. The second section, 6.2, consists of various EPFs, starting from a base model with only immigrant categories and ending with a complete, final model that includes all predictors. The third section, 6.3, includes Blinder-Oaxaca decompositions between the ethnic groups and elaborates more on the test score gaps between native and immigrant students. The last section, 6.4, presents the results towards the hypotheses.

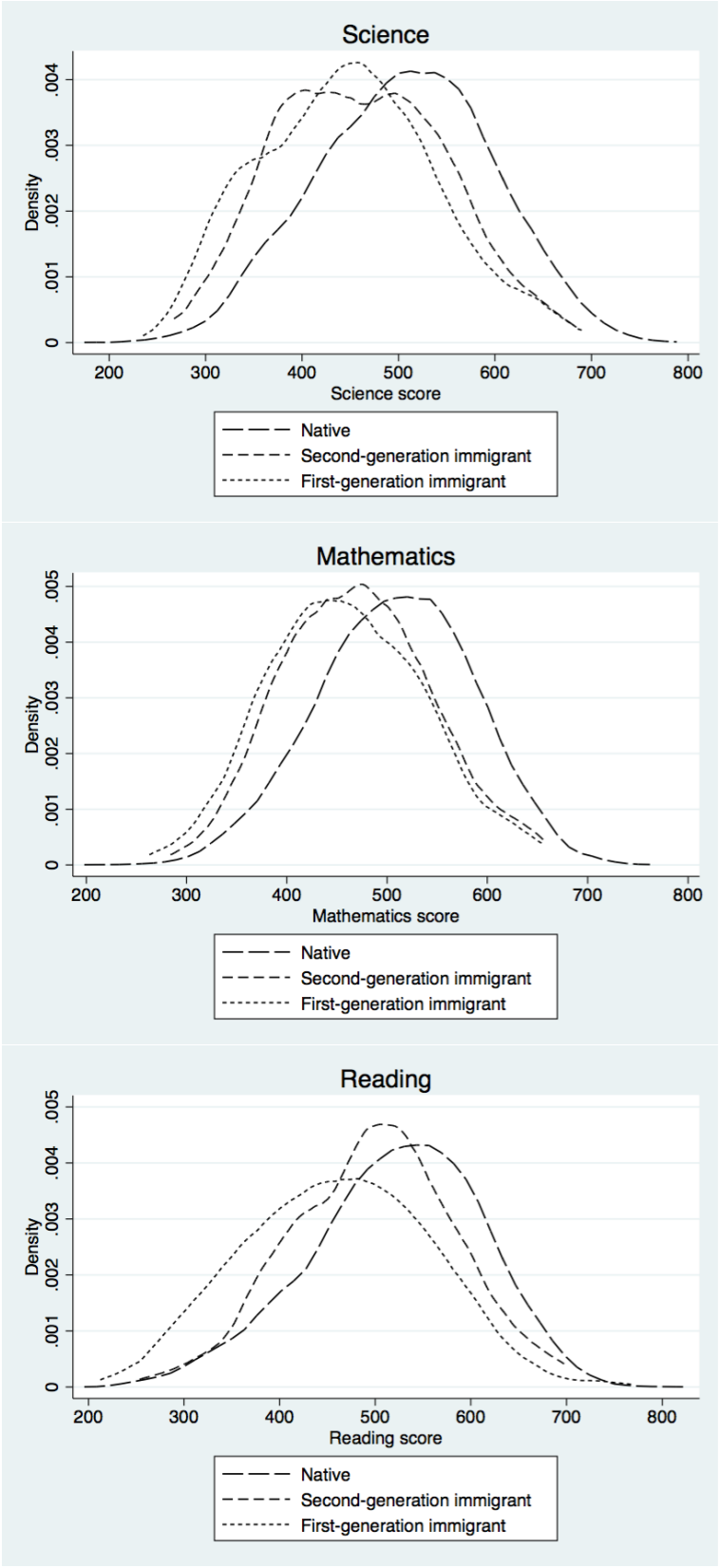
6.1 Preliminary analysis

This section includes an unconditional analysis of, and between, native and immigrant students in Norway. The figure on the next page displays the student score distributions (kernel densities) for each test domain.

These three test score distributions (in figure 6.1) showed that student performance varied among the three different domains. Furthermore, immigrant students had in general lower test scores than native students. Additionally, while native and first-generation immigrant students seemed to have a more defined global stationary point in science, that was not the case for second-generation students where scores ranging from approximately 380 to 480 occurred "equally" often. In mathematics, the score distributions were seemingly normally distributed for all ethnic groups. Lastly, the reading scores for first-generation immigrant students were found more broadly distributed than for the other two groups.

These gaps between native and immigrant students may be due to differences in endowments or returns to educational inputs. This will be furtherly discussed in the following sections. The next subsections will describe the students' endowments and how these create/not create gaps across the ethnic groups. A later section, 6.2, presents estimations on how different educational inputs affect student achievement.

Figure 6.1: Test score distributions, PISA 2015



6.1.1 Descriptive statistics

Table 6.1 contains means for all variables used in this dissertation. Corresponding standard deviations are placed in Table B.1 in Annex B. A t-test checked whether the mean differences between the groups were equal to zero and the asterisk(s) displayed the significance level of the test.

Table 6.1: Student endowments, variable means and differences, PISA 2015

Variable	**Means**			**T-test, diff = 0**		
	Native (1)	**2nd generation immigrant (2)**	**1st generation immigrant (3)**	**2-1**	**3-1**	**3-2**
Test Scores:						
Science	507	464	446	***	***	*
Mathematics	509	473	459	***	***	*
Reading	521	500	458	***	***	***
Descriptive:						
Female	0,50	0,48	0,48			
Speak Norwegian at home	0,98	0,57	0,26	***	***	***
Community size						
- Village	0,21	0,03	0,17	***	**	***
- Small town	0,32	0,17	0,29	***		***
- Town	0,29	0,30	0,28			
- City	0,18	0,49	0,26	***	***	***
School size	342	435	351	***		***
Student:						
Socio-economic status (ESCS)	0,54	0,09	0,02	***	***	
- Home possessions	0,69	0,31	0,16	***	***	**
· Cultural items	0,23	-0,14	-0,13	***	***	
· Educational resources	0,32	0,37	0,17		**	**
· ICT resources	0,64	0,46	0,31	***	***	**
· Wealth items	0,66	0,33	0,12	***	***	***
· Books at home						
- More than 200 books	0,32	0,12	0,14	***	***	
- Between 100 and 200 books	0,22	0,14	0,09	***	***	**
- Less/equal than 100 books	0,45	0,73	0,77	***	***	
Study hours outside of class						
- Science	3,5	4,5	4,9	***	***	
- Mathematics	4,4	5,9	5,8	***	***	
Subjective perceptions						
- Emotional support from parent(s)	0,08	0,21	-0,13	**	***	***
- Educational expectation	4,32	4,75	4,36	***		***
- Educational anxiety	0,04	0,30	0,25	***	***	
- Ambition/competitiveness	0,07	0,43	0,22	***	***	**
- Occupational expectation	58,29	65,22	61,65	***	***	**
- Student preference/characteristic						

Table 6.1 (*continued*)

Variable	Means			T-test, diff = 0		
	Native (1)	2nd generation immigrant (2)	1st generation immigrant (3)	2-1	3-1	3-2
· Prefer working as part of a team	0,39	0,40	0,43			
· A good listener	0,12	0,11	0,15			
· Enjoy seeing success of others	0,12	0,14	0,15			
· Feel like an outsider	0,12	0,12	0,18		***	*
· Feel like I belong at school	0,76	0,82	0,73	***		**
No class skipped	0,81	0,81	0,72		***	**
Ate breakfast before school	0,83	0,78	0,79		*	
Parent:						
Parents' highest education						
- In ISCED levels[1]	5,09	4,72	4,76	***	***	
Mother's highest education						
- None / Pre-primary	0,00	0,03	0,06	***	***	
- Primary	0,00	0,03	0,03	***	***	
- Lower secondary	0,04	0,12	0,08	***	**	*
- Vocational upper secondary	0,04	0,06	0,05			
- General upper secondary	0,26	0,29	0,27			
- Vocational tertiary	0,39	0,29	0,25	***	***	
- Theoretically oriented tertiary	0,26	0,18	0,26	***		**
Father's highest education						
- None / Pre-primary	0,00	0,02	0,05	*	***	**
- Primary	0,00	0,02	0,03	**	**	
- Lower secondary	0,05	0,11	0,05	***		**
- Vocational upper secondary	0,06	0,05	0,05			
- General upper secondary	0,31	0,33	0,28			
- Vocational tertiary	0,28	0,22	0,20	**	***	
- Theoretically oriented tertiary	0,28	0,26	0,34		*	**
Parental occupational status						
- Mother	55,92	45,01	43,68	***	***	
- Father	53,10	46,03	47,01	***	***	
School:						
Proportion certified teacher staff	0,84	0,75	0,86	***		***
Class size	23,9	23,8	23,6			
Student-teacher ratio	10,2	10,8	9,9	***		*
Class division by ability	2,84	2,76	2,85	***		***
Within class-division by ability	2,42	2,32	2,37	***	**	**
Report achievement data publicly	0,67	0,87	0,76	***	***	***
School climate						
- Staff capacity	0,13	0,01	-0,01	**	***	
- Student behaviour	0,14	-0,16	-0,03	***	***	*
- Teacher behaviour	-0,52	-0,71	-0,63	***	**	

P-values: *** p < 0,01; ** p < 0,05; * p < 0,10

[1] ISCED levels are used throughout this dissertation. See data section 4.2 for explanations.

Mean score differences across groups were clear. Native students performed significantly better than both immigrant groups, while second-generation immigrants had significantly higher test scores than first-generation immigrants, especially in reading. This, combined with the fact that Norway performed better than the OECD average in 2015, consolidates the importance of performance analysis between the groups.

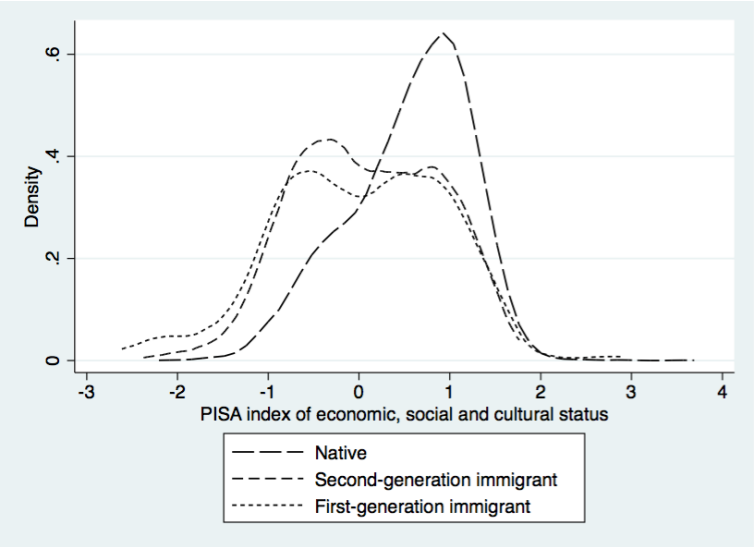
Demographic differences were found. Firstly, all ethnic groups were gender-balanced. Furthermore, native students were evenly distributed among the four community size categories where 61% lived in communities with a population between 3000 and 100 000 inhabitants. Meanwhile, half of the second-generation immigrant students lived in cities with more than 100 000 inhabitants, while only 3% lived in communities smaller than 3000 inhabitants. On the other hand, first-generation immigrant students were more evenly distributed throughout the community size categories, like native students, but with some higher percentage of students living in cities. School size was found strongly correlated to community size, with a Pearson correlation coefficient of 0,56, and followed the same pattern. Lastly, 98% of the native students spoke Norwegian at home, while 57% of second-generation immigrant students did so and only 26% of first-generation immigrant students spoke Norwegian at home[27].

Figure 6.2 (on the next page) shows the distribution (kernel densities) of socio-economic status (ESCS). A higher ESCS value indicates a stronger position. Both Table 6.1 and figure 6.2 shows that immigrant students were significantly socio-economically disadvantaged in comparison to native students. Immigrant students also seemed to be more broadly distributed (between -1 and 1) compared to native students which were strongly centered towards a higher ESCS score of approximately 0.9.

Home possessions was an overall index by OECD that included a set of household items that served as proxies for family wealth, and which furtherly was divided into several subcategories (see Table A.1 in Annex A for further details). Native students had significantly higher endowment on home possessions than both immigrant groups, while first-generation immigrants had the lowest endowment. Furthermore, these significant differences were also found across all the subcategories.

[27]The remaining 2% of native students that did not speak Norwegian at home either spoke Sami, 29% (a language spoken by an indigenous group from Scandinavia), Danish, 3%, or other languages, 66%.

Figure 6.2: Socio-economic status (ESCS) distribution, PISA 2015



Both immigrant categories were found to study significantly more than native students in both science and mathematics, but despite studying more, they performed significantly worse.

Considering the subjective perceptions, native and second-generation immigrant students were found to be better endowed than first-generation immigrants on factors such as emotional support from parent(s), and feeling like an outsider. Meanwhile, immigrant students were found to have more educational anxiety than native students, but they also scored higher on ambition/competitiveness, and educational and occupational expectations.

First-generation immigrants were found to skip classes significantly more often, as native and second-generation immigrants had no absenteeism more frequently than first-generation immgrants. Furthermore, around 80% of all students ate breakfast before school.

Native students' parents were generally found higher educated than immigrant students' parents. Furthermore, while only 4% of the native students' mothers, and 5% of their fathers, did not have compulsory schooling, the percentages were much higher for the immigrant students. For the second-generation immigrants' mothers, 18% did not have that educational level, while 15% applied for their fathers. 17% and 13% applied for first-generation immigrants. Two particular characteristics were found for tertiary education: 1) more fathers had theoretically oriented tertiary education, and 2) more mothers had vocational tertiary education.

Occupational data was obtained through open-ended questions. The data showed that the par-

ents of native students had significantly higher occupational status than the immigrants students' parents, furthermore that native students' mothers had higher scores than fathers. The opposite was the case for both immigrant categories where fathers were better off. The ISEI scores for first-generation immigrants' fathers were the highest among all the immigrant groups.

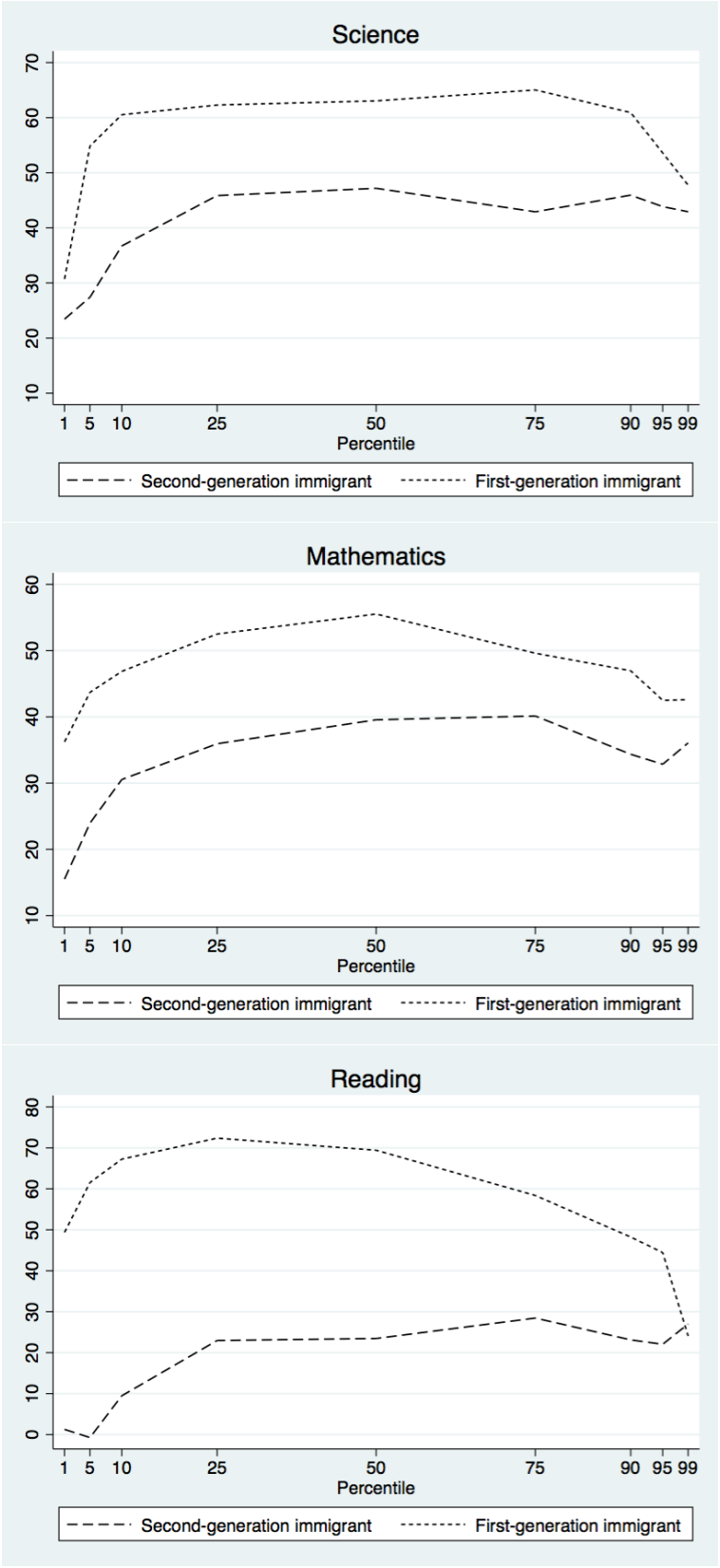
The school variables were combined to each student through their respective unique identifiers. Around 85% of the teacher staff was certified for native and first-generation immigrants, while only 75% was certified for second-generation immigrants. Meanwhile, only marginal differences for class size and student-teacher ratio were found between the subgroups. Fewer second-generation students experienced that classes were split or divided by ability than the two other groups, while achievement data was more frequently published publicly for the same group. The principals also reported their perspective on staff capacity, and how student and teacher behaviour hindered education. According to the principals, native students experienced significantly better learning environments than immigrant students on all three measures. Furthermore, second-generation students had the worst environments of the three groups.

I have in this section confirmed significant achievement differences between native and immigrant students. Some of the other key findings were that significantly fewer immigrant students, and particular first-generation immigrant, spoke Norwegian at home. Meanwhile, native and first-generation immigrant students were found to be more evenly placed in the different community sizes. Furthermore, native students had significantly higher socio-economic status (ESCS). Immigrant students were found to have higher motivation than native students through higher ambitions and expectations, but they were also found to have more educational anxiety than native students. Both mothers and fathers of native students were found to have higher education and occupational status than the immigrant students' parents. Lastly, native students experienced significantly better school climate.

6.1.2 Percentile differences

This section demonstrates the mean score percentile differences between native and immigrants students for each of the test domains. The percentiles allowed me to see how the differences between native and immigrant students appeared throughout the score distribution. The analysis was done for the following percentile levels: 1%, 5%, 10%, 25%, 50%, 75%, 90%, 95%, and 99%.

Figure 6.3: Percentile score differences from natives, PISA 2015



Tables C.1, C.2 and C.3 in Annex C includes the percentile mean scores that were used to create the graphs presented in figure 6.1.

Figure 6.3 shows that the test score differences in science were quite evenly distributed across most of the percentiles and that first-generation immigrant students performed substantially worse than second-generation immigrant students across all percentiles. However, the differences towards native students, for both immigrants groups, were significantly smaller for the three lowest percentiles. For the other percentiles, the mean test score difference seemed to be centered around 45 score points for second-generation immigrants and 60 score points for first-generation immigrant students (with a substantial decline for the highest percentiles).

Similar effects were found for mathematics. The difference was found lower on the three lower percentiles here also, while for the other percentiles, the differences were centered around 35 score points for second-generation immigrant students and 50 for first-generation immigrant students.

The last graph for reading scores indicated a slightly different dynamic than the other two domains. First-generation immigrant students experienced a significantly higher difference than second-generation immigrant students across all percentiles (except for the highest percentile, 99%, were the difference actually was smaller). Second-generation immigrant students scored marginally better than native students on the 5% percentile level and score differences only appeared higher than 20 score points from the 25% percentile and up. Furthermore, for the first-generation immigrants, differences were substantial already from the first percentiles, but the differences continuously declined from the 25% percentile.

I have in this section presented the score difference between native and immigrant student across several percentiles. The differences for the three lower percentiles, 1%, 5% and 10%, were found systematically lower than the others and thus indicating that differences between immigrant and native students are more relevant for the higher percentiles. The score differences for the other percentiles were found relatively stable.

6.1.3 T-test, mean score differences

This subsection reveals how mean score differences appeared when the ethnic groups were separated by various variable categories. This allowed me to see how certain variables affected the students' performance both across and between ethnic groups.

Table 6.2: T-test, mean score differences by categories, PISA 2015

T-test, diff = mean(1) - mean(0)	**Science**			**Mathematics**			**Reading**		
By ethnic group:	**Native**	**2nd gen. immigrant**	**1st gen. immigrant**	**Native**	**2nd gen. immigrant**	**1st gen. immigrant**	**Native**	**2nd gen. immigrant**	**1st gen. immigrant**
Descriptive:									
Female	-4,65*	-8,33	9,07	1,05	-1,95	5,95	38,03***	31,59***	63,06***
Speak Norwegian at home	43,76***	17,57*	-0,77	41,87***	11,03	-3,85	53,04***	12,84	-7,09
Community size									
- Village	-22,74***	-91,43***	8,74	-18,43***	-69,45***	8,92	-27,38***	-100,37***	-12,07
- Small town	-6,04**	12,83	1,33	-3,64	11,06	6,52	-3,86	-4,07	2,88
- Town	5,70*	-6,40	8,39	3,52	-4,76	-1,64	7,22**	-6,47	11,96
- City	26,56***	9,02	-15,99	21,24***	6,04	-11,16	26,34***	19,32*	-7,13
School size									
- High	5,07	5,18	1,14	-0,38	-3,25	-0,51	16,81**	15,06	8,21
- Middle	-5,99**	-7,15	-21,75**	-4,28*	0,17	-17,39*	-5,15*	-16,50	-18,94
- Low	-9,03***	5,48	27,26**	-5,20*	7,37	23,32**	-12,57***	5,23	15,99
Student:									
Socio-economic status (ESCS)									
- High	45,22***	18,63	42,44***	42,24***	17,74	36,16***	38,05***	4,83	26,98
- Middle	-5,47**	15,52	30,92***	-4,43*	13,03	26,93***	-1,77	19,02**	33,02***
- Low	-43,76***	-23,80**	-50,90***	-41,87***	-21,02***	-43,91***	-40,97***	-20,33**	-44,68***
- Home possessions									
· High	34,48***	-1,06	9,29	32,04***	2,51	0,40	25,43***	-14,52	-15,86
· Middle	5,20*	9,36	43,45***	5,34**	14,89*	38,37***	7,01***	8,82	43,36***
· Low	-47,37***	-9,25	-44,72***	-44,75***	-16,52**	-37,07***	-39,56***	-2,88	-36,86***
· Cultural items									
- High	39,00***	23,85*	54,78***	32,06***	23,24*	42,20***	32,95***	25,16*	49,65***
- Middle	-0,78	-16,56*	-11,77	-0,06	-15,06*	-9,05	1,58	-20,81**	-9,44
- Low	-43,59***	2,59	-23,90**	-36,59***	1,35	-18,42**	-39,82***	6,39	-22,96**
· Educational resources									
- High	28,24***	15,84	32,97***	23,95***	11,01	24,74***	15,84***	8,06	19,79*
- Middle	3,69	-0,52	-0,42	5,74**	9,18	1,12	8,43***	-0,19	-0,04
- Low	-41,53***	-20,77**	-37,23***	-37,95***	-24,12***	-29,38***	-29,97***	-10,64	-22,56**

Table 6.2 (*continued*)

T-test, diff = mean(1) - mean(0)	**Science**			**Mathematics**			**Reading**		
By ethnic group:	**Native**	**2nd gen. immigrant**	**1st gen. immigrant**	**Native**	**2nd gen. immigrant**	**1st gen. immigrant**	**Native**	**2nd gen. immigrant**	**1st gen. immigrant**
· ICT resources									
- High	0,36	-34,20***	-13,58	1,45	-20,49**	-6,17	-9,47***	-41,59***	-35,58**
- Middle	13,18***	32,45***	24,97**	14,41***	30,76***	21,88**	17,60***	31,84***	24,18**
- Low	-18,52***	-8,83	-15,27	-21,52***	-16,89**	-16,69*	-12,83***	-2,93	-1,88
· Wealth items									
- High	-17,02***	-24,38**	-14,68	-10,21***	-11,06	-16,20	-23,43***	-39,53***	-35,93**
- Middle	19,28***	1,13	9,22	19,42***	3,93	9,40	20,24***	2,98	-4,54
- Low	-10,93***	9,31	-5,38	-19,70***	-3,99	-10,02	-5,25	10,47	7,68
· Books at home									
- More than 200 books	49,87***	30,45*	39,31**	44,03***	21,64	28,45**	48,94***	28,13	41,35*
- Between 100 and 200 books	12,90***	33,33**	42,33**	6,66**	26,76**	25,40	14,32***	20,44	39,62**
- Less/equal than 100 books	-53,23***	-37,95***	-46,07***	-43,68***	-28,86***	-31,05***	-53,38***	-28,67**	-46,31***
Study time outside (subject-specific)									
- High	-24,70***	-26,41***	-9,29	-18,72***	-25,85***	-9,90			
- Middle	-4,66	1,21	-18,38*	-12,18***	-0,88	-4,98			
- Low	30,31***	37,90***	38,08***	28,70***	37,05***	16,12			
Subjective perceptions									
- Emotional support from parent(s)									
· High	9,62***	5,81	6,59	9,91***	1,42	5,74	16,31***	10,60	17,33
· Middle	14,27***	26,49***	4,84	11,51***	20,31**	4,88	14,43***	27,90***	8,06
· Low	-24,89***	-28,05***	-10,85	-22,42***	-25,88***	-10,09	-32,34***	-23,10**	-24,07**
- Expect to complete tertiary education	61,34***	43,71***	62,20***	57,14***	45,41***	60,90***	73,99***	53,70***	86,14***
- Educational anxiety									
· High	-27,62***	-31,35***	-20,28*	-20,97***	-31,54***	-12,16	-7,37**	-12,03	0,57
· Middle	3,93	3,52	9,46	2,12	7,63	5,58	1,98	-2,32	0,01
· Low	21,48***	40,03***	11,48	17,44***	33,39***	7,04	4,52	21,54	-0,78
- Ambition/competitiveness									
· High	37,54***	23,18**	10,48	35,81***	16,76**	16,62*	40,45***	27,58***	32,30***
· Middle	8,79***	-9,69	-0,15	8,79***	-3,27	-3,89	12,06***	-10,63	-5,23

Table 6.2 (*continued*)

T-test, diff = mean(1) - mean(0)	**Science**			**Mathematics**			**Reading**		
By ethnic group:	**Native**	**2nd gen. immigrant**	**1st gen. immigrant**	**Native**	**2nd gen. immigrant**	**1st gen. immigrant**	**Native**	**2nd gen. immigrant**	**1st gen. immigrant**
· Low	-47,76***	-28,36*	-12,64	-46,08***	-28,91**	-15,19	-54,76***	-35,75**	-32,62***
- Occupational expectation									
· High	56,58***	35,65***	44,93***	48,23***	33,15***	40,13***	55,50***	36,71***	58,58***
· Middle	8,79***	-3,53	1,53	9,03***	-3,47	1,04	10,63***	-9,69	-0,30
· Low	-68,75***	-59,82***	-59,20***	-60,56***	-55,26***	-52,46***	-70,00***	-50,79***	-74,25***
- Student preference/characteristic									
· Prefer working as part of a team	-39,86***	-12,36	-23,77**	-36,31***	-9,32	-25,42***	-42,14***	-21,17**	-37,20***
· A good listener	46,07***	40,28***	28,77**	36,23***	38,16***	16,60	56,04***	49,86***	46,73***
· Enjoy seeing success of others	25,99***	15,89	28,23*	22,84***	24,00**	11,02	33,06***	15,52	38,04**
· Feel like an outsider	-38,51***	-43,69***	-37,29***	-31,11***	-38,94***	-27,16**	-44,27***	-45,00***	-46,16***
· Feel like I belong at school	33,62***	22,79*	-2,20	32,58***	21,47*	-6,21	37,09***	12,01	2,74
No class skipped	49,02***	41,52***	35,28***	46,12***	36,19***	34,44***	42,92***	28,73**	37,04***
Ate breakfast before school	33,91***	-2,25	7,41	31,73***	6,11	3,96	30,82***	-1,46	2,82
Parent:									
Parental education									
- Don't have compulsory schooling									
· Mother	-46,72***	-13,33	-36,74***	-44,60***	-12,08	-29,42***	-50,22***	-18,29	-27,81**
· Father	-39,69***	-17,83	-52,93***	-39,51***	-12,63	-44,93***	-40,11***	-30,23**	-50,78***
- Parent have tertiary education									
· Mother	27,73***	11,81	29,32***	25,47***	9,78	24,79***	29,69***	11,29	25,44**
· Father	26,89***	18,99*	10,17	24,40***	17,18**	12,09	24,69***	16,21*	6,75
Parental occupational status									
- Mother									
· High	26,61***	0,00	26,57	24,79***	3,02	30,41***	24,19***	1,45	20,56
· Middle	0,76	21,99**	23,04*	0,53	12,49	16,19	2,92	10,85	14,59
· Low	-31,25***	-20,84**	-33,38***	-28,87***	-13,36	-28,96***	-31,49***	-11,02	-22,89*
- Father									
· High	40,98***	31,17**	33,49**	36,11***	24,25**	34,11***	38,69***	22,45*	39,59***
· Middle	-10,70***	-9,98	2,59	-9,02***	-2,62	-5,66	-10,01***	-9,64	2,72

Table 6.2 (*continued*)

T-test, diff = mean(1) - mean(0)	Science			Mathematics			Reading		
By ethnic group:	**Native**	**2nd gen. immigrant**	**1st gen. immigrant**	**Native**	**2nd gen. immigrant**	**1st gen. immigrant**	**Native**	**2nd gen. immigrant**	**1st gen. immigrant**
· Low	-31,83***	-12,44	-31,23**	-28,59***	-14,92	-23,96**	-30,17***	-6,46	-36,60***
School:									
Proportion certified teacher staff									
- High	7,45**	-17,02	21,88*	6,34**	-19,29*	23,67**	6,00*	-22,25*	18,53
- Middle	-2,39	11,13	-4,06	-6,14**	13,94	-9,11	-0,92	10,25	4,33
- Low	-7,63**	9,37	-23,66*	-2,15	9,65	-20,38*	-7,19**	15,38	-28,66**
Class size									
- High	4,97*	2,07	12,21	5,03**	4,45	10,41	10,44***	10,55	5,55
- Middle	-	-	-	-	-	-	-	-	-
- Low	-4,97*	-2,07	-12,21	-5,03**	-4,45	-10,41	-10,44***	-10,55	-5,55
Student-teacher ratio									
- High	14,63***	-7,37	13,58	10,15***	-7,72	7,18	18,92***	-6,52	11,81
- Middle	-9,33***	10,28	-9,76	-4,33*	8,55	-3,20	-10,08***	17,10	-3,60
- Low	-1,96	-6,28	-0,68	-4,18	-2,24	-2,76	-5,14	-21,32	-6,57
No class division by ability	6,28	20,55*	16,90	3,24	22,17**	21,21*	1,74	12,18	11,14
No within class-division by ability	7,03**	0,18	-0,35	11,17***	1,71	8,68	7,25**	-4,73	1,82
Report achievement data publicly	10,21***	-5,14	4,16	9,89***	-0,12	5,60	18,35***	-8,60	4,69
School climate									
- Staff capacity									
· High	6,36**	1,76	12,79	5,66**	-4,27	10,75	9,56***	0,11	26,64**
· Middle	-4,98*	9,25	-5,95	-4,00	13,09	-2,80	-6,77*	10,82	-13,36
· Low	-4,46	-8,52	-3,66	4,91*	-8,47	-2,55	-7,50**	-14,05	-7,50
- Student behaviour									
· High	9,46***	26,23**	13,33	9,34***	16,99*	10,96	9,78***	33,11***	10,36
· Middle	-8,09**	1,48	-2,47	-3,86	7,19	8,50	-8,77***	-6,20	-0,97
· Low	-3,76	-22,06**	-10,46	-7,67***	-18,50**	-16,55*	-3,49	-22,39**	-8,84
- Teacher behaviour									
· High	4,74	13,50	1,01	3,51	11,30	0,55	2,32	1,29	3,78
· Middle	-6,70**	3,55	19,69*	-6,49**	2,14	19,13**	-5,03	4,08	8,38

Table 6.2 (*continued*)

T-test, diff = mean(1) - mean(0)	**Science**			**Mathematics**			**Reading**		
By ethnic group:	**Native**	**2nd gen. immigrant**	**1st gen. immigrant**	**Native**	**2nd gen. immigrant**	**1st gen. immigrant**	**Native**	**2nd gen. immigrant**	**1st gen. immigrant**
· Low	2,09	-13,85	-17,78	3,34	-10,90	-16,87*	3,07	-4,49	-10,81

P-values: *** p < 0,01; ** p < 0,05; * p < 0,10

Upper bounds were set to bigger/equal than the 75th percentile value, while lower bounds were set to lower/equal than 25th percentile value. Followingly, the middle category was defined as values between the upper and lower bound. See Table A.2 in Annex A for details.

Table 6.2 shows the calculated mean difference between the two compared groups[28]. The reported difference was obtained by subtracting the mean score of a control group (=0) without the characteristic from the mean score of the group with a certain characteristic (=1). A t-test was employed for all cases, where the null hypothesis was specified as mean difference equal to zero, and the corresponding asterisk(s) show if, and at which significance level, the null-hypothesis was rejected. Furthermore, upper and lower bounds were obtained for both the quantitative and index variables, using the 75th percentile value as upper bound and 25th percentile value as lower bound[29]. The middle category was set as values between these two boundaries. These categories were followingly used to demonstrate the implications of upper, mid and lower values on mean scores across ethnic groups, and thus, allowed me to see the particular effects of specific data points.

Some of the descriptive variables were found to have a significant impact on student achievement. Firstly, female students performed much better in reading than male students across all ethnic groups, especially first-generation immigrants. Immigrant students that spoke Norwegian at home were surprisingly not found to perform significantly better than the ones who did not. This may indicate that language spoken at home was not an important determinant to explain student achievement, and more importantly, differences between native and immigrant students. Increasing community size was also found significantly positive for native students and second-generation immigrants, while irrelevant for first-generation immigrants. Oppositely, smaller school size was found significantly positive for first-generation immigrants, while negative for native students.

Lower socio-economic status (ESCS) was found significantly negative for student achievement across all groups, while increased levels also seemed to have positive effects on student achievement. The subindices to *home possessions* had varying results, where: 1) cultural items, educational resources and books at home were found significantly positive across all groups, and 2) ICT resources and wealth items were found negative across all groups, as the middle categories performed significantly better. Additionally, immigrants students were more frequently observed in the lower quartile and less frequently in the higher quartile, and thus confirmed that immigrants

[28] An additional table, Table D.1 in Annex D, includes the percentages of each ethnic group with the respective characteristics. A t-test was also employed to check whether the endowment differences were significant or not.

[29] Table A.2 in Annex A shows the boundary values for the variables where this methodology was applied.

experienced lower endowments on these scales (see Table D.1 in Annex D).

Interestingly, domain-specific study time were found to have negative implications on performance for all groups. This may indicate a miscorrespondance between what was tested in PISA 2015 and the national curricula. Another explanation could be that better students study less, but score higher, while students that struggle, study more, but still experience lower scores. The effects were found marginally weaker for first-generation immigrants than the other subgroups.

The students responded to several items regarding their motivations, qualities, and perceptions. Results indicate that students, across all groups, with a higher motivation experienced significantly higher scores. Particularly, ambition/competitiveness, educational and occupational expectations, and no absenteeism (in the last two weeks) were found highly conducive on student achievement. The students that experienced little emotional support from their parent(s) or had higher educational anxiety performed significantly worse. Furthermore, in the Norwegian context, the students that perceived themselves as good listeners, that enjoyed the success of others and felt a belonging to their school, experienced higher scores, while preferring teamwork and feeling like an outsider had negative implications on test scores. These effects were found marginally weaker for immigrant students. Native students that had eaten breakfast (on that day) also performed significantly better.

Parental education and occupation were found significantly positive for student achievement across all groups. The immigrant students' parents were also found to have significantly poorer parental background than native students (see Table D.1 in Annex D).

Results indicated that a higher proportion of certified teacher staff had a significant positive effect on student achievement for native and first-generation immigrant students, while negative for second-generation immigrants. Furthermore, native students with a high student-teacher ratio performed significantly better than the other native students. No clear indications were found for class division and reporting achievement data publicly, but no class (and within) division by ability was found significantly positive in some cases, and the same for reporting achievement data publicly. Additionally, better school climate, measured through staff capacity, student and teacher behaviour, was associated with higher scores across all groups. Immigrant students were also found to be hindered by adverse learning environments more frequently (see Table D.1 in Annex D).

This section has consolidated that the ethnic groups both experienced differences in endowments and returns. Additionally, immigrant students had in general worse endowments than native stu-

dents. Not only differences between native and immigrant students were found, but also internal differences between the immigrant categories, and thus, consolidating the separation of the two immigrant categories. Furthermore, female students were found to perform much better in reading. Socio-economic status (ESCS) were also found to have significant positive effects on achievement, and particularly cultural items, educational resources, and books at home, while both ICT resources and wealth items had significant negative effect on the students' performance. Both student motivation and ambition, as well as parental education and occupation, had significant positive effects on student achievement. Lastly, immigrant students experienced worse school climate than native students.

6.1.4 Missing values

This subsection includes an analysis of missing values in the PISA 2015 data. Missing values were systematically omitted in the econometric models, and thus, in the section for educational production functions and decomposition methods. Hence, considering the missing values, there could have been problems with bias, apart from losing possibly valuable information by dropping students, if the missing values were not occurring randomly.

A t-test was implemented for all variables used in this dissertation, in Table 6.3, to check whether the mean score differences between non-missing and missing values were significantly different from zero. The asterisk(s) indicated if, and at which, significance level the null hypothesis was rejected.

The highest percentages of the missing data were found for variables from the school questionnaire but significant differences were not found for these variables. However, for the variables obtained through the student questionnaire, significant negative differences were found, and thus, indicating a pattern in the students' responses. Nevertheless, the number of observations with missing values for these variables were small and should not disturb the results obtained too much.

Table 6.3: T-test, between missing and non-missing observations

T-test, diff = mean(1) - mean(0)	**% missing**	**Science**	**Mathematics**	**Reading**
Descriptive:				
- Gender	-	-	-	-
- Language at home	0,04%	35,99	9,76	64,46

Table 6.3 (*continued*)

T-test, diff = mean(1) - mean(0)	% missing	Science	Mathematics	Reading
- Community size	11,4%	-3,94	-3,31	-5,86
- School size	15,5%	-0,66	-2,24	-4,09
Student:				
Socio-economic status (ESCS)	0,6%	-64,49***	-57,70***	-91,45***
- Home possessions	0,02%	62,14***	51,36***	4,36***
· Cultural items	1,5%	-78,09***	-49,77***	-79,65***
· Educational resources	0,2%	-133,45***	-98,56***	-119,00***
· ICT resources	0,2%	-73,88	-66,21*	-86,60**
· Wealth items	0,1%	7,37	-0,53	-52,48
· Books at home	0,7%	-82,11***	-64,86***	-94,38***
Study hours outside of class				
- Science	12,8%	-55,09***	-47,62***	-63,79***
- Mathematics	12,4%	-55,73***	-48,62***	-65,70***
Subjective perceptions				
- Emotional support from parent(s)	0,4%	-85,50***	-86,75***	-112,50***
- Educational expectation	0,6%	-111,76***	-99,22***	-134,51***
- Educational anxiety	0,5%	-96,81***	82,44***	114,80***
- Ambition/competitiveness	0,7%	-110,66***	-88,43***	-130,57***
- Occupational expectation	19,0%	-5,93*	-4,71	-5,91*
- Student preference/characteristic				
· Prefer working as part of a team	1,1%	-91,78***	-84,59***	-96,11***
· A good listener	1,3%	-89,59***	-77,56***	-95,44***
· Enjoy seeing success of others	1,4%	-78,05***	-74,72***	-90,88***
· Feel like an outsider	1,0%	-110,87***	-96,34***	-122,69***
· Feel like I belong at school	1,6%	-77,84***	-69,92***	-79,82***
Class skipped	1,7%	-78,32***	-75,78***	-81,59***
Ate breakfast before school	4,4%	-72,86***	-55,06***	-87,22***
Parent:				
Parents' highest education	1,9%	-59,67***	-49,56***	-68,58***
Mother's highest education	2,4%	-57,55***	-47,53***	-64,49***
Father's highest education	4,3%	-53,42***	-45,81***	-54,22***
Parental occupational status				
- Mother	10,0%	-60,08***	-51,02***	-66,06***
- Father	11,6%	-59,94***	-52,06***	-62,08***
School:				
Proportion certified teacher staff	25,8%	-0,95	-1,71	-2,62
Class size	12,8%	-2,46	-1,85	-4,12
Student-teacher ratio	19,9%	-1,79	-3,31	-3,35
Class division by ability	19,7%	-0,60	-2,76	-0,18
Within class-division by ability	19,7%	-0,60	-2,76	-0,18
Report achievement data publicly	19,8%	-2,09	-4,92*	-3,60
School climate				
- Staff capacity	16,0%	0,27	-0,40	-1,21
- Student behaviour	19,0%	-1,55	-3,38	-1,42

Table 6.3 (*continued*)

T-test, diff = mean(1) - mean(0)	% missing	Science	Mathematics	Reading
- Teacher behaviour	19,0%	-1,55	-3,38	-1,42

P-values: *** p < 0,01; ** p < 0,05; * p < 0,10

6.2 Educational production functions

The preliminary results suggest some interesting relations between student achievement and various predictors. I will in this section perform several regression models, referred to as educational production functions (EPFs), to capture the individual effects of various predictors while controlling for variable dependencies and subgroups[30]. This could help predicting how the various factors explained student achievement. Firstly, a base model is estimated which only includes the individual effects of the two immigrant categories. In the second subsection, test scores are analysed and estimated independently towards the four variable groups: descriptive, student, parent and school. The final model includes all variables[31]. A t-test checking whether the estimated immigrant coefficients were equal, or not, was employed for all models. This was done to check the robustness of individual analysis of the two immigrant categories.

6.2.1 Base model

Table 6.4: Preliminary regression model, immigrant categories

Dependent variable:	Science		Mathematics		Reading	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Intercept	507,03***	(2,27)	508,95***	(2,33)	520,87***	(2,60)
Second-generation immigrant (β_0)	-43,49***	(5,73)	-36,19***	(6,10)	-21,21***	(6,72)
First-generation immigrant (β_1)	-60,90***	(6,61)	-50,21***	(6,75)	-62,37***	(8,09)

[30]The variables *socio-economic status (ESCS)* and *home possessions* were not included in the econometric models because their subcategories were included instead, and thus, omitted to avoid colinearity issues. *ICT resources* was also omitted to avoid colinearity between the sub-indices of *home possessions*.

[31]An additional final model, in Table E.1 in Annex E, was estimated to check the robustness of the results. The difference was that both quantitative and index variables were split into the upper and lower bounds defined in Table A.2. The estimation results consolidated the results obtained in the main final model (in Table 6.9).

N (observations)	5261	5261	5261
T-test, $\beta_0 = \beta_1$	1,98**	1,73*	4,01***
F-statistic	88,76***	77,95***	66,72***
R-squared	0,0327	0,0288	0,0247
Adjusted R-squared	0,0323	0,0284	0,0244

Standard errors in parentheses.
P-values: *** p < 0,01; ** p < 0,05; * p < 0,10

This section includes the estimation results for the base model. The estimated coefficients captured the unconditional effects of being immigrant as all other relevant variables were omitted.

The results in Table 6.4 confirmed my previous findings as both the estimated immigrant coefficients were significantly negative for student achievement. The negative effect of being a first-generation immigrant was significantly higher than the negative effect of being a second-generation immigrant. Furthermore, the estimated coefficients were also rejected for being equal, and thus, confirmed an existing difference between second-generation and first-generation immigrants.

6.2.2 Sub-group models

This section shows the results on four different educational production functions, divided into 1) descriptive variables (Table 6.5), 2) student variables (Table 6.6), 3) parent variables (Table 6.7) and 4) school variables (Table 6.8). Discussions for the individual predictors are more extensively elaborated for the final model in section 6.2.3.

Table 6.5: Educational production function, descriptive variables

Dependent variable:	**Science**		**Mathematics**		**Reading**	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Intercept	496,05***	(12,78)	499,30***	(13,21)	486,31***	(12,72)
Second-generation immigrant (β_0)	-43,87***	(8,99)	-34,78***	(7,80)	-21,47**	(9,31)
First-generation immigrant (β_1)	-49,46***	(8,90)	-40,83***	(8,60)	-52,28***	(9,39)
Female	-3,25	(3,04)	2,09	(2,70)	40,12***	(3,13)
Speak Norwegian at home	19,36**	(9,48)	17,00*	(9,04)	18,98**	(9,28)
Community size						
- Village	-20,66***	(7,22)	-16,89**	(7,43)	-26,36***	(7,98)
- Small town	-7,05	(5,07)	-3,98	(5,72)	-8,13	(6,45)

Table 6.5 (*continued*)

Dependent variable:	**Science**		**Mathematics**		**Reading**	
- City	12,64**	(6,37)	12,50	(7,65)	8,76	(7,69)
School size	-0,01	(0,02)	-0,01	(0,02)	0,01	(0,02)
N (observations)	4441		4441		4441	
T-test, $\beta_0 = \beta_1$	0,61		0,67		2,90***	
F-statistic	27,63***		24,32***		52,59***	
R-squared	0,0475		0,0420		0,0867	
Adjusted R-squared	0,0458		0,0403		0,0850	

Standard errors in parentheses.
P-values: *** p < 0,01; ** p < 0,05; * p < 0,10

The estimated immigrant coefficients were substantially reduced for first-generation immigrants, while no, or at best marginal reductions, were found for second-generation immigrants. This may indicate that the descriptive variables help in explaining the differences between native and first-generation immigrants. The immigrant coefficients were also only rejected for being equal in reading. Furthermore, being female was found to have a significant positive effect on student achievement in reading. The same was found for students that spoke Norwegian at home but for all three domains. Meanwhile, living in a *village* was found to have a significant negative impact on achievement.

Table 6.6: Educational production function, student variables

Dependent variable:	**Science**		**Mathematics**		**Reading**	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Intercept	419,66***	(10,91)	425,96***	(10,09)	426,65***	(11,42)
Second-generation immigrant (β_0)	-46,30***	(5,83)	-36,55***	(6,37)	-30,36***	(6,88)
First-generation immigrant (β_1)	-47,40***	(6,78)	-39,16***	(7,30)	-57,82***	(8,10)
Home possessions						
- Cultural items	5,25***	(1,61)	3,58**	(1,45)	5,25**	(2,22)
- Educational resources	3,42*	(1,79)	2,19	(1,61)	-4,49**	(1,78)
- Wealth items	-13,04***	(1,99)	-5,59**	(2,46)	-17,96***	(2,56)
- Books at home						
· More than 200 books	12,70***	(4,45)	15,38***	(5,02)	12,64***	(4,93)
· Less/equal than 100 books	-21,41***	(3,72)	-12,26***	(4,60)	-23,09***	(4,77)
Study time outside of class	-2,42***	(0,40)	-2,01***	(0,31)		
Subjective perceptions						
- Emotional support from parent(s)	-7,10***	(1,66)	-5,86***	(2,39)	-1,73	(1,82)

Table 6.6 (*continued*)

Dependent variable:	**Science**		**Mathematics**		**Reading**	
- Expect to complete tertiary education	19,32***	(3,45)	22,37***	(3,84)	34,32***	(4,29)
- Educational anxiety	-14,91***	(1,32)	-11,15***	(1,53)	-5,19***	(1,53)
- Ambition/competitiveness	8,22***	(1,55)	8,92***	(1,46)	8,90***	(1,77)
- Occupational expectation	1,06***	(0,10)	0,82***	(0,10)	0,96***	(0,10)
- Student preference/characteristic						
· Prefer working as part of a team	-17,36***	(3,19)	-17,49***	(3,10)	-22,31***	(3,56)
· A good listener	15,57***	(4,83)	7,88*	(4,43)	22,75***	(5,17)
· Enjoy seeing success of others	12,56***	(4,82)	12,80***	(4,61)	15,74***	(5,50)
· Feel like an outsider	-9,64**	(4,80)	-4,15	(5,21)	-18,22***	(5,20)
· Feel like I belong at school	4,45	(3,25)	6,42*	(3,48)	6,93*	(4,18)
No class skipped	25,27***	(4,23)	25,37***	(4,16)	16,24***	(4,35)
Ate breakfast before school	4,52	(4,19)	6,43*	(3,86)	3,87	(4,25)
N (observations)	3533		3546		3915	
T-test, $\beta_0 = \beta_1$	0,14		0,32		2,93***	
F-statistic	80,11***		75,77***		89,30***	
R-squared	0,3132		0,3006		0,3034	
Adjusted R-squared	0,3093		0,2966		0,3000	

Standard errors in parentheses.
P-values: *** p < 0,01; ** p < 0,05; * p < 0,10

The immigrant coefficients, in Table 6.6, were found different from the ones obtained in the base model. The first-generation immigrant coefficients were found substantially reduced, as in the previous sub model (Table 6.5), and the second-generation coefficients were found marginally increased and could indicate lower returns than native students. The immigrant coefficients were also only rejected for being equal in reading. Furthermore, R-squared was also found substantially higher here than in any of the other sub-models which furtherly implies that the student-variables were the better predictors to explain the variation in student achievement.

Various results were found for *home possessions*. Cultural items and books at home were found significantly positive for student achievement, while educational resources, and particularly wealth items, were found to have a strong negative impact on students. Domain-specific (in science and mathematics) study time outside of class were confirmed to have a negative relationship to test scores.

Meanwhile, for the subjective perceptions, variables such as ambition/competitiveness, educational and occupational expectations, and students that perceived themselves as good listeners and enjoyed the success of others, were all found significantly positive. On the other hand, emotional

support from parent(s), educational anxiety, preferring teamwork, and feeling like an outsider, were all found significantly negative on student achievement.

Lastly, the students that had not skipped any classes in the last two weeks, experienced significant positive effects on student achievement, while whether the students had eaten breakfast or not on the current day, was not found significant in most cases.

Table 6.7: Educational production function, parent variables

Dependent variable:	**Science**		**Mathematics**		**Reading**	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Intercept	447,91***	(5,50)	456,44***	(6,21)	466,60***	(5,85)
Second-generation immigrant (β_0)	-25,72***	(7,36)	-20,49***	(7,26)	-3,85	(8,89)
First-generation immigrant (β_1)	-32,07***	(8,37)	-26,22***	(8,49)	-32,10***	(9,60)
Parental education						
- Don't have compulsory schooling						
· Mother	-19,26**	(7,90)	-18,00**	(7,35)	-17,99**	(9,14)
· Father	-11,26	(7,39)	-15,50**	(6,97)	-17,07**	(7,92)
- Parent have tertiary education						
· Mother	2,84	(3,98)	2,45	(3,61)	6,20	(4,39)
· Father	0,20	(3,83)	0,31	(4,45)	-3,25	(3,91)
Parental occupational status						
- Mother	0,44***	(0,08)	0,41***	(0,07)	0,37***	(0,09)
- Father	0,79***	(0,09)	0,69***	(0,08)	0,78***	(0,09)
N (observations)	4221		4221		4221	
T-test, $\beta_0 = \beta_1$	0,60		0,59		2,22**	
F-statistic	48,47***		49,96***		40,43***	
R-squared	0,0843		0,0866		0,0713	
Adjusted R-squared	0,0826		0,0849		0,0695	

Standard errors in parentheses.
P-values: *** p < 0,01; ** p < 0,05; * p < 0,10

Both the estimated immigrant coefficients were substantially lower in this model than any of the others. This could imply that a significant proportion of the negative effects of being any of the two immigrant categories was highly captured through parental background. The immigrant coefficients were only rejected for being equal in reading.

Meanwhile, parental background, both education and occupational status, were found as expected to be significantly positive for student achievement. The results also indicated that assuring

compulsory schooling could be a more efficient instrument to improve student achievement than motivating tertiary education. Furthermore, the positive effect of increasing the fathers' occupational status was found almost twice as strong as for the mothers' occupational status.

Table 6.8: Educational production function, school variables

Dependent variable:	**Science**		**Mathematics**		**Reading**	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Intercept	466,55***	(15,49)	472,63***	(14,93)	460,69***	(20,36)
Second-generation immigrant (β_0)	-43,71***	(7,15)	-35,59***	(7,00)	-24,47***	(8,37)
First-generation immigrant (β_1)	-63,15***	(7,69)	-53,02***	(7,72)	-65,89***	(8,95)
Proportion certified teacher staff	5,02	(6,19)	0,11	(6,87)	-0,52	(7,59)
Class size	0,48	(0,56)	0,73	(0,59)	1,33*	(0,68)
Student-teacher ratio	1,29	(1,49)	0,64	(1,32)	1,36	(1,76)
No class division by ability	2,38	(5,86)	-1,02	(5,32)	0,48	(7,56)
No within class-division by ability	5,54	(6,15)	10,95**	(5,28)	4,83	(6,78)
Report achievement data publicly	5,87	(5,52)	5,75	(5,39)	13,46**	(6,84)
School climate						
- Staff capacity	8,36**	(3,73)	7,94**	(3,34)	11,35***	(4,13)
- Student behaviour	3,32	(3,61)	3,73	(3,51)	2,67	(3,93)
- Teacher behaviour	-3,88	(4,03)	-6,15	(3,90)	-4,64	(5,42)
N (observations)	3713		3713		3713	
T-test, $\beta_0 = \beta_1$	1,88*		1,85*		3,42***	
F-statistic	16,35***		17,70***		18,15***	
R-squared	0,0463		0,0500		0,0512	
Adjusted R-squared	0,0435		0,0471		0,0483	

Standard errors in parentheses.
P-values: *** p < 0,01; ** p < 0,05; * p < 0,10

The estimated immigrant coefficients were rejected for being equal across all domains. Furthermore, they were approximately equal as in the base model, and thus, indicating that the school variables didn't capture the adverse effect of being an immigrant.

The school variables were generally found less significant than the other predictors in the other sub-models, but increasing staff capacity was found significantly positive for student achievement. Class size, no within class-division by ability and reporting achievement data publicly were also found significantly positive, but not across all domains.

6.2.3 Final model

The final model included all variables and controlled for plausible dependencies between the predictors, and the estimated results are presented in Table 6.9:

Table 6.9: Educational production function, final model

Dependent variable:	**Science**		**Mathematics**		**Reading**	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Intercept	408,48***	(23,56)	399,17***	(25,03)	389,17***	(29,25)
Second-generation immigrant (β_0)	-31,93***	(10,49)	-22,43**	(9,06)	-20,04	(12,78)
First-generation immigrant (β_1)	-24,05***	(11,48)	-21,03*	(11,99)	-36,02***	(11,85)
Descriptive:						
Female	-13,94***	(4,07)	-7,05**	(3,59)	24,85***	(4,66)
Speak Norwegian at home	19,42*	(10,67)	15,81*	(9,34)	12,28	(10,89)
Community size						
- Village	-11,51	(7,32)	-4,67	(8,51)	-7,44	(8,37)
- Small town	-8,35	(5,18)	-4,24	(5,93)	-5,50	(6,84)
- City	13,45**	(6,59)	16,98**	(7,15)	5,67	(8,17)
School size	-0,01	(0,02)	-0,04	(0,02)	0,01	(0,03)
Student:						
Home possessions						
- Cultural items	6,15***	(1,82)	4,30**	(1,89)	4,53**	(2,26)
- Educational resources	-1,05	(2,15)	-0,61	(2,01)	-5,38***	(2,02)
- Wealth items	-16,74***	(2,55)	-8,26***	(2,69)	-20,49***	(3,34)
- Books at home						
· More than 200 books	12,12**	(5,40)	13,93**	(5,99)	10,56*	(6,03)
· Less/equal than 100 books	-22,47***	(5,15)	-11,95**	(5,79)	-25,75***	(5,93)
Study time outside of class	-2,85***	(0,43)	-2,11***	(0,37)		
Subjective indices						
- Emotional support from parent(s)	-6,82***	(1,91)	-5,28**	(2,64)	-4,94**	(2,12)
- Expect to complete tertiary education	22,25***	(4,41)	23,60***	(4,23)	25,26***	(5,43)
- Educational anxiety	-13,90***	(1,97)	-10,50***	(1,95)	-10,54***	(2,11)
- Ambition/competitiveness	8,38***	(2,16)	8,38***	(1,90)	9,63***	(2,20)
- Occupational expectation	0,80***	(0,12)	0,64***	(0,12)	0,72***	(0,13)
- Student preference/characteristic						
· Prefer working as part of a team	-18,11***	(3,88)	-18,16***	(3,86)	-18,69***	(4,34)
· A good listener	14,64**	(6,00)	5,83	(5,10)	15,85**	(6,41)
· Enjoy seeing success of others	14,50**	(6,10)	13,96**	(5,83)	14,50**	(6,68)
· Feel like an outsider	-3,85	(6,37)	-0,56	(6,26)	-8,89	(6,52)
· Feel like I belong at school	5,51	(4,75)	8,18*	(4,72)	8,92*	(5,38)
No class skipped	26,61***	(5,64)	27,90***	(5,56)	19,14***	(5,21)
Ate breakfast before school	5,16	(5,75)	6,40	(4,85)	3,67	(5,68)
Parent:						

Table 6.9 (*continued*)

Dependent variable:	**Science**		**Mathematics**		**Reading**	
Parental education						
- Don't have compulsory schooling						
· Mother	-18,62*	(10,70)	-12,03	(9,69)	-18,64	(12,05)
· Father	-8,72	(9,88)	-8,79	(10,18)	-6,30	(9,44)
- Parent have tertiary education						
· Mother	-5,18	(4,30)	-2,26	(4,22)	-1,63	(5,13)
· Father	-5,38	(5,00)	-4,91	(4,95)	-9,86**	(5,20)
Parental occupational status						
- Mother	0,02	(0,10)	0,03	(0,09)	0,04	(0,10)
- Father	0,48***	(0,10)	0,38***	(0,10)	0,51***	(0,10)
School:						
Proportion certified teacher staff	0,09	(0,07)	0,04	(0,07)	0,02	(0,08)
Class size	-0,93*	(0,49)	-0,27	(0,51)	-0,01	(0,63)
Student-teacher ratio	0,52	(1,33)	1,15	(1,25)	-0,03	(1,70)
No class division by ability	7,27	(4,93)	1,84	(5,36)	4,59	(7,45)
No within class-division by ability	3,80	(4,69)	8,65**	(4,15)	5,15	(6,08)
Report achievement data publicly	1,09	(4,87)	3,05	(5,14)	7,10	(5,96)
School climate						
- Staff capacity	3,13	(3,42)	3,78	(3,46)	6,05*	(3,55)
- Student behaviour	6,19**	(3,02)	5,99**	(2,95)	4,49	(3,47)
- Teacher behaviour	-6,89**	(3,36)	-8,97***	(3,56)	-5,99	(4,60)
N (observations)	2110		2134		2327	
T-test, $\beta_0 = \beta_1$	0,75		0,12		1,18	
F-statistic	26,37***		25,47***		29,12***	
R-squared	0,3433		0,3329		0,3374	
Adjusted R-squared	0,3302		0,3199		0,3258	

Standard errors in parentheses.
P-values: *** p < 0,01; ** p < 0,05; * p < 0,10

The F-statistics indicated that the models were suitable and that the variables were jointly significant on the 1% significance level. The R-squared for science was 34,33%, 33,29% for mathematics and 33,74% for reading, and thus, the included variables explained approximately one third of the variation in student achievement on all domains. Meanwhile, significant differences were not found between the estimated immigrant coefficients on any of the domains, and thus, a difference between the effect of being second-generation and first-generation immigrant was rejected. The estimated coefficients were also significantly lower than in the base model and suggest that the included variables captured a significant proportion of the adverse effect of being an immigrant.

Regarding the predictors, female students were found to perform significantly worse in both sci-

ence and mathematics, while much better in reading (24,85 points). Rangvid (2007) and Stoet and Geary (2013) also found that female students performed better in reading. Speaking Norwegian at home was also found significantly positive and Norwegian language instruction that assure Norwegian proficiency (and as language at home) could be implemented to increase student achievement. Meanwhile, students living in *cities* were found to perform significantly better, while school size was not found significant for student achievement.

The final model provided similar results as in the sub-model for the student variables for *home possessions*. Hence, the final results suggest that cultural items and books at home are significantly positive for student achievement, while significant negative effects were found for educational resources and wealth items. This could consolidate that particular items, like for example computers, televisions, tablets and smartphones, have a distracting and negative effect on students' learning.

Domain-specific study time outside of class (in hours) were confirmed to have a negative impact on their achievement in their respective domain. However, study time *should* be positive on students' performance, and the results may indicate a miscorrespondance between what is measured in PISA 2015 and the national curricula, as well as that the better students score higher despite studying less, and vice versa for students that struggle.

The estimation results for the subjective perceptions were found similar to the ones in sub-model (in Table 6.6). Results suggest that cultivation of student ambition, expectations and motivation can be effective instruments that positively enhances student achievement. Meanwhile, assuring healthy learning environments that reduce educational anxiety and prevents student absenteeism are also factors that can increase student achievement. Furthermore, results may indicate that Norwegian students benefit from individualistic behaviour as students that received less emotional support and/or didn't prefer working as part of a team performed significantly better than the ones that did. Since these characteristics are behavioural traits, they should be addressed accordingly, and thus, the Norwegian education system should advocate which moral and ethics that should be rewarded and preferred, and not. Additionally, the students that perceived themselves as good listeners and enjoyed the success of others were found to perform significantly better.

Parental background was found significantly positive for the students' performance. Students with parents that did not have compulsory schooling performed significantly worse, while parent(s) with tertiary education had marginal negative effects on student achievement, but not significant.

Nonetheless, considering occupational status, fathers' occupation were found to be significantly more positive for student achievement than mothers' occupation.

Few school variables were found significant, however, results suggests that improving school climate and learning environments, through better staff capacity and student behaviour, can increase student achievement, while better teacher behaviour, surprisingly, was found to have a negative impact on student achievement. The latter may correspond to other results that indicated that individualistic behaviour enhanced student achievement.

I have in this section analysed the impact of various factors on student achievement. The estimated immigrant coefficients were still found significantly negative after including all the predictors and indicate either the existence of omitted variables and/or inherent negative effects of being an immigrant. Speaking Norwegian at home was also found to be conducive for the students' performance while varying results were found for *home possessions* where increasing books and reducing wealth items at home seemed most efficient to improve student achievement. Meanwhile, cultivating the students' ambitions, expectations and motivations were found to have a significant positive impact on student achievement, while preventing educational anxiety and student absenteeism also could be highly conducive for students. Parental background, particularly increasing the fathers' occupational status, was also found to have a significant positive impact. Results also suggested that improved school climate could have a positive effect on student achievement.

6.3 Decomposition methods

This section includes decomposition results between 1) natives and second-generation immigrants, and 2) natives and first-generation immigrants[32]. The total test score gap was first obtained by estimating two individual educational production functions, as the final model in the previous section. The estimated gap was then decomposed by two different decomposition techniques, where 1) decomposed the total test score gap into a characteristic effect, a return effect, and an interaction effect, and 2) an explained part and an unexplained part. Decomposition results for individual predictors and variable groups were also included for the second methodology.

[32]Table F.1, in Annex F, includes the decomposition results between the two immigrant groups but few significant results were obtained. Nevertheless, the interaction effect was found significant across all domains, and thus, indicates that the primary concern of the estimated gap was differences in both endowment and returns, existing simultaneously, rather than the individual effects.

Table 6.10: Blinder-Oaxaca decomposition, between natives and second-generation immigrants

	Science			Mathematics			Reading		
	Coeff.	**S.E.**	**% of gap**	**Coeff.**	**S.E.**	**% of gap**	**Coeff.**	**S.E.**	**% of gap**
Total test score gap	37,99***	(9,76)		28,06***	(9,23)		16,47	(10,81)	
- Characteristic effect	-6,09	(16,97)	-16,0%	-9,12	(14,77)	-32,5%	-33,30*	(18,91)	-202,2%
- Return effect	32,87**	(13,04)	86,5%	21,93*	(11,22)	78,2%	18,11	(13,42)	110,0%
- Interaction effect	11,22	(19,15)	29,5%	15,25	(15,64)	54,3%	31,67	(19,89)	192,3%
Total gap:									
- Explained	6,87	(7,83)	18,1%	5,82	(7,22)	20,7%	-2,39	(8,12)	-14,5%
· Descriptive variables									
- Female	-0,32	(0,71)	-0,8%	-0,22	(0,38)	-0,8%	0,40	(1,15)	2,4%
- Speak Norwegian at home	10,99*	(6,12)	28,9%	8,33*	(5,06)	29,7%	8,03	(5,90)	48,8%
- Community size	-9,97***	(3,55)	-26,2%	-9,10**	(3,56)	-32,4%	-6,24	(3,91)	-37,9%
- School size	0,83	(1,79)	2,2%	2,98	(1,82)	10,6%	-0,90	(2,32)	-5,5%
· Student variables									
- Home possessions	3,30	(2,16)	8,7%	3,21*	(1,81)	11,4%	2,45	(2,39)	14,9%
- Study time outside of class	2,90**	(1,23)	7,6%	3,22***	(1,14)	11,5%			0,0%
- Subjective perceptions	-9,95***	(2,79)	-26,2%	-9,06***	(2,51)	-32,3%	-12,02***	(2,90)	-73,0%
- No class skipped	1,39	(0,86)	3,7%	1,33	(0,90)	4,7%	0,56	(0,55)	3,4%
- Ate breakfast at home	0,04	(0,26)	0,1%	-0,01	(0,26)	0,0%	0,03	(0,18)	0,2%
· Parent variables									
- Parental education	1,04	(1,70)	2,7%	0,87	(1,44)	3,1%	1,21	(1,67)	7,3%
- Parental occupational status	4,19**	(1,84)	11,0%	3,09*	(1,61)	11,0%	3,82**	(1,68)	23,2%
· School variables	2,43	(1,91)	6,4%	1,18	(1,88)	4,2%	0,28	(2,15)	1,7%
- Unexplained	31,12***	(11,10)	81,9%	22,24**	(9,60)	79,3%	18,86	(13,12)	114,5%
N (observations)									
- Natives		1906			1926			2098	
- Second-generation immigrants		121			124			133	

Standard errors in parentheses.
P-values: *** p < 0,01; ** p < 0,05; * p < 0,10

Table 6.10 displays the decomposition results obtained between natives and second-generation immigrants[33]. The estimated score gap was found significant for science and mathematics.

The characteristic effect was found significantly negative in reading, and thus, indicating that with the native students' endowments, given the second-generation immigrants' returns, would perform 33,3 score points worse. On the other hand, the return effect was found significantly positive in both science and mathematics and indicates that second-generation immigrants, given the native students' endowments, would perform 32,87 points better in science and 21,93 points better in mathematics. The interaction effect was not found significant for any of the domains.

The second technique allowed me to see how much individual predictors contributed to explaining the differences between native and second-generation immigrant students' achievement. Even with the estimated final model, a substantial amount of the differences remained unexplained. Nonetheless, a significant proportion of the gap was explained by differences in the number of students that spoke Norwegian at home, study time outside of class and parental occupational status. On the other hand, differences in community size and subjective perceptions were found to significantly increase the gap between native and second-generation students.

Table 6.11, on the next page, displays the decomposition results between native and first-generation immigrant students. The results consolidated a substantial score gap between the two ethnic groups.

Furthermore, only the return effect (for reading) was found significant and indicated that 65,1% reduction of the estimated gap would occur if first-generation immigrants experienced the same returns to the educational inputs, given their own endowments. The other effects were not found significant, but results indicate that the interaction effect accounted for the biggest differences between the two ethnic groups.

Almost half of the gap in science (49,97 score points) and mathematics (41,63 score points) was explained by the estimated model. On the other hand, 80% of the gap in reading remained unexplained. Furthermore, results suggest that differences in home possessions, student absenteeism, and parental occupational status (in reading) helped to explain the underachievement of first-generation immigrant students. Substantial differences were explained by differences in the number of students that spoke Norwegian at home, but the results were not found significant.

[33]The school variables were not decomposed on a variable level in any of the models because results had already indicated a low significance for these variables.

Table 6.11: Blinder-Oaxaca decomposition, between natives and first-generation immigrants

	Science			Mathematics			Reading		
	Coeff.	**S.E.**	**% of gap**	**Coeff.**	**S.E.**	**% of gap**	**Coeff.**	**S.E.**	**% of gap**
Total test score gap	49,97***	(10,40)		41,63***	(11,10)		47,54***	(11,43)	
- Characteristic effect	-8,18	(26,10)	-16,4%	0,14	(25,06)	0,3%	-23,09	(26,07)	-48,6%
- Return effect	22,10	(16,83)	44,2%	17,33	(14,32)	41,6%	30,94*	(15,97)	65,1%
- Interaction effect	36,05	(31,18)	72,1%	24,15	(27,75)	58,0%	39,68	(28,78)	83,5%
Total gap:									
- Explained	22,72*	(11,91)	45,5%	20,35*	(10,50)	48,9%	9,53	(10,83)	20,1%
· Descriptive variables									
- Female	0,37	(0,58)	0,8%	0,24	(0,30)	0,6%	-1,38	(0,91)	-2,9%
- Speak Norwegian at home	12,37	(10,04)	24,7%	12,52	(8,86)	30,1%	7,27	(9,55)	15,3%
- Community size	-3,13	(1,94)	-6,3%	-2,86	(1,79)	-6,9%	-1,16	(1,26)	-2,4%
- School size	0,12	(0,50)	0,2%	0,29	(0,89)	0,7%	-0,10	(0,41)	-0,2%
· Student variables									
- Home possessions	4,76*	(2,52)	9,5%	3,87**	(1,92)	9,3%	2,51	(2,52)	5,3%
- Study time outside of class	2,05	(1,32)	4,1%	1,32	(1,20)	3,2%			0,0%
- Subjective perceptions	-2,45	(3,59)	-4,9%	-2,67	(3,10)	-6,4%	-4,59	(3,39)	-9,7%
- No class skipped	3,68**	(1,57)	7,4%	4,06**	(1,69)	9,8%	2,84**	(1,20)	6,0%
- Ate breakfast at home	0,49	(0,51)	1,0%	0,55	(0,51)	1,3%	0,26	(0,39)	0,5%
· Parent variables									
- Parental education	0,65	(1,30)	1,3%	0,36	(0,98)	0,9%	0,92	(1,18)	1,9%
- Parental occupational status	2,88	(2,03)	5,8%	2,65	(1,90)	6,4%	3,17*	(1,85)	6,7%
· School variables	0,93	(1,38)	1,9%	0,02	(1,48)	0,1%	-0,20	(1,48)	-0,4%
- Unexplained	27,25**	(13,16)	54,5%	21,27	(13,59)	51,1%	38,01***	(12,95)	80,0%
N (observations)									
- Natives		1906			1926			2098	
- First-generation immigrants		83			84			96	

Standard errors in parentheses.
P-values: *** p < 0,01; ** p < 0,05; * p < 0,10

6.4 Summary

I have in this dissertation researched student achievement in Norway and compared native and immigrant students. Results indicated that immigrant students, and particularly first-generation immigrants, performed worse on PISA 2015. Differences were also found between second-generation and first-generation immigrant students and confirmed that the separation of the immigrant categories was convenient.

The results of this dissertation have helped to answer the preliminary research questions and hypotheses. The following was found:

Q1: *Which factors are important for student achievement in Norway?*

Immigrant category, socio-economic status, student motivation and expectations, and parental background were found to be the most important factors to explain student achievement. More specifically, the following was found for the main hypotheses for Q1:

H1a: *"Demographic differences, i.e. descriptive variables such as gender, community size, and school size, are expected to only have a small impact on student achievement, while language spoken at home, and specifically speaking Norwegian at home, is expected to be conducive for student achievement."*

Demographic differences were found to have a significant impact on student achievement. Female students were found to perform significantly better in reading, while worse in science and mathematics. Varying results were found for community sizes, but students living in *cities* were found to perform significantly better. School size was not found significant. Results suggest that speaking Norwegian at home has a significant positive effect on student achievement.

H1b: *"Student-related variables are expected to have a significant impact on student achievement. Socio-economic status, study time outside of class and student motivation are expected to be particularly positive on the students' test scores."*

Socio-economic status, which primarily was captured through home possessions among the student variables was found significantly positive for student achievement. Results suggested that cultural items and books at home had strong positive effects for students, while significant negative effects were found for educational resources and wealth items. This may be

due that household items such as computers, tablets, televisions, and smartphones have a distracting effect on students' learning.

Study time outside of class was found, surprisingly, significantly negative on student achievement. This contradicted both my hypothesis and the general consensus that studying improves performance. Nonetheless, the result may be due to a miscorrespondance between what was tested in PISA 2015 and the national curricula, as well as that better students study less and score higher, while students that struggle, study more, but still score lower. This could also imply that homework has a marginally negative effect on students.

Student motivation, ambition, and expectations were found particularly positive for student achievement. The students that had higher educational and occupational expectation, and ambitions scored significantly better, while students with educational anxiety and absenteeism performed significantly worse. Personal traits such as being a good listener, enjoying the success of others were found positive for student achievement, while the students that preferred working as part of a team and received more emotional support from their parent(s), performed significantly worse. This latter effect may indicate that individualistic behaviour pays off.

H1c: *"Parental education and occupation are expected to have a significant positive impact on student achievement."*

Increasing the students' parents education was generally found to significantly raise their achievement. Parent(s) that did not have compulsory schooling was particularly found to have an adverse effect on the students' achievement. Hence, policies that ensure compulsory schooling for the students' parents can be conducive for the students. That the parents had a tertiary education was also found to be significantly positive for student achievement, but with smaller effects than compulsory schooling. Similar results were found for the parents' occupational status, as better jobs were associated with higher student achievement. The fathers' occupations also seemed to be more important for student achievement than mothers' occupational status.

H1d: *"The school variables are expected to have marginal effects on student achievement."*

School variables were generally found to have either marginal or no significant impact on student achievement. Nevertheless, results suggested that school climate matters and that

improving staff capacity and learning environments could have a significant positive effect on student achievement.

Q2: *Which factors are important for explaining differences in achievement between native and immigrant students?*

Significant differences were found between native and immigrant students but also between the two immigrant groups. Results indicated that the ethnic groups both reacted differently to educational inputs as well as experienced different endowments. These two effects, the characeristic and return effect, had significant implications for their respective achievement. The Blinder-Oaxaca decomposition also showed that the return effect accounted for around 80% of the gap between natives and second-generation immigrants in science and mathematics, while the characteristic effect indicated that the gap would double if second-generation students experience the same endowments as natives, given their own estimated returns. The return effect accounted for 65,1% of the gap (in reading) between natives and first-generation immigrants. The interaction effect was found significant across all domains between the two immigrant groups. Considering the predictors, the following results were found for the four main hypotheses:

H2a1: *"The endowments of language at home, and student and parent variables are expected to explain differences between native and immigrant students, particularly socio-economic status."*

Significantly fewer immigrant students, particularly first-generation immigrants, spoke Norwegian at home. Considering the positive effect of doing this, it can be expected that this had a negative impact on the immigrant students' achievement. The decomposition methods also consolidated that a substantial proportion of the estimated gap was due to differences in the number of students that spoke Norwegian at home.

Meanwhile, significant endowment differences were found for the student variables. Firstly, immigrant students, and particularly first-generation immigrants, had worse endowments than native students for home possessions. This was also found to explain a significant proportion of the gap between the ethnic groups. Considering the effects on student achievement, immigrants were favorably endowed with respect to wealth items but experienced significant negative effects through their lower endowments for cultural items and books at home.

Immigrant students were also found to study significantly more than native students at home. However, considering the negative effect that was found for this, it can also be expected that this had more negative implications for immigrant students' achievement than for native students. These differences were also found to explain a marginal proportion of the estimated gap between native and immigrant students.

Furthermore, for the subjective perceptions, second-generation immigrants experienced significant positive effects through higher educational and occupational expectations, and ambitions. Relative to native students, first-generation immigrants also experienced these positive effects for educational expectation and ambition/competitiveness. On the other hand, immigrant students experienced significant negative effects from having more educational anxiety than native students. Furthermore, fewer first-generation immigrants had not skipped any classes during the last two weeks and considering the significant positive effect that this had, it can also be expected that this had negative effects on their achievement. The overall effect of differences in subjective perceptions was found to significantly increase the gap between native and immigrant students. On the other hand, differences in student absenteeism were found to help explain the estimated gap between them.

H2a2: *"The endowments of descriptive and school variables, except language at home, are not expected to explain differences between native and immigrant students."*

Gender was found to have a significant impact on student achievement, however, considering that the ethnic groups were gender-balanced, it was irrelevant for explaining achievement differences between the ethnic groups. This was also consolidated by the decomposition method. Immigrant students, and particularly second-generation immigrants, lived in *cities* more frequently, and thus, benefit from the significant positive effect that was found for this demographic characteristic. The decomposition results also indicated that the differences between native and immigrant students in community size significantly increased the estimated gap, particularly for second-generation immigrants. School size was found irrelevant for achievement differences between the ethnic groups.

Second-generation immigrant students had different endowments for the school variables compared to the two other ethnic groups. Nevertheless, both immigrant groups experienced worse school climate through staff capacity and student/teacher behaviour, and consider-

ing their significant positive effects, it could be expected a negative impact on immigrants' achievement. This was furtherly consolidated in the decomposition method, as school variables helped to explain the gap between natives and immigrants, but the results were not significant.

H2b1: *"Native students are expected to have better returns than immigrant students."*

The Blinder-Oaxaca decomposition found that the estimated gap between natives and both immigrant group would have been significantly reduced if they experienced the same estimated returns as native students, given their own endowments, but not across all domains. This was an important finding, as other results suggested that endowment differences could be the primary cause of immigrants' underachievement.

Furthermore, considering the effects that were found in the educational production function, unconditional effects of various predictors were also found through t-tests in Table 6.2. The results here suggested that native students experienced significantly higher returns for living in *cities*, while substantial significant negative effects for living in *villages* were found for second-generation immigrants.

Results also suggested that immigrant students, in particular, second-generation immigrants, experienced significantly lower positive effects from *home possessions*, relative to other ethnic groups. Other examples of this were found for the subjective perceptions where immigrant students usually seemed to experience worse returns than native students.

Parental background, measured through education and occupational status, was also found to give lower returns for immigrant students, particularly second-generation students.

Few particularities were found among the school variables. However, immigrant students seemed to benefit more from not dividing classes by ability, while student behaviour seemed to have a stronger impact on student achievement for the immigrant categories.

7 Conclusions

This dissertation had two main purposes where the first was to explain student achievement in Norway, and secondly to explain achievement differences between native and immigrant students. Results indicate that these topics were successfully addressed.

The most important predictors that determined student achievement were gender, language spoken at home, socio-economic status (measured through home possessions and parental background), study time outside of class, subjective perceptions, student absenteeism and school climate. Furthermore, speaking Norwegian at home, living in a city, home possessions such as cultural items and books, educational and occupational expectation, ambition/competitiveness, zero absenteeism (the last two weeks), staff capacity, student behaviour, and that students perceived themselves as good listeners and enjoyed success of others, were found to have a significant positive effect on student achievement. On the other hand, home possessions such as educational resources, ICT resources, and wealth items, domain-specific study time outside of class, emotional support from parent(s), educational anxiety, preferring teamwork, feeling like an outsider, and parent(s) not having compulsory schooling had significant negative impacts on student achievement.

The educational processes of native and immigrant students were also found significantly different. Additionally, differences between the immigrant groups were also found. Figure 3.1 displays a substantial and persisting gap between native students and both immigrant categories ranging from 2000 to 2015. The PISA 2015 gap was furtherly elaborated through two main channels: 1) endowments, and 2) returns. Considering the first channel, the most important predictors that explained and reduced the gaps between the ethnic groups were the language spoken at home, home possessions, study time outside of class, student absenteeism, and school climate. On the other hand, immigrant students experienced a more favourable endowment for where they lived and for the subjective perceptions, and thus, these variables significantly increased the gaps between native and immigrant students, particularly for second-generation immigrants. Considering the second channel, the decomposition results indicated that second-generation immigrants would perform significantly better in science and mathematics if they experienced the same estimated returns as native students, while the same was found for first-generation immigrants in reading. The same results were found for the other domains, but the results were not found significant. Lastly, the

estimated gaps between the two immigrant categories were explained by significant interaction effects, which measures how much of the estimated gap that is due to simultaneous differences in both endowments and returns.

These results have given useful insights on education dynamics that were important to both explain student achievement in Norway and differences between native and immigrant students. The main syntheses of this dissertation can help Norwegian policy-makers to ensure improved educational achievement and social cohesion. The results suggest that Norwegian language instruction would increase immigrant students performance significantly. Another instrument could be assuring equity for home possessions, in particular, cultural items and books, through a higher emphasis on these sort of household items, or alternatively, at a minimum, ensure free public access to those types of items. Oppositely, focus should be removed from wealth items and ICT resources (e.g. tablets, smartphones, televisions, cars, and computers) as they had adverse effects on students. A negative relationship was found between study time outside of class and student achievement. A plausible suggestion would be to enable schools to help the students directly, and thus, ensuring that students get proper assistance and don't need to study at home, could prove beneficial. Additionally, preventing educational anxiety and ensuring healthy school environments could contribute to raising students' expectation, motivations, and reduce absenteeism which followingly will improve student achievement. Student achievement was also significantly affected by parents' education and occupation. Ensuring that parents acquire compulsory schooling, which primarily lacked among immigrant students' parents, would increase achievement and reduce the gap between the ethnic groups. Followingly, assuring higher education could improve the chances of getting better jobs, and thus, increase the parents' occupational status, which would improve student achievement even further. Lastly, ensuring that schools have adequate staff capacity and healthy learning environments, through student and teacher behaviour, would also improve student achievement.

The PISA study provides great research potential, however, some limitations are worth mentioning. Firstly, one of the primary objectives of PISA is to measure international student achievement, and thus, the results should be internationally comparable and representative. However, as PISA 2015 was the sixth assessment, it can be expected that previous results have had implications for educational policies. As an example, my literature review mentions that some of the Norwegian education reforms partially came as a response to poor results on PISA, and thus, a certain bias on

PISA achievement cannot be rejected. Hence, caution should be taken when inferring the results on PISA to education and social systems. Furthermore, the scales and measurability used in PISA are not necessarily the same as in the national curricula. This was also indicated in my dissertation as I found that more study time was associated with poorer results on PISA 2015. Another relevant discussion is whether schools sort resources according to students needs and achievement, or not. This is problematic because of diversity in the skill distribution within the student population, as a "good" student may need fewer resources to perform well, and oppositely for "bad" students.

A future extension of the analyses done in this dissertation could be investigating why, and how, certain descriptive variables, particularly gender and community size, determined differences in student achievement and between ethnic groups. Other topics that were not covered here were the cost and efficiency of the educational inputs in the Norwegian education system. In a policy perspective, these economic measurements should be compared towards the achievement effects that were found in this dissertation. Lastly, this type of analysis could have been applied to any categorical variable, for both within and cross-country analysis purposes. In the first case, categorisation could have been determined by other decompositions of the population (e.g. rural vs urban areas, private vs public schools, school sizes, etc.). For cross-country analysis, the achievement could have been furtherly elaborated dependent on a categorisation determined by macroeconomic indicators like GDP per capita or other qualitative variables (e.g. main religion of the country, continent, political regime, etc.).

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Annex A: Variable explanations

Table A.1: Indicators for home possessions (*homepos*) for Norway, PISA 2015

Description	**Data (OECD)**	**Items used to measure index**				
		homepos	***cultposs***	***hedres***	***ictres***	***wealth***
A desk to study at	*st011q01ta*	x		x		
A room of your own	*st011q02ta*	x				x
A quiet place to study	*st011q03ta*	x		x		
A computer for school work	*st011q04ta*	x		x		
Educational software	*st011q05ta*	x		x	x	
A link to the Internet	*st011q06ta*	x			x	x
Classic literature (e.g. Shakespeare)	*st011q07ta*	x	x			
Books of poetry	*st011q08ta*	x	x			
Works of art (e.g. paintings)	*st011q09ta*	x	x			
Books to help with the school work	*st011q10ta*	x		x		
Technical reference books	*st011q11ta*	x		x		
A dictionary	*st011q12ta*	x		x		
Books on art, music, or design	*st011q16ta*	x	x			
Tablets (e.g. iPad)	*st011q17ta*	x				x
iPhone	*st011q18ta*	x				x
Televisions	*st012q01ta*	x				x
Cars	*st012q02ta*	x				x
Rooms with a bath or shower	*st012q03ta*	x				x
Cell phones with Internet access	*st012q05na*	x			x	x
Computer	*st012q06na*	x			x	x
Tablet computers (e.g. BlackBerry)	*st012q07na*	x			x	x
E-book readers (e.g. Kindle)	*st012q08na*	x			x	x
Musical instruments	*st012q09na*	x	x			
Books at home	*st013q01ta*	x				

See OECD (2017), p. 300-305, for further details.

Table A.2: Upper and lower bounds for the quantitative and index variables

Variable description	**Data (OECD)**	**P75**	**P25**
Descriptive:			
School size	*schsize*	437	248
Student:			
Socio-economic status (ESCS)	*escs*	1,028	0,0088
- Home possessions	*homepos*	1,0993	0,1828
· Cultural items	*cultposs*	0,7777	-0,5975
· Educational resources	*hedres*	1,1563	-0,4081
· ICT resources	*ictres*	0,9104	0,1321
· Wealth items	*wealth*	1,0295	0,1004
Study time outside of class			
- Science	*st071q01na*	4	1
- Mathematics	*st071q02na*	5	2
Subjective perceptions			
- Emotional support from parent(s)	*emosups*	1,0991	-0,889
- Educational anxiety	*anxtest*	0,6571	-0,6079
- Ambition/competitiveness	*motivat*	0,8101	-0,5996
- Occupational expectation	*bsmj*	72	46
Parent:			
Parental occupational status			
- Mother	*bmmj1*	71	31
- Father	*bfmj2*	71	29
School:			
Proportion certified teacher staff	*proatce*	1	0,9143
Class size	*clsize*	23	28
Student-teacher ratio	*stratio*	11,4359	8,9811
School climate			
- Staff capacity	*staffshort*	0,5736	-0,5078
- Student behaviour	*stubeha*	0,3334	-0,3058
- Teacher behaviour	*teachbeha*	-0,2229	-0,9807

Annex B: Standard deviations

Table B.1: Variable standard deviations, PISA 2015

Variable S.D.	Natives	2nd generation immigrants	1st generation immigrants
Test Scores:			
Science	94,29	91,54	93,33
Mathematics	83,42	80,44	83,39
Reading	96,90	91,60	103,84
Descriptive:			
Female	0,50	0,50	0,50
Speak Norwegian at home	0,14	0,50	0,44
Community size			
- Village	0,41	0,17	0,37
- Small town	0,47	0,38	0,46
- Town	0,45	0,46	0,45
- City	0,38	0,50	0,44
School size	143,66	173,07	155,90
Student:			
Socio-economic status (ESCS)	0,69	0,79	0,94
- Home possessions	0,75	0,72	0,91
· Cultural items	1,06	0,98	0,99
· Educational resources	0,93	0,89	1,03
· ICT resources	0,81	0,90	0,90
· Wealth items	0,79	0,76	0,82
· Books at home			
- More than 200 books	0,47	0,33	0,35
- Between 100 and 200 books	0,42	0,35	0,28
- Less/equal than 100 books	0,50	0,44	0,42
Study hours outside of class			
- Science	4,18	5,04	6,07
- Mathematics	4,64	5,87	6,42
Subjective perceptions			
- Emotional support from parent(s)	0,99	0,97	1,12
- Educational expectation	1,49	1,39	1,66
- Educational anxiety	1,09	1,05	1,09
- Ambition/competitiveness	1,02	0,98	1,09
- Occupational expectation	17,05	16,67	18,44
- Student preference/characteristic			
· Prefer working as part of a team	0,49	0,49	0,49
· A good listener	0,33	0,31	0,36
· Enjoy seeing success of others	0,32	0,35	0,36
· Feel like an outsider	0,32	0,32	0,39
· Feel like I belong at school	0,43	0,38	0,44
No class skipped	0,39	0,39	0,45

Table B.1 (*continued*)

Variable S.D.	**Natives**	**2nd generation immigrants**	**1st generation immigrants**
Ate breakfast before school	0,38	0,41	0,41
Parent:			
Parents' highest education			
- In ISCED levels	0,91	1,24	1,46
Mother's highest education			
- None / Pre-primary	0,04	0,18	0,23
- Primary	0,04	0,17	0,18
- Lower secondary	0,19	0,32	0,26
- Vocational upper secondary	0,20	0,24	0,23
- General upper secondary	0,44	0,45	0,44
- Vocational tertiary	0,49	0,45	0,43
- Theoretically oriented tertiary	0,44	0,38	0,44
Father's highest education			
- None / Pre-primary	0,05	0,13	0,22
- Primary	0,05	0,15	0,16
- Lower secondary	0,22	0,31	0,21
- Vocational upper secondary	0,24	0,22	0,23
- General upper secondary	0,46	0,47	0,45
- Vocational tertiary	0,45	0,42	0,40
- Theoretically oriented tertiary	0,45	0,44	0,47
Parental occupational status			
- Mother	20,84	22,33	23,52
- Father	21,71	22,71	24,04
School:			
Proportion certified teacher staff	0,33	0,40	0,30
Class size	4,42	3,85	4,38
Student-teacher ratio	2,09	1,69	2,23
Class division by ability	0,38	0,42	0,36
Within class-division by ability	0,55	0,48	0,52
Report achievement data publicly	0,47	0,34	0,43
School climate			
- Staff capacity	0,82	0,92	0,81
- Student behaviour	0,84	0,79	0,82
- Teacher behaviour	0,73	0,75	0,75

Annex C: Percentile means

Table C.1: Science scores, percentile means, PISA 2015

Mean	**Native**	**Immigrant**	**2nd generation immigrant**	**1st generation immigrant**	**Overall**
Overall	507	455	464	446	501
P1	289	260	266	258	281
P5	349	305	321	294	340
P10	382	334	346	322	374
P25	442	388	396	380	434
P50	510	453	462	447	503
P75	573	520	530	508	568
P90	628	576	582	567	623
P95	660	613	616	606	656
P99	715	670	672	667	711

Table C.2: Mathematics scores, percentile means, PISA 2015

Mean	**Native**	**Immigrant**	**2nd generation immigrant**	**1st generation immigrant**	**Overall**
Overall	509	466	473	459	504
P1	309	280	293	273	305
P5	368	333	344	325	362
P10	400	361	370	353	394
P25	452	409	416	400	446
P50	511	463	472	456	506
P75	567	522	527	517	563
P90	615	574	581	568	611
P95	642	604	609	599	639
P99	693	655	657	650	690

Table C.3: Reading scores, percentile means, PISA 2015

Mean	**Native**	**Immigrant**	**2nd generation immigrant**	**1st generation immigrant**	**Overall**
Overall	521	479	500	458	516
P1	278	245	277	229	273
P5	351	311	352	290	345
P10	392	349	382	324	385
P25	459	410	436	386	452
P50	526	482	503	457	521
P75	589	549	560	530	585
P90	641	606	618	593	638
P95	671	639	648	626	668
P99	727	702	700	703	725

Annex D: T-tests, characteristic proportions

Table D.1: Characteristic proportions and differences, PISA 2015

% with characteristic	(1) Native	(2) 2nd gen. immigrant	(3) 1st gen. immigrant	2-1	3-1	3-2
Descriptive:						
Female	0,50	0,48	0,48			
Speak Norwegian at home	0,98	0,57	0,26	***	***	***
Community size						
- Village	0,21	0,03	0,17	***	**	***
- Small town	0,32	0,17	0,29	***		***
- Town	0,29	0,30	0,28			
- City	0,18	0,49	0,26	***	***	***
School size						
- High	0,24	0,38	0,28	***		***
- Middle	0,49	0,50	0,45			
- Low	0,26	0,12	0,27	***		***
Student:						
Socio-economic status (ESCS)						
- High	0,26	0,14	0,16	***	***	
- Middle	0,52	0,39	0,35	***	***	
- Low	0,22	0,47	0,49	***	***	
- Home possessions						
· High	0,27	0,12	0,08	***	***	
· Middle	0,51	0,48	0,40		***	**
· Low	0,22	0,40	0,52	***	***	***
· Cultural items						
- High	0,30	0,19	0,19	***	***	
- Middle	0,46	0,46	0,44			
- Low	0,24	0,35	0,37	***	***	
· Educational resources						
- High	0,48	0,50	0,40		***	***
- Middle	0,27	0,26	0,30			
- Low	0,25	0,24	0,31		*	
· ICT resources						
- High	0,32	0,21	0,18	***	***	
- Middle	0,45	0,41	0,35		***	
- Low	0,23	0,38	0,47	***	***	**
· Wealth items						
- High	0,27	0,16	0,11	***	***	**
- Middle	0,52	0,41	0,34	***	***	*
- Low	0,22	0,43	0,55	***	***	***
· Books at home						
- More than 200 books	0,32	0,12	0,14	***	***	

Table D.1 (*continued*)

% with characteristic	(1) Native	(2) 2nd gen. immigrant	(3) 1st gen. immigrant	2-1	3-1	3-2
- Between 100 and 200 books	0,22	0,14	0,09	***	***	**
- Less/equal than 100 books	0,45	0,73	0,77	***	***	
Study time outside						
- Science						
· High	0,32	0,39	0,43	***	***	
· Middle	0,37	0,41	0,35			
· Low	0,31	0,20	0,22	***	***	
- Mathematics						
· High	0,33	0,43	0,40	***	**	
· Middle	0,30	0,34	0,29			
· Low	0,37	0,23	0,31	***	***	**
Subjective perceptions						
- Emotional support from parent(s)						
· High	0,37	0,42	0,32		*	***
· Middle	0,32	0,36	0,32	*		
· Low	0,31	0,21	0,37	***	*	***
- Expect to complete tertiary education	0,39	0,27	0,37	***		***
- Educational anxiety						
· High	0,24	0,32	0,28	***		
· Middle	0,50	0,49	0,54			
· Low	0,26	0,19	0,18	***	***	
- Ambition/competitiveness						
· High	0,26	0,39	0,34	***	***	
· Middle	0,48	0,48	0,41		**	
· Low	0,27	0,12	0,25	***		***
- Occupational expectation						
· High	0,28	0,44	0,38	***	***	*
· Middle	0,46	0,40	0,38	**	**	
· Low	0,27	0,16	0,25	***		**
- Student preference/characteristic						
· Prefer working as part of a team	0,39	0,40	0,43			
· A good listener	0,12	0,11	0,15			
· Enjoy seeing success of others	0,12	0,14	0,15			
· Feel like an outsider	0,12	0,12	0,18		***	*
· Feel like I belong at school	0,76	0,82	0,73	***		**
No class skipped	0,81	0,81	0,72		***	**
Ate breakfast before school	0,83	0,78	0,79		*	
Parent:						
Parental education						
- Don't have compulsory schooling						
· Mother	0,04	0,18	0,17	***	***	
· Father	0,06	0,14	0,13	***	***	
- Parent have tertiary education						
· Mother	0,65	0,47	0,51	***	***	

Table D.1 (*continued*)

% with characteristic	(1) Native	(2) 2nd gen. immigrant	(3) 1st gen. immigrant	2-1	3-1	3-2
· Father	0,57	0,48	0,54	***		
Parental occupational status						
- Mother						
· High	0,29	0,15	0,14	***	***	
· Middle	0,48	0,38	0,35	***	***	
· Low	0,24	0,47	0,51	***	***	
- Father						
· High	0,30	0,22	0,28	***		
· Middle	0,45	0,40	0,33	*	***	
· Low	0,25	0,38	0,39	***	***	
School:						
Proportion certified teacher staff						
- High	0,49	0,39	0,43	***	*	
- Middle	0,26	0,23	0,30			**
- Low	0,24	0,38	0,27	***		***
Class size						
- High	0,43	0,39	0,39			
- Middle						
- Low	0,57	0,61	0,61			
Student-teacher ratio						
- High	0,24	0,37	0,25	***		***
- Middle	0,50	0,48	0,46			
- Low	0,26	0,15	0,30	***		***
No class division by ability	0,85	0,76	0,85	***		***
No within class-division by ability	0,45	0,32	0,39	***	**	**
Report achievement data publicly	0,67	0,87	0,76	***	***	***
School climate						
- Staff capacity						
· High	0,26	0,29	0,22	*		**
· Middle	0,49	0,40	0,46	***		*
· Low	0,25	0,31	0,31	*	**	
- Student behaviour						
· High	0,45	0,29	0,34	***	***	
· Middle	0,26	0,22	0,25	**		
· Low	0,29	0,49	0,41	***	***	**
- Teacher behaviour						
· High	0,38	0,28	0,35	***		**
· Middle	0,35	0,27	0,28	**	***	
· Low	0,27	0,45	0,37	***	***	

P-values: *** p < 0,01; ** p < 0,05; * p < 0,10

Annex E: Educational production function

Table E.1: Educational production function, final model, upper and lower bounds

Dependent variable:	**Science**		**Mathematics**		**Reading**	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Intercept	447,75***	(19,29)	439,48***	(17,86)	457,67***	(22,20)
Second-generation immigrant	-30,15***	(10,18)	-21,10**	(8,66)	-17,16	(13,14)
First-generation immigrant	-22,97**	(11,61)	-18,20	(12,19)	-35,51***	(12,24)
Descriptive:						
Female	-11,74***	(4,18)	-5,00	(3,53)	26,71***	(4,72)
Speak Norwegian at home	21,80**	(10,83)	17,72*	(9,57)	12,78	(11,03)
Community size						
- Village	-12,15*	(7,00)	-3,94	(7,38)	-10,17	(8,51)
- Small town	-10,48*	(5,61)	-4,16	(5,53)	-8,05	(7,04)
- City	9,68	(6,88)	14,31**	(7,25)	3,86	(7,69)
School size						
- High	3,25	(7,01)	-3,20	(7,02)	5,28	(7,61)
- Low	4,46	(6,50)	5,53	(7,67)	-0,03	(8,80)
Student:						
Socio-economic status (ESCS)						
- Home possessions						
· Cultural items						
- High	9,79**	(4,27)	5,63	(3,92)	8,13*	(4,91)
- Low	-7,21	(5,13)	-5,77	(4,92)	-3,81	(5,98)
· Educational resources						
- High	-2,29	(3,91)	-5,63	(3,66)	-7,79**	(3,87)
- Low	2,30	(4,66)	-3,91	(4,34)	6,92	(5,50)
· Wealth items						
- High	-14,29***	(4,05)	-10,45**	(4,11)	-17,52***	(4,34)
- Low	9,42**	(4,60)	-1,24	(4,45)	13,31**	(5,67)
· Books at home						
- High	11,80**	(5,36)	13,88**	(6,06)	11,69**	(5,87)
- Low	-22,03***	(5,02)	-12,27**	(5,68)	-25,02***	(5,99)
Study time outside of class						
- High	-8,17*	(4,56)	-5,09	(4,47)		
- Low	16,24***	(4,29)	15,95***	(4,48)		
Subjective indices						
- Emotional support from parent(s)						
· High	-14,91***	(3,73)	-11,58**	(4,65)	-16,43***	(3,96)
· Low	1,26	(4,65)	0,50	(4,15)	-4,29	(4,67)
- Expect to complete tertiary education	22,47***	(4,30)	23,23***	(4,14)	25,27***	(5,29)
- Educational anxiety						
· High	-19,27***	(4,23)	-15,40***	(4,48)	-12,99***	(4,99)

Table E.1 (*continued*)

Dependent variable:	**Science**		**Mathematics**		**Reading**	
· Low	18,60***	(4,78)	14,57***	(3,91)	18,25***	(4,76)
- Ambition/competitiveness						
· High	12,64**	(5,02)	11,58***	(3,88)	11,45**	(4,67)
· Low	-9,36*	(5,25)	-10,01**	(4,82)	-14,24***	(4,98)
- Occupational expectation						
· High	17,42***	(4,46)	10,66***	(3,99)	10,53**	(4,14)
· Low	-23,40***	(5,03)	-22,65***	(4,73)	-26,59***	(4,87)
- Student preference/characteristic						
· Prefer working as part of a team	-20,43***	(3,82)	-19,54***	(3,89)	-20,93***	(4,21)
· A good listener	12,98**	(6,57)	3,93	(5,25)	15,28**	(6,67)
· Enjoy seeing success of others	16,87***	(6,19)	15,76***	(5,82)	15,23**	(6,77)
· Feel like an outsider	-2,12	(6,59)	1,02	(6,38)	-8,70	(6,80)
· Feel like I belong at school	5,63	(4,92)	8,70*	(4,78)	8,48	(5,58)
No class skipped	28,24***	(5,81)	29,15***	(5,73)	20,67***	(5,39)
Ate breakfast before school	5,68	(5,81)	7,60	(4,77)	5,38	(5,55)
Parent:						
Parental education						
- Don't have compulsory schooling						
· Mother	-18,64	(11,52)	-10,71	(10,34)	-16,86	(12,33)
· Father	-9,74	(9,48)	-10,63	(9,58)	-7,93	(9,60)
- Parent have tertiary education						
· Mother	-6,57	(4,52)	-3,05	(4,35)	-2,81	(4,92)
· Father	-4,78	(4,77)	-3,72	(4,82)	-8,05	(4,99)
Parental occupational status						
- Mother						
· High	5,82	(3,86)	6,17*	(3,62)	3,93	(3,67)
· Low	1,11	(4,84)	2,48	(4,62)	-2,16	(5,25)
- Father						
· High	13,51***	(4,17)	11,98***	(3,97)	13,68***	(4,24)
· Low	-10,31**	(4,69)	-6,08	(4,27)	-9,51*	(5,14)
School:						
Proportion fully certified teacher staff						
- High	3,62	(5,90)	6,02	(5,78)	3,01	(6,45)
- Low	-1,17	(6,57)	5,11	(6,26)	1,27	(7,71)
Class size						
- High	-5,74	(4,51)	-0,29	(4,70)	0,70	(5,50)
- Low	-		-		-	
Student-teacher ratio						
- High	5,14	(5,83)	4,97	(6,45)	7,04	(6,51)
- Low	7,35	(5,33)	6,02	(5,00)	8,48	(6,22)
No class division by ability	3,75	(5,46)	-0,43	(5,36)	1,00	(7,63)
No within class-division by ability	4,73	(5,09)	9,10**	(4,49)	7,13	(6,20)
Report achievement data publicly	0,86	(4,98)	3,59	(5,21)	6,50	(6,14)
School climate						
- Staff capacity						

Table E.1 (*continued*)

Dependent variable:	**Science**		**Mathematics**		**Reading**	
· High	0,07	(5,91)	0,59	(6,57)	2,28	(6,53)
· Low	2,49	(7,70)	1,87	(6,65)	-1,84	(7,93)
- Student behaviour						
· High	6,35	(5,73)	4,50	(5,44)	6,85	(6,32)
· Low	-4,26	(4,87)	-9,01	(5,95)	-2,14	(7,48)
- Teacher behaviour						
· High	1,46	(5,65)	-0,40	(5,76)	1,20	(6,35)
· Low	1,97	(6,52)	5,74	(5,51)	5,19	(6,37)
N (observations)	2110		2134		2327	
T-test, 2nd = 1st gen immigrant	0,64		0,25		1,33	
F-statistic	18,28***		18,48***		20,85***	
R-squared	0,3367		0,3366		0,3354	
Adjusted R-squared	0,3183		0,3184		0,3193	

Standard errors in parentheses.
P-values: *** p < 0,01; ** p < 0,05; * p < 0,10

Annex F: Decomposition results

Table F.1: Blinder-Oaxaca decomposition, between second-generation and first-generation immigrants

	Science			Mathematics			Reading		
	Coeff.	**S.E.**	**% of gap**	**Coeff.**	**S.E.**	**% of gap**	**Coeff.**	**S.E.**	**% of gap**
Total test score gap	11,98	(13,67)		13,57	(12,36)		31,07*	(16,24)	
- Characteristic effect	-13,13	(18,39)	-109,6%	-10,89	(16,07)	-80,3%	-14,20	(18,67)	-45,7%
- Return effect	-16,51	(14,63)	-137,8%	-10,34	(15,02)	-76,2%	-3,07	(17,18)	-9,9%
- Interaction effect	41,62**	(19,21)	347,4%	34,80**	(16,90)	256,4%	48,33**	(20,18)	155,6%
Total gap:									
- Explained	9,05	(12,82)	75,5%	5,59	(11,54)	41,2%	8,94	(11,79)	28,8%
· Descriptive variables									
- Female	0,68	(1,05)	5,6%	0,51	(0,99)	3,8%	-2,05	(1,88)	-6,6%
- Speak Norwegian at home	2,21	(4,31)	18,5%	-0,02	(3,80)	-0,2%	1,08	(4,05)	3,5%
- Community size	-1,09	(6,50)	-9,1%	-0,30	(5,55)	-2,2%	-1,50	(6,15)	-4,8%
- School size	1,04	(3,60)	8,7%	1,98	(3,54)	14,6%	2,20	(3,80)	7,1%
· Student variables									
- Home possessions	1,39	(3,93)	11,6%	0,40	(2,65)	3,0%	0,24	(3,68)	0,8%
- Study time outside of class	-0,68	(1,76)	-5,7%	-2,43	(2,39)	-17,9%			0,0%
- Subjective perceptions	7,09	(6,37)	59,2%	4,74	(6,01)	34,9%	8,50	(6,03)	27,4%
- No class skipped	4,71	(3,42)	39,3%	4,59	(3,04)	33,8%	6,21*	(3,39)	20,0%
- Ate breakfast at home	-1,86	(1,77)	-15,5%	-1,06	(1,35)	-7,8%	-0,58	(0,99)	-1,9%
· Parent variables									
- Parental education	-2,59	(3,14)	-21,6%	-2,58	(3,07)	-19,0%	-3,47	(3,94)	-11,2%
- Parental occupational status	-0,12	(2,12)	-1,0%	-0,01	(1,71)	-0,1%	-0,95	(2,25)	-3,1%
· School variables	-1,74	(5,02)	-14,5%	-0,22	(4,53)	-1,6%	-0,74	(4,19)	-2,4%
- Unexplained	2,93	(11,61)	24,5%	7,97	(12,68)	58,7%	22,12	(14,24)	71,2%
N (observations)									
- Second-generation immigrants		121			124			133	
- First-generation immigrants		83			84			96	

Standard errors in parentheses.
P-values: *** p < 0,01; ** p < 0,05; * p < 0,10