Intergenerational Transmission of Educational Attainment and Its Relationship to the Quality of the Education System

A Cross-Country Study

David Sandberg
Daniel Strandberg
Supervisor: Petra Thiemann

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Department of Economics
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Abstract

The purpose of having a high-quality education system is not only to increase the human capital level of the younger population, but also a mechanism to minimize the differences between children's chances to succeed in life. Children who come from poor backgrounds and have low educated parents will be given a possibility to succeed through a high-quality education system. This thesis will investigate how much the parents' educational background affects the child's educational attainment and what role the quality of the country's education system has.

The theoretical frameworks originally developed by Gary Becker will be applied to determine the educational transmission from the parents to the child. The findings show that there exist some intergenerational transmission of educational attainment which is lower if the country has a high-quality education system. High-quality education system makes children to low educated parents higher educated than in countries with low-quality education system. Children to high educated parents are less likely to receive high educational attainment in high-quality education systems compared with in countries with low-quality education system.

Keywords: intergenerational mobility, education quality, econometrics.

Table of Contents

1. Introduction

1.1 Background

Children are born with different parental backgrounds and research has shown that these differences seem to play a crucial role in determining the children's future success in life (Blau, Duncan & Tyree 1967; Björklund & Jänti 1997; Corak 2013). A broad field of research has been focusing on this under the name *intergenerational mobility* or *intergenerational transmission.* In economics, the largest focus has been on the mobility in income while sociologists have been focusing more on the mobility in classes of society. Regardless of which variable is chosen it seems to be fair to say that education plays a crucial role in determining people's future success in life. Human capital theory states that future earnings depend on educational attainment because they raise productivity or signal ability (Borjas 2013). This makes intergenerational educational mobility strongly related to intergenerational mobility in earnings, wealth and success.

Another important factor in a child's success is the quality of the education system, as a low-quality education system could have a negative impact on children's success. However, high educated parents should be more able to compensate their children for the poor education than low educated parents will. This thesis aims to find out if that assumption is correct and, if possible, to explain what factors it depends on. Furthermore, the relationship between intergenerational mobility and a country's education quality will be examined.

In order to get a more complete picture of the intergenerational mobility, the thesis also aims to examine patterns between parents' educational attainment and their children's cognitive abilities. The hypothesis is that an increases in the parental educational attainment will increase the child's cognitive ability. Perhaps, the magnitude will depend on the quality of the education system. In this thesis, cognitive ability of the children will be measured as a test score outcome.

The findings in this thesis show that there exist intergenerational transmission that is reduced if the quality of the education system increases. High-quality education system makes it more likely for a child of a parent with primary education to receive either

secondary or tertiary education, while it reduces the probability of receiving primary education. For children to parents with either secondary or tertiary education, the probability of acquire primary or tertiary education is lower if they live in a country with a high-quality education system.

1.2 Purpose

The purpose of the thesis is to answer the following three questions:

1. Is there any transmission of educational attainment across generations?
2. Is the intergenerational transmission of educational attainment different between countries with education system of high respectively low quality?
3. Assuming there is a difference of intergenerational transmission of educational attainment between countries with high- and low-quality education system, how does the intergenerational transmission of educational attainment change for each specific group of educational attainment, i.e. primary, secondary and tertiary education?

To answer these questions, we conduct a cross country study of 19 countries that are all members of the Organization of Economic Co-operation and Development (OECD). Different theories of intergenerational mobility will be used to explain and discuss why or why not the success of a child from an educational perspective should depend on the quality of the education system. In economic terms this boils down to the question if the quality of the education system, that can be seen as the public investment in the child, should be identified as a substitute or complement to the parents' investments. The size of parents' investment represents their own effort to make sure that their child receives good education. To be able to understand the questions we will now define the most important keywords.

1.3 Definitions of Keywords

Some keywords are used throughout the thesis which are important to understand.

- **Transmission** in this thesis refers to the transmission of educational attainment from one generation to the next.
- **Intergenerational mobility** refers to the likeliness to reach a certain level of achievement, in our case education and cognitive ability, regardless of your parents' level. High transmission of educational attainment is equal to low

intergenerational mobility and if the transmission is low, or does not exist, it implies a high intergenerational mobility. This has been measured on income or education between fathers and sons (see for example Corak (2006 & 2013)). In this thesis, however, no distinction is made for the gender of the individuals. Instead the parent with the highest education in the family, independent of gender, will be chosen to explain the education of the child that also will be independent of gender.

- **Quality of education system** in this thesis is an approximation of **public expenditures** or **investments**. The quality of education systems is a complex and sometimes subjective measure and could refer to many parameters. However, in this thesis it is measured as earlier students' level on test scores from Trends in International Mathematics and Science Study (TIMSS). The countries are divided in two groups. Half of the countries, with the highest average test scores, form one group which will be referred as countries with high-quality education systems. The rest of the countries, which has the lowest average test scores, forms the group with low-quality education system. A dummy variable will be used which shows whether the country's education system is of high or low quality.

- **Parental investments** are used alternatively with **parental expenditures** and do refer to the same thing which in this thesis is the resources parents allocates to the child's educational development. This could be e.g. to which extent they help their child with homework or monetary investments that aims to improve their educational environment. The theories originate from Becker (1979 & 1986) who assumes that a child's future achievements to some extent depends on the parents' investments. The parents get utility from their own consumption and the utility of their children and they will invest in the children's development in a way that maximizes their own utility. The grade of the investments will depend on the parents' resources and level of altruism towards the child. These two factors combined with public investments and certain characteristics that a child inherits from its parents then determines the future human capital level of the child. We do not have data on the parents' investments partly because it is a very broad concept since it could refer to many different types of investments. Instead, the presumption will be that the cost of investment from a parent into a child is lower for a parent with high educational attainment. This means that parents with low

educational attainment do not have the resources to do the same investments into their child's educational attainment as parents with high educational attainment. For instance, it is easier for high educated parents to help their child with its home works. If all parents have identical utility functions (i.e. their level of altruism with respect to the child is the same), then the parents with higher educational attainment will, due to lower cost, invest more in their children's education and the parents with lower education will invest less. This reasoning is similar as what Becker (1986, p. 15-16) suggests. Because of parents with low educational attainment are not able to make optimal investments their child will receive lower educational attainment than will parents with high educational attainment, holding everything else equal.

- **Educational attainment** in this study refers to three different levels of education, i.e. all individuals either takes the educational attainment value 1, 2 or 3. The first level is the lowest and refers to primary and lower secondary school. Individuals without any education is also included in this category. Children typically finishes lower secondary school after a 9 year of schooling (OECD 1999, p. 33-36). The second level means upper secondary school. Children usually enter upper secondary school at the age 15 or 16 and it typically ranging from between 2 and 5 years (ibid., p. 39-45). This level also includes "post-secondary, non-tertiary" education, which only some countries offers and typically last between 6 months and 2 years. This education stage is slightly more advanced than upper secondary school but it cannot be seen as tertiary education (ibid., p. 47-50). The third and highest level represent all education attainments on a tertiary education level or higher. From now on, these three levels will be referred as primary, secondary and tertiary education and are coded as 1, 2 and 3. Parents' educational attainment represents the highest of mother or father's educational attainment.

1.4 Method and Data

We are going to use econometric models to measure the different effects. Relevant economic theory will be used in order to explain the results. The data is collected from a dataset from the Programme for the International Assessment of Adult Competencies (PIAAC) (OECD 2016) which will most importantly provide us with the children's educational attainment and test score outcome and as well as their parents' educational

attainment. PIAAC will also provide us with other variables and information about the children. As measurement of the countries' quality of education systems, data is collected from the Trends in International Mathematics and Science Study (TIMSS).

1.5 Restrictions

Our measurement of quality of education is restricted to just the average test score outcomes on tests which can be seen as a measure of academic ability. Hence, we do not take into account other possible factors that could determine the choice of educational attainment as, for instance, return to schooling. We do not have data on the parents' age which could affect their educational attainment. Intergenerational mobility is sometimes measured across more than two generations (see Lindahl et al. 2014), however, this is outside the scope of this thesis where focus will only be on the transmission across two generations.

2. Theory

The theories used in this thesis are principally related to the field of intergenerational mobility. The theories are used in different social sciences but the economic theories could be traced back to Becker and Tomes' (1979) ideas about utility maximizing behaviour of families as an explanation of intergenerational transmission of income. Becker and Tomes wrote two articles (1979 & 1986) about intergenerational transmission which Becker later included in a comprehensive book (1991). Goldberger (1989), who was inspired by Galton's (1886) ideas, criticizes Becker's ideas and promotes instead theories about regression to the mean across generations without any significant impact of parental investments and utility maximizing behavior. In the following sections, the theories will be discussed more in detail.

2.1 Intergenerational Mobility

Theories of intergenerational mobility try to explain the mobility or transmission of different variables across generations. Usually, this variable is income, social class or education. The general model normally used in intergenerational mobility theory is a regression model over two periods (see equation (1)) constructed as a log-log-model. A log-log-model is a model where both the independent and dependent variables are transformed to their natural logarithms. With income as an example, Y_t will be the logarithmic income of the child in period t and Y_{t-1} will be the logarithmic income of the parent in period t-1. The important parameter in the following regression is the β-value.

$$(1)\ Y_t = \alpha + \beta \times Y_{t-1} + \mathcal{E}_t$$

The value of β tells us the intergenerational earnings' elasticity of the child's income with respect to the parents' income. If β=0.5 a 10% difference in earnings in parents' generation results in a 5% difference in the child's generation. If β=1 that means the relationship is the same in both generations and would mean that there is no mobility in the society. A β=0 would mean that there exists no relationship between the parents and the child with respect to income, which implies absolute mobility. See Blanden (2013) for a more technical review.

When the model is constructed as a log-log-model, with respect to income, it is possible to interpret the β-value as elasticity, which is shown above. However, when educational attainment is measured it cannot be constructed as a log-log model but instead as a linear model. The reason is that the educational attainment values are discrete and restricted between 1 and 3 (in this thesis) and therefore not suitable as a log-log-model. The interpretation of the values will be slightly different but the general idea will be the same, i.e. high values on β will indicate low mobility and low values on β will indicate high mobility.

2.1.1 Becker-Tomes Model

Becker and Tomes (1979 & 1986) have developed a theory that aims to explain the transmission of income from one generation to the next. Their model is built upon utility maximizing parents. They assume that parents gain utility not only from their own consumption but also from the utility of their children. This is explained through a utility function:

(2) $U_t = (Z_t) + \delta \times U_{t+1}$

where U_t is the utility of the parent, Z_t is their own consumption and U_{t+1} is the utility of the child. The value of δ indicates the level of altruism of the parents towards the child. Parents will choose to maximize this function given their budget constraint:

(3) $X = Z + I$

where X is the parents income, Z is their consumption and I the investment in the child. In Becker and Tomes (1986) the budget constraint is dropped and replaced with the assumption that parents could borrow at the capital market in order to invest but there will be capital restrictions for poorer families stopping them from optimal investments. However, the principle of utility maximization is still the same.

Parents invest both in their children's human and non-human capital. In this thesis, focus will be at the investments in human capital and more specifically the investments in the

children's education. According to Becker and Tomes (1986), the human capital level of the child is determined by three factors:

(4) $H_t = (E_t, x_{t-1}, s_{t-1})$

The first term, E_t, represents the fact that children are born with different conditions which affects their ability to acquire human capital in different ways. In the BeckerTomes model this is called endowments and is gained as:

(5) $E_t = \alpha + \beta \times E_{t-1} + v_t$

where E_{t-1} is the endowments that are inherited by the parents. In human capital theory this could be both cultural and biological characteristics. For instance, some families could have a tradition of childhood learning. The error term v_t is a component that depends only on luck and not on the parents. Parents are assumed to not be able to invest in the child's endowments.

The second term, x_{t-1}, illustrates in what extent the parents are able to make other investments in their children. This could be monetary investments but also investments in their own time and energy to, for example, help their child with homework and in other ways create a good educational environment for the child.

Lastly, the third term, s_{t-1}, shows that public investments which targets education can affect children's educational attainment. For instance, this could be public policies with the aim to improve the country's education system or the children's growth and development environment. These three factors - inherited abilities, childhood investments and public investments - will, according to Becker and Tomes, determine the level of human capital of children.

Becker (1991, p. 191-192) assumes that parents will invest in the child in a way that compensates for the endowment and public expenditures which in other words mean that they are seen as substitutes. Suppose there was an increase in public expenditures, then this will be compensated by a decrease in the parental investments because they will

then allocate their resources in a way that is more efficient. Becker also mentions the possibility of public expenditures as complementary to parental expenditures but comes to the conclusion that they are more likely to be substitutes and expresses it like this:

> "Parents might not reduce, and could even raise, their expenditures on participating children if these programs raised returns on parental expenditures. Still, however, the main effect of these programs is probably a redistribution of family expenditures away from the children participating, with a small net increase in total expenditure on these children. These programs could even be classified as failures, since redistribution is not supposed to be their main purpose" (Becker 1991, p. 192).

However, he argues that for poorer families it will not necessarily be any offsetting effect due to the fact that public programs help them to afford the optimal level. Hence, they will be complementary to parental expenditures (Becker 1986, p.35).

2.1.2 Regression to the Mean-Model

In contrast to the Becker-Tomes model (1986), the regression to the mean-models are built on assumptions of mechanical transmissions to the next generation. The theory can be traced back to Galton (1886) that used the heights of different generations to show that it was more likely for the child of an extraordinarily tall parent to be shorter than the parent and the other way around, instead of both generations being extraordinarily tall. This reasoning could be applied to any other characteristic that is transmitted across generations. For instance, children can inherit very beneficial attributes but, of course, it is also possible to inherit very large weaknesses. Across generations these two effects will cancel each other out and transmission across generations in any family will eventually regress to the mean.

These theories were later developed and translated to make it more applicable in an economic context by among others Goldberger (1989) who criticized the Becker-Tomes model. Goldberger argues that theories about utility maximizing parents are not crucial to explain the transmission of income or other variables across generations. More specific, Goldberger argues that these theories do not capture anything that mechanical models fails to do. Goldberger is for instance sceptical towards Becker's (1991) conclusion about offsetting effects. As described in our description of the Becker-Tomes

model, every increase in a child's luck, E, or public expenditures, s_{t-1}, will be compensated by a decrease in parental expenditures. This effect will be greater than the effect of raised rates of return on parental expenditures. Goldberger (1989) does not agree with this and describes his critics against Becker through a change in Becker's function:

(6) Becker's function: $Y = r(x + s) + E$

(7) Goldberger's adjustment: $Y = r(x + s) \times E$

where x is the parental investments, s the public investments and E is the child's endowments. r denotes the rate which only affects the investments. According to Becker's function, the factors are most likely substitutes towards each other in the sense that, if e.g. an increase in public investment would occur, it would result in a decrease in parental investments and the effects would eventually cancel each other. Goldberger's equation, on the other hand, implies that children's income is based multiplicatively on parental investments, public investments and the child's endowments. This means that the factors are complementary.

3 Earlier Research

In this chapter a brief presentation will be made of what some other studies have concluded regarding intergenerational mobility in education.

3.1 Studies on Intergenerational Mobility in Education

Apart from the relatively broad literature on intergenerational mobility in income and social class there has been some studies about intergenerational mobility in educational attainment as well. In 2007, a comprehensive cross-country study about intergenerational mobility and education equality was made by Hertz et al. (2007) including 42 different countries over 50 years. The authors compared both correlations and measurements on education elasticity to try to discover patterns over time. Their results are presented in table 1. The elasticities (in the table called Coefficient) is a measurement of intergenerational mobility in education but they are not calculated directly from a regression model, as was presented in section 2.1. Instead, the calculations of the education elasticities are based on the intergenerational mobility for income. See Hertz et al. (2007) for a thoroughly derivation of the calculated elasticities. In the study they find that the regression coefficients for the parents' education attainment falls over time, which indicates higher mobility now than before. However, they see no such trends when it comes to correlation.

Table 1.

Countries Ranked by Average Parent-Child Schooling Correlation, Ages 20-69

Country	Coefficient	Rank	Correlation	Rank
Peru	0.88	6	0.66	1
Ecuador	0.72	12	0.61	2
Panama	0.73	11	0.61	3
Chile	0.64	18	0.60	4
Brazil	0.95	4	0.59	5
Colombia	0.80	8	0.59	6
Nicaragua	0.82	7	0.55	7
Indonesia	0.78	9	0.55	8
Italy†	0.67	17	0.54	9
Slovenia†	0.54	27	0.52	10
Egypt	1.03	2	0.50	11
Hungary†	0.61	20	0.49	12
Sri Lanka	0.61	19	0.48	13
Pakistan	1.00	3	0.46	14
USA	0.46	33	0.46	15
Switzerland†	0.49	30	0.46	16
Ireland†	0.70	15	0.46	17
South Africa (KwaZulu-Natal)	0.69	16	0.44	18
Poland†	0.48	31	0.43	19
Vietnam	0.58	23	0.40	20
Philippines	0.41	36	0.40	21
Belgium (Flanders)	0.41	35	0.40	22
Estonia	0.54	28	0.40	23
Sweden	0.58	26	0.40	24
Ghana	0.71	13	0.39	25
Ukraine	0.37	40	0.39	26
East Timor	1.27	1	0.39	27
Bangladesh (Matlab)	0.58	25	0.38	28
Slovakia	0.61	21	0.37	29
Czech Republic†	0.44	34	0.37	30
The Netherlands	0.58	24	0.36	31
Norway	0.40	38	0.35	32
Nepal	0.94	5	0.35	33
New Zealand†	0.40	37	0.33	34
Finland	0.48	32	0.33	35
Northern Ireland	0.59	22	0.32	36
Great Britain†	0.71	14	0.31	37
Malaysia	0.38	39	0.31	38
Denmark	0.49	29	0.30	39
Kyrgyzstan	0.20	42	0.28	40
China (Rural)	0.34	41	0.20	41
Ethiopia (Rural)	0.75	10	0.10	42

Notes. Retrieved from Hertz et al. (2007). Coefficients can be seen as the elasticities.

3.2 Studies on Intergenerational Mobility and Public Investments

Checchi et al. (1999) compares Italy and the US with respect to education and intergenerational mobility. They use a probit regression model to compare probabilities of reaching a higher educational attainment between the two countries. They conclude that the mobility in Italy is lower than in the US, despite a more egalitarian education system in Italy compared to the US. The study showed that it is more likely for children of high educated parents to be high educated in Italy and also less likely to receive higher education if you have a low educated parent, compared to the US. This contradicted their hypothesis which said that higher public spending on education, as in Italy, would result in higher mobility than if the public spending was low, as in the US.

Solon (2004) developed a model built on Becker and Tomes' theories to explain intergenerational mobility through parental and public investments in children. By analyzing the Becker-Tomes model, he defines some factors that could determine the level of intergenerational mobility with respect to income. Solon discovers that the mobility is negatively affected by heritability of income related traits, the return in earnings of human capital and the efficacy of human capital investment. It increases with more progressive public investments in human capital. See Solon (2004) for a more technical review.

4 Data

Data will be used primarily to measure the educational attainment of parents and children, the test score outcome of the child and the quality of countries' education system. The data on the parents' and the children's educational attainment as well as the children's test score outcome is collected from the PIAAC survey that is organized and conducted by OECD (2016). The data of the surveys were collected the first time in 2012 and then again for some countries in 2015. In order to measure the countries' quality of education system data will be used from TIMSS which was carried out in 1995.

In this thesis the education system quality is preferably measured at the time when the children start their education. Then it is possible to assume that the parent had information about the quality of the country's education system at the time of their potential investment in the child's education, which is related to the mentioned theories developed by Becker. Furthermore, the goal is to measure the children's educational attainment when they are old enough to have been able to finish a tertiary education. Based on these two restrictions, the cohorts 1985, 1986 and 1987 from the PIAAC data have been chosen. Each individual in the sample will then be 10 years old or younger in 1995 when the TIMSS results was collected and at least turn 25 in 2012 when the first PIAAC data was collected. The countries from the PIAAC data that do not also have data from the TIMSS-test will be excluded. There will be data on around 5500 individuals from 19 countries. The exact number of individuals differ between the regressions because, for instance, some individuals have not a valid test score and others has not mentioned their own educational attainment. The distribution of the individuals over the countries and cohorts are shown in figure 1.

Figure 1.
Number of Individuals from Each Country and Cohort
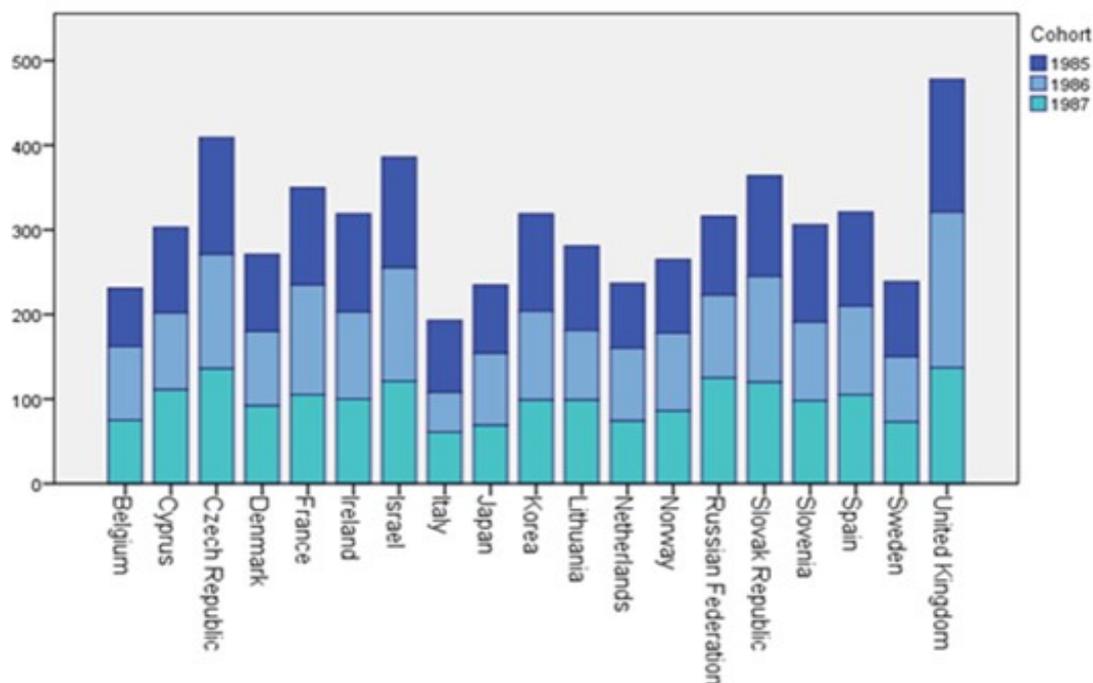
Notes. Retrieved from PIAAC.

4.1 Variables

In this section it will be describe in detail how the variables, educational attainment and quality of education system are defined and constructed.

4.1.1 Educational Attainment

Education is typically defined as either years of schooling or educational attainment. In this thesis it is defined as educational attainment. To define education as years of schooling could create problems in a cross-country analysis because you then have to assume that one year of schooling has the same effect in all countries which the differences in the construction of countries' education systems prevents. The same amount of years of schooling could mean different things in different countries (Blanden 2013, p.44-45). Instead, data on educational attainment of both parent and child will be used in this thesis.

PIAAC contains data of children's educational attainment which is distributed over seven different levels, according to the International Standard Classification of Education (ISCED) (OECD 1999). Additionally, there is also one variable which shows children's educational attainment in three different levels, more specific "Less than upper

secondary", "Upper secondary" and "Above upper secondary". When the children are asked about the highest of their mother or father's level of education they are measured in three different levels, namely "Neither parent has attained upper secondary", "At least one parent has attained secondary and post-secondary, nontertiary" and "At least one parent has attained tertiary". The answers "Don't know", "Refused", "Not definable" and "Not stated" are coded as missing values. The children's and parents' educational attainments are comparable because both corresponds with the "1 to 3" classification which is illustrated in "Descriptive Statistics".

The PIAAC survey is our main dataset used. It is essentially a survey of adult skills and is relevant for this thesis to measure educational attainment and the test score outcome of the children. This survey is done in three different rounds for different countries and around 250 000 adults participated. It was done through home interviews of individuals between the age 16 and 65. Data have been collected from 19 countries from the two first rounds that were carried out in 2012 and 2015 which resulted in around 5500 individuals. The survey was only conducted on individuals who have finished their education.

The child's test score outcome is based on their score on PIAAC's numeracy and literacy test. The average of these two tests was derived and used as a measurement of the child's cognitive ability. The countries differ in their means of their child's test score, which can be seen in figure 2.

Figure 2.
*The Countries' Average Score on the PIAAC-test*
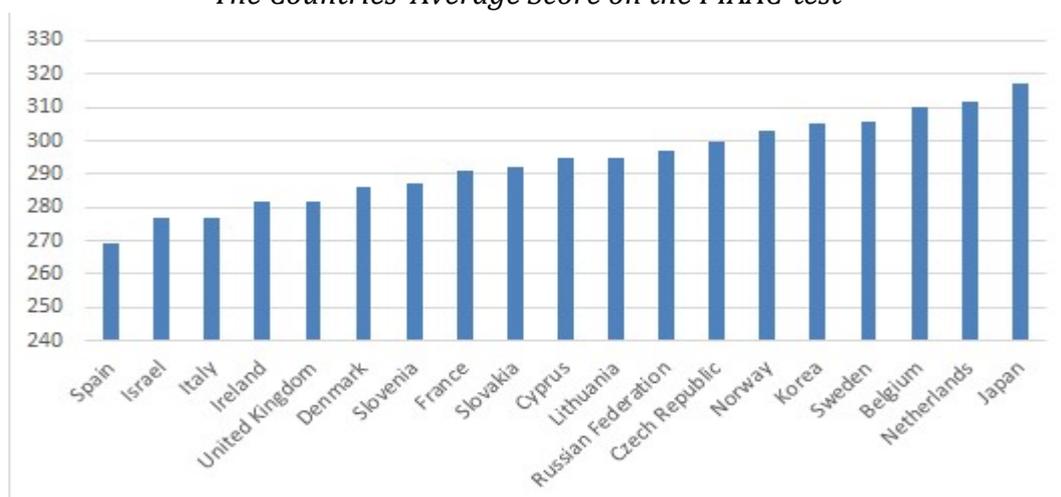
Notes. Retrieved from PIAAC. The test was made in 2012 for all countries except Israel, Lithuania and Slovenia where it was made in 2015.

4.1.2 Quality of the Education System

Education quality could be defined in different ways, many of them impossible to measure. Therefore, studies are limited to the definitions that are possible to quantify. This could be for example public spending on education. However, this definition could be misleading because it does not say anything about where or to what the money is spent. Because one major goal of countries' educational system is to improve the academic performance of the student, test scores is probably a better measurement (Rosen & Gayer 2014, p. 138-139). The test scores from the TIMSS-test from 1995 will be used, which was also the first time the study was carried out. TIMSS from 1995 is chosen because it matches the time when the individuals in the sample are young enough to just have started school. This is crucial to the thesis of several reasons. First of all, if it measured the quality when they had already started their education it would not have been possible to distinguish if it is the parents' investment choice or the education quality which affects the children's test score outcomes. Secondly, economic theories of utility maximizing parents will not be applicable if they did not have information about the quality of the education system at the time of their potential investments. Thirdly, the results of the TIMSS-test is comparable between countries and will then be easy to interpret.

The quality of a country's education system is based on the average results on the TIMSS-test from 1995. TIMSS is performed on students in primary school, middle school and the final year of secondary school and it includes tests in both mathematics and science. This comprehensive study gathers contextual data from over a half million students. The results were reported some years after the study was done in three different *achievement reports* (Beaton et.al. 1996a, 1996b, 1997a, 1997b and 1998). In order to get an appropriate estimation of the countries' education quality, the average test score from the different education levels of schools and both subjects for each country has been calculated. Some of the countries did not perform the test for all the education levels or subjects which means that our estimation of their quality is not as precise as the estimations based on results from both subjects and all three levels. The ten best performing countries, colored dark blue in figure 4, are defined as countries with high-quality education system.

Figure 3.
The Countries' Average Score on the TIMSS-test.
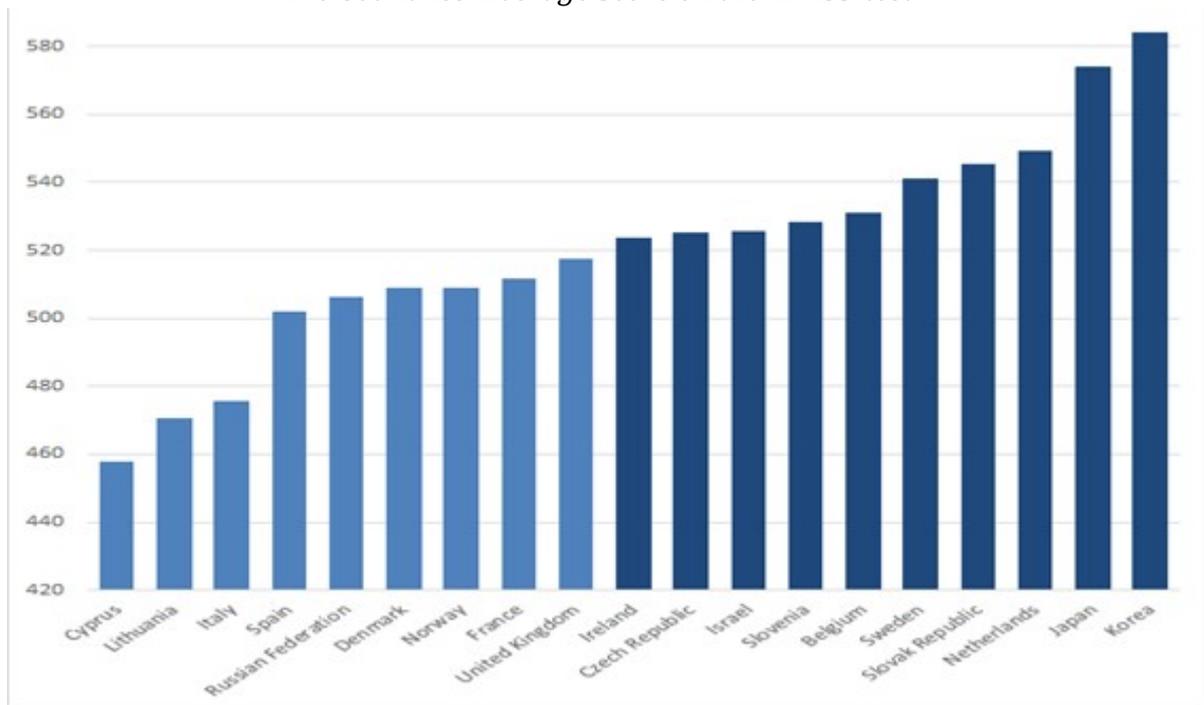
Notes. Retrieved from Beaton et.al. (1996a, 1996b, 1997a, 1997b and 1998). The test was carried out in 1995 for all countries.

4.2 Coding

The sample used in this thesis consists of 5970 observations of children. 478 of them did not report any of their parent's educational attainment, i.e. they answered "Not definable", "Don't know/Refused" or "Not stated or inferred". This answers are coded as missing. However, if the child only reported one of their parent's educational attainment, this was used as a measurement of the highest of mother or father's level of education. We are then left with 5492 individuals. Additionally 5 children did not report their own educational attainment but reported at least one of their parents'. This ends up with 5487 valid observations and 483 invalid for the regressions where we use children's educational attainment as dependent variable. 2 individuals did not do the PIAAC test and did not report their parents' educational attainment. We are then left with 5490 individuals when we run regressions with children's test score outcome as dependent variable. For the control variable "native", which shows if the individual are born in the country or not, 156 individuals had this as missing variable. Instead of excluding all these individuals we replaced the missing values with the average of the rest individuals, which was 0.884.

4.3 Problems with the Data

There is some problem with the data which will be described in detail in this section.

4.3.1 Assumption regarding when individuals finish their education

One issue with this data and the chosen cohorts is the assumption that individuals have finished their education when they are 25 years old, which not necessarily has to be the case. However, without this assumption the cohorts would be even older and the measurement of quality would be less accurate. The PIAAC survey excludes individuals who have not completed their studies yet and therefore the population could be distorted. Individuals who still has not finished their education when they are 25 or older could have certain characteristics which could affect our result, because they are not included. For instance, individuals who still educate themselves at the age of 26 tend to have attained higher educational level and therefore tend to differ in their characteristics compared to other 26 year olds who have finished their education. This problem could have been solved if instead the quality of the education system was measured earlier than 1995 because then we could use older cohorts. With older cohorts, it would not be a problem to assume that the age group have finished their education. However, this is not possible due to the fact that the first TIMSS was carried out in 1995. We will now try to show that our chosen individuals' educational characteristics is similar to the whole populations'.

Table 2 shows the proportion of the individuals who have tertiary education from another data set (Barro & Lee 2010) and ours (PIAAC). Barro and Lee (2013) uses the same grouping system of educational attainment as in this thesis, namely the ISCED, and their individuals are between 25 and 29 years old. The differences between the averages are relatively small (43.1% and 46.9%). If our chosen sample has approximately the same ratio of tertiary educated individuals as the rest of the 25 to 28 years olds in the whole population (which is represented by Barro and Lee's dataset) it indicates that our assumption that individuals finish their education when they are 25 years old is somewhat accurate. Note, however, that the Barro and Lee data set and PIAAC is from 2010 respectively 2012. The Barro & Lee data set also included 29 years old which also could affect the numbers.

Table 2.

Comparison Between Tertiary Educated Individuals in Two Different Data Sets

Country	Individuals who have attained tertiary education	
	Barro & Lee	Our sample
Belgium	43.1%	53.7%
Cyprus	50.5%	64.8%
Czech Republic	26.7%	37.2%
Denmark	33.1%	47.8%
France	42.2%	49.4%
Ireland	61.3%	39.2%
Israel	38.0%	47.2%
Italy	21.8%	22.5%
Japan	55.5%	61.3%
Korea	78.3%	65.3%
Lithuania	51.3%	52.7%
Netherlands	39.5%	39.2%
Norway	35.9%	42.3%
Russian Federation	71.6%	81.0%
Sweden	35.5%	43.1%
Slovak Republic	30.4%	31.3%
Slovenia	29.1%	39.9%
Spain	37.4%	35.2%
United Kingdom	37.3%	38.5%
Average (not weighted)	**43.1%**	**46.9%**

Notes. Retrieved from Barro & Lee (2010) and PIAAC.

4.3.2 Different Age

Another problem with the data is the individuals from the three countries where PIAAC was carried out in 2015 (the rest are carried out in 2012). They are from the same cohorts which means that they are in average three years older than the rest. This could suggest that their characteristics differ, due to their higher age. For instance, their performance on the PIAAC-test could differ.

4.3.3 Measurement of Quality of Education System

The TIMSS data, which measures the quality of education system, only includes individual's test score outcomes in mathematics and science. Their test score outcomes in reading are therefore not included in the classification of the education system's quality. This gap would be filled if data also was collected from another OECD organized survey called Progress in International Reading Literacy Study (PIRLS), which is basically the same as TIMSS except that it focus on reading ability rather than mathematics and science. Naturally, this addition would provide the study a more accurate measurement of countries' education systems and presumably contributed to a more correct outcome.

However, the reason this is not feasible for this thesis is simple that PIRLS was first carried out in 2001 which is, as discussed above, too late to qualify as a measurement of the quality of education systems in this thesis.

4.3.4 Cohorts

The decision to choose the cohorts 1985, 1986 and 1987 is considered the best to fulfill the purpose of the thesis. Still, the chosen cohorts will create some complications. If one assumes that children start their education at the age of five or six, it means that the chosen cohorts are already in school in 1995 when TIMSS was performed. This implies that our measurement of quality of education system is partly incorrect. Despite this, these cohorts have been chosen. This is motivated by the fact that the students who did TIMSS in 1995 either goes to primary, middle or secondary school which means that some of them started school in the late 1980's. This indicates that the TIMSS from 1995 also, in some extent, measures the countries' education quality from the years before 1995, assuming that a student accumulates knowledge and ability from all their years in school.

5 Descriptive Statistics

The following tables and figures will provide us some descriptive statistics of the used variables.

5.1 Some Descriptives of the Countries

Table 3 contains descriptive statistics of the countries used in the study.

Table 3.
Educational Attainment and Test Score Outcome

Country	Obs.	% of total observations	Mean of educational attainment, children	Std. Dev.	Mean of educational attainment, parents	Std. Dev.	Mean of test score	Std. Dev.
Belgium	260	4.4%	2.47	0.62	2.27	0.72	310.25	41.51
Cyprus	361	6.1%	2.54	0.69	2.01	0.76	294.76	39.12
Czech Republic	411	6.9%	2.31	0.58	2.22	0.48	300.30	39.13
Denmark	276	4.6%	2.36	0.68	2.30	0.75	286.18	59.24
France	356	6.0%	2.37	0.70	2.09	0.73	290.51	50.22
Ireland	319	5.3%	2.29	0.64	1.98	0.78	282.19	46.22
Israel	392	6.6%	2.34	0.70	2.33	0.79	277.20	53.86
Italy	196	3.3%	2.03	0.65	1.64	0.68	276.77	41.50
Japan	239	4.0%	2.56	0.60	2.55	0.54	317.12	34.45
Korea	322	5.4%	2.64	0.50	2.06	0.72	304.93	32.83
Lithuania	284	4.8%	2.46	0.62	2.64	0.61	295.03	40.31

Netherlands	239	4.0%	2.21	0.73	2.07	0.81	311.69	43.33
Norway	281	4.7%	2.34	0.63	2.45	0.66	303.00	50.14
Russian Federation	316	5.3%	2.78	0.48	2.42	0.63	297.34	39.23
Sweden	239	4.0%	2.36	0.61	2.49	0.68	305.88	59.73
Slovakia	364	6.1%	2.20	0.62	2.00	0.56	292.03	44.02
Slovenia	310	5.2%	2.31	0.57	2.09	0.65	286.53	46.78
Spain	321	5.4%	1.96	0.86	1.64	0.80	268.87	47.73
United Kingdom	484	8.1%	2.29	0.64	2.14	0.68	282.02	51.31
All countries	**5970**	**100.0%**	**2.36**	**0.67**	**2.17**	**0.73**	**292.72**	**47.61**

Notes. Retrieved from PIAAC.

5.2 Grouping of Educational Attainment

Table 4 illustrates how the different educational attainments are grouped in this thesis and how the different levels are defined. The distribution of both the children's and the parents' educational attainments are presented.

Table 4.
Grouping and Distribution of the Educational Levels

Level	Description	Number of observations			Coding	Our definitions
		Children	Children	Parents		
Below ISCED 1	Pre-primary or no schooling	75	636	1081	1	Primary
ISCED 1	Primary	86				
ISCED 2	Lower secondary	475				
ISCED 3	Upper secondary	2276	2493	2370	2	Secondary
ISCED 4	Post-secondary, non-tertiary	217				
ISCED 5	First stage of tertiary (e.g bachelor or master)	2740	2752	2040	3	Tertiary
ISCED 6	Second stage of tertiary (e.g PhD)	12				

Notes. Retrieved from OECD (1999) and PIAAC.

5.3 Distribution of Educational Attainment between Parents and Children

Table 5 shows the educational attainment of children of parents with different educational attainments. The proportion of children with primary education diminish as the parents' education increases (it goes from 29.5% to 3.63%). Similarly, the proportion of tertiary educated children increases as the parents' education increases (from 25.7% to 66.27%).

Table 6 is the same as table 5 except that only children from countries with high-quality education systems are included. The pattern is similar as in table 5.

Table 7 is the same as table 5 and 6 except that only children from countries with low quality education systems are included. The numbers differ slightly from table 6, especially for children with low educated parents where a bigger part of children in countries with low-quality education system attain primary education.

Table 5.

Distribution between parents and children with respect to educational attainment

Parents highest educational attainment	Child's highest educational attainment			Total
	Primary	Secondary	Tertiary	
Primary	318	483	277	1,078
	29.50	44.81	25.70	100.00
Secondary	158	1,178	1,033	2,369
	6.67	49.73	43.60	100.00
Tertiary	74	614	1,352	2,040
	3.63	30.10	66.27	100.00
Total	550	2,275	2,662	5,487
	10.02	41.46	48.51	100.00

Notes. Retrieved from PIAAC. The upper values represent the number of individuals and the lower values represent the percentage.

Table 6.

Distribution Between Parents and Children with Respect to Educational Attainment in Countries with High-Quality Education System

Parents highest educational attainment	Child's highest educational attainment			Total
	Primary	Secondary	Tertiary	
Primary	114	247	129	490
	23.27	50.41	26.33	100.00
Secondary	85	765	541	1,391
	6.11	55.00	38.89	100.00
Tertiary	35	348	666	1,049
	3.34	33.17	63.49	100.00
Total	234	1,360	1,336	2,930
	7.99	46.42	45.60	100.00

Notes. Retrieved from PIAAC. The upper values represent the number of individuals and the lower values represent the percentage.

Table 7.

Distribution Between Parents and Children with Respect to Educational Attainment in

Countries with Low-Quality Education System

Parents highest educational attainment	Child's highest educational attainment			
	Primary	Secondary	Tertiary	Total
Primary	204	236	148	588
	34.69	40.14	25.17	100.00
Secondary	73	413	492	978
	7.46	42.23	50.31	100.00
Tertiary	39	266	686	991
	3.94	26.84	69.22	100.00
Total	316	915	1,326	2,557
	12.36	35.78	51.86	100.00

Notes. Retrieved from PIAAC. The upper values represent the number of individuals and the lower values represent the percentage.

5.4 Test Score Outcome

PIAAC's test score can take a value between 0 and 500 and the following histogram and table illustrate the distribution and some characteristics of the test scores of the individuals in our sample.

Figure 4.
Test Score Outcome
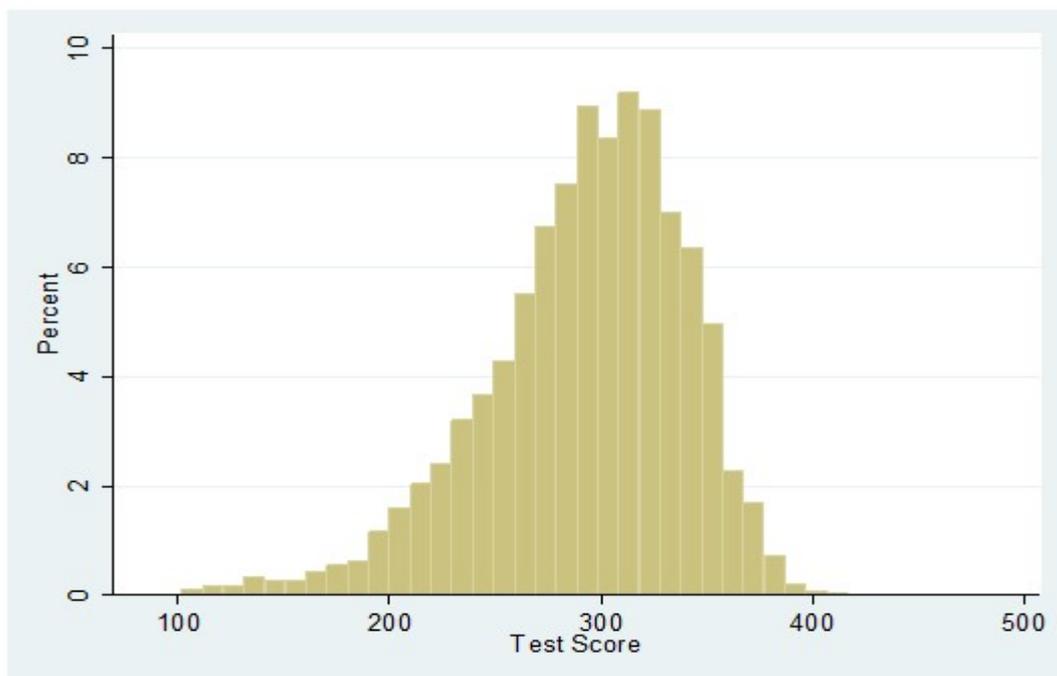
Notes. Retrieved from PIAAC.

Table 8.
Characteristics of the Test Score Outcome

Variable	Obs	Mean	Std. Dev.	Min	Max
Testscore	5823	292.7162	47.60856	81.8557	446.3593

Notes. Retrieved from PIAAC.

6 Method

Different econometric models will be used to answer our three questions:

1. Is there any transmission of educational attainment across generations?
2. Is the intergenerational transmission of educational attainment different between countries with education system of high respectively low quality?
3. Assuming there is a difference of intergenerational transmission of educational attainment between countries with high- and low-quality education system, how does the intergenerational transmission of educational attainment change for each specific group of educational attainment, i.e. primary, secondary and tertiary education?

For the first question, two simple ordinary least squares (OLS) regression models will be run, with two different outcomes: educational attainment of the child and the test score outcome of the child. The test score outcome is a measurement of cognitive ability. To answer the second question the quality of the countries' education system will be implemented in to the model. This is done by creating a dummy variable for quality and an interactive variable that consists of parents' educational attainment and quality of the education system. For the third and last question both a linear probability model (LPM) and a probit model will be used. In all models some control variables will be used which will be described more thoroughly later on.

6.1 Question 1

To see if there is any transmission across the two generations two OLS regressions will be run. They are both based on the original model of intergenerational mobility. Regression (8) aims to explain the educational attainment of children, E_i^{Child}, through the educational attainment of the parents. Regression (9) aims to explain the test score outcome of children, $TEST_i^{Child}$, through the educational attainment of the parents, $E_i^{Parents}$.

$$(8) \quad E_i^{Child} = \alpha + \beta \times E_i^{Parents} + ControlVariables + \varepsilon_i$$

$$(9) \quad TEST_i^{Child} = \alpha + \beta \times E_i^{Parents} + ControlVariables + \varepsilon_i$$

Just as in the original model of intergenerational mobility the β coefficients are of interest. A positive significant value indicates transmission across generations. The higher the value is of β, the lower is the mobility. An insignificant value or values close to zero would indicate that there is no transmission across generations which implies high mobility.

These regressions are done for all countries all together and separately for all countries. When the regressions are run for all the countries some country level variables are included, such as the Gini coefficient, GDP per capita and the amount that the country spends on education as percent of the country's GDP.

6.2 Question 2

The second question is answered by developing the models used for Question 1. The new additions are a variable for quality of education system, $Qual_c$, and an interactive variable that consists of the parents' educational attainment and quality of the education system, $Qual_c \times E_i^{Parents}$.

(10) $E_i^{Child} = \alpha + \beta_1 \times E_i^{Parents} + \beta_2 \times Qual_c + \beta_3 \times Qual_c \times E_i^{Parents} + ControlVariables + \varepsilon_i$

(11) $TEST_i^{Child} = \alpha + \beta_1 \times E_i^{Parents} + \beta_2 \times Qual_c + \beta_3 \times Qual_c \times E_i^{Parents} + ControlVariables + \varepsilon_i$

The quality variable is a dummy variable coded 1 for high-quality education system and 0 for low-quality education system. This will make it possible for us to tell the relationship between the quality of the education system and the educational attainment of the child as well as the relationship between the quality of the education system and the test score outcome of the child.

The value of β3 determines if the transmission of educational attainment or if the relationship between parents' educational attainment is different depending on whether the quality of the education system is high or low. The magnitude of β3 will determine to what extent the quality of the education system and the parents' investment in their

children are complements. If β3 is 0, then the quality of the education system and the parental investments are not complementary.

6.3 Question 3

6.3.1 Linear Probability Model

In the third and last question, the aim is to answer how the transmission of educational attainment and the relationship between the parents' educational attainment and the child's test score outcome change when controlling for the quality of the education system for different educational attainments. To do this, a linear probability model (LPM) is used which is an OLS model with a dummy variable as the dependent variable. A dummy variable is constructed for every level of education, i.e. one for primary education, one for secondary education and one for tertiary education. Furthermore, dummy variables for secondary education and tertiary education for the parents will be constructed. The parents with primary education will represent the intercept in the regression. There will be one regression for each educational attainment that the children can attain and additionally one for the test score outcome of the child. The regressions are presented below in equation (12) to (15). The educational attainment will be explained by parents with secondary and tertiary education (β1 and β2), the quality of the education system (β3) and interactive variables (β4 and β5). The interactive variables are an interaction between two dummy variables: the quality of the education system and the parents' educational attainment.

$$(12)\ TERT_i^{Child} = \alpha + \beta_1 \times SEC_i^{Parents} + \beta_2 \times TERT_i^{Parents} + \beta_3 \times Qual_c + \beta_4 \times Qual_c \times SEC_i^{Parents} + \beta_5 \times Qual_c \times TERT_i^{Parents} + ControlVariables + \varepsilon_i$$

$$(13)\ SEC_i^{Child} = \alpha + \beta_1 \times SEC_i^{Parents} + \beta_2 \times TERT_i^{Parents} + \beta_3 \times Qual_c + \beta_4 \times Qual_c \times SEC_i^{Parents} + \beta_5 \times Qual_c \times TERT_i^{Parents} + ControlVariables + \varepsilon_i$$

$$(14)\ PRI_i^{Child} = \alpha + \beta_1 \times SEC_i^{Parents} + \beta_2 \times TERT_i^{Parents} + \beta_3 \times Qual_c + \beta_4 \times Qual_c \times SEC_i^{Parents} + \beta_5 \times Qual_c \times TERT_i^{Parents} + ControlVariables + \varepsilon_i$$

$$(15)\ TEST_i^{Child} = \alpha + \beta_1 \times SEC_i^{Parents} + \beta_2 \times TERT_i^{Parents} + \beta_3 \times Qual_c + \beta_4 \times Qual_c \times$$
$$SEC_i^{Parents} + \beta_5 \times Qual_c \times TERT_i^{Parents} + ControlVariables + \varepsilon_i$$

The α-value represents the probability that the dependent variable takes the value 1 if all the explanatory variables takes the value 0. It is the same as the probability of a child to receive e.g. tertiary education when having a parent with primary education. The value of one coefficient represent the additional probability for the observations that takes the value 1 of that specific dummy variable. For instance, the value of the coefficient of the dummy variable for parents with secondary education (β_1) will be the additional probability for a child to receive e.g. tertiary education if its parents have secondary education.

To calculate the different probabilities for a child to receive e.g. tertiary education depending on the educational attainment of the parent, all the values of the coefficients of the dummy variables which takes the value 1 will be added. This will be done for all three levels of parental education. To clarify, an example of how to calculate a child's probability to attain tertiary education will be given. The example will be linked to equation (12). Let's say that the child lives in a country with a high-quality education system and its parents have tertiary education. The probability to attain tertiary education then consists of the values of α, β_2, β_3 and β_5. The α-value, i.e. the intercept, is the baseline and therefore always included as explained earlier. The β-values represent the additional effect of parents having attained tertiary education (β_2), the child living in a country with high-quality education system (β_3) and the combination of that the child has tertiary educated parents and living in a country with a high-quality education system (β_5).

There is, however, some problems with the LPM. It assumes that the marginal effects will be constant and also there is nothing that prevents the LPM from taking negative values or values larger than 1 (Dougherty 2011, p. 354-358). To avoid these problems the LPM will be compared to a probit model, which will be described in the next section.

6.3.2 Probit Model

There could be uncertainty in the accuracy of the results of the LPM model. Therefore, the results from the LPM will be compared with results from a probit model. A probit model is, just as the LPM, a model used when the dependent variable is a dummy variable. It is a binary choice model that instead of OLS uses maximum likelihood to predict probabilities. The model is nonlinear in its distribution and therefore the interpretation of the model will be different from the LPM. In the probit model is it not possible to interpret the coefficients in a standard way because they are only one part of the probability estimates. Unlike the LPM, the probit model is restricted to outcome values between 0 and 1, and the marginal effects will not be constant. (Dougherty 2011, p. 365-367)

The probit model have some weaknesses in this study. The probability of the outcome variable will be the unconditional probability for the child to receive a certain educational level. That implies that the intercept will not have the same interpretation as in the LPM. This means that the probabilities from the LPM and the probit model will not be comparable for the children of parents with primary education. Instead, only the coefficients for each dummy variable from the LPM will be compared with the probabilities for each dummy variable from the probit model. Ideally, the values from the probit model will be similar to the values from the LPM. This indicates that the probabilities from the LPM is accurate and inferences are possible to do.

6.4 Control Variables

The regressions include two dummy variables as control variables, namely if the child is born in the country and if both parents are born in the country. This data is collected from PIAAC. When running regressions for all countries, country level variables will be added as control variables in order to remove possible country level effects which could affect the outcome. These are the countries' Gini coefficients, GDP per capita and the spending on all educational levels measured as a percentage of the country's GDP. By keeping these variables the same, we will ideally show that our main independent variables are the reason for the changes in the dependent variable. The numbers are presented below for each country and represents data from 1995. If a country did not have any data from 1995, then data on years as close to 1995 as possible will be used. The Gini coefficient,

GDP per capita and the spending on education is collected from OECD (2018a & 2018b) and the World Bank (2018a, 2018b & 2018c).

The variable which shows the countries' quality of education system can be seen as a control variable. It shows whether or not the country has an education system of high quality and is based on their results on TIMSS. To get a better understanding of the country level variables, they will be presented below (table 9) followed by their effect on the children's educational attainment, where all control variables are included (table 10). See Appendix A for more characteristics of the control variables.

Table 9.
Country Level Variables

Country	Number of observations	High quality of education system?	Gini coefficient	GDP per capita	% of GDP spending on education
Belgium	260	yes	0.29	28 566	5.4
Cyprus	361	no	0.3	15 098	3.8
Czech Republic	411	yes	0.26	5 788	3.5
Denmark	276	no	0.26	35 351	5.4
France	356	no	0.31	27 038	5.1
Ireland	319	yes	0.33	19 181	4.4
Israel	392	yes	0.38	18 096	5.5
Italy	196	no	0.35	20 596	4.1
Japan	239	yes	0.32	43 440	3.2
Korea	322	yes	0.32	12 333	3.0
Lithuania	284	no	0.35	2 169	4.8
Netherlands	239	yes	0.3	28 885	4.0
Norway	281	no	0.28	34 875	5.7
Russian Federation	316	no	0.46	2 666	2.9
Sweden	239	yes	0.25	29 914	5.3
Slovakia	364	yes	0.27	4 799	3.7
Slovenia	310	yes	0.24	10 690	4.9
Spain	321	no	0.32	15 430	4.0
United Kingdom	484	no	0.36	23 013	4.8

Notes. Retrieved from PIAAC, OECD (2018a, 2018b & 2018c) and World Bank (2018a & 2018b). Gini coefficient, GDP per capita and % of GDP spending on education are collected from 1995 or as close to 1995 as possible.

Table 10.
The control variables' effect on the children's educational attainment.

	ChildEdu
Quality	0.0435*
	(0.024)
native	0.00865
	(0.809)
Parents natives	0.136***
	(0.000)
Gini	0.0129***
	(0.000)
GDP per capita	0.00000174*
	(0.048)
Spending	−0.0378**
	(0.001)
Constant	1.949***
	(0.000)
Observations	5881

Notes. *, ** and *** denote significance at the 0.10, 0.05 and 0.01 level, respectively. P-values in parentheses. Quality = A dummy variable which shows if the country has high-quality or low-quality education system. Native = A dummy variable which shows if the child is born in the country or not. Parents natives = A dummy variable which shows if both of the child's parents are born in the country. Gini = The country's Gini coefficient (OECD 2018a & World Bank 2018a). GDP per capita = The country's GDP per capita (World Bank 2018b). Spending = The country's spending on all educational levels measured as the percentage of all public spending (OECD 2018b & World Bank 2018c).

7 Results

Each question will be answered by an explanation and interpretation of the tables which will be presented below. The regressions have all been presented in chapter 6.

7.1 Question 1

By running the OLS regressions presented in 6.1 it is possible to identify significant positive values for the coefficients that explain the child's outcome with respect to the parents' education. The results is presented in table 11. When all countries are included, the intergenerational transmission of educational attainment is 0.324, which means that a difference of 1 unit of educational attainment in the parents' generation results in a difference of 0.324 units in the children's generation. With respect to each country the highest intergenerational transmission is observed in the Slovak Republic (0.591) and the lowest in Korea (0.124).

The results also show a relationship between test score outcome of the child and parents educational attainment. The coefficient for all countries is 21.8 which says that for each unit increase in the parents' educational attainment the child's test score outcome increases with 21.8 units. The relationship is the strongest in the Slovak Republic, 41.8, which also had the highest intergenerational transmission of educational attainment. The weakest relationship between the children's test score outcome and the parents' educational attainment is observed in the Russian Federation, 5.24. This coefficient is not significant so we cannot conclude any relationship at all. The results indicate that there is intergenerational transmission of educational attainment and that the test score outcome of the child has a positive relationship towards parents' educational attainment, for all countries except the Russian Federation. The results are presented in table 11. Both the results with respect to the specific countries and when all countries are included are presented.

Table 11.
Transmission Between Children and Their Parents

Country	Educational transmission from parents educational attainment	Std. Dev.	Rank	Test score outcome transmission from parents educational attainment	Std. Dev.	Rank
Slovak Republic	0.591***	0.0502	1	41.1***	3.54	1
Lithuania	0.468***	0.0549	2	24.8***	3.62	6
Italy	0.443***	0.0617	3	15.9***	4.20	14
United Kingdom	0.439***	0.0433	4	33.7***	3.44	2
Czech Republic	0.416***	0.0566	5	28.0***	3.88	3
Spain	0.384***	0.0567	6	16.5***	3.08	13
Japan	0.353***	0.0678	7	8.40**	3.96	18
Denmark	0.317***	0.0532	8	25.3***	3.97	4
Netherlands	0.308***	0.0570	9	18.4***	3.14	10
Belgium	0.307***	0.0550	10	25.0***	3.13	5
France	0.275***	0.0527	11	17.6***	3.58	11
Ireland	0.258***	0.0465	12	20.0***	3.24	9
Cyprus	0.244***	0.0412	13	9.81***	2.89	16
Norway	0.226***	0.0570	14	17.3***	4.05	12
Israel	0.226***	0.0457	15	24.5***	3.26	7
Slovenia	0.193***	0.0490	16	22.6***	3.76	8
Sweden	0.187***	0.0584	17	15.2***	4.45	15
Russian Federation	0.139***	0.0433	18	5.24	3.70	19
Korea	0.124***	0.0386	19	8.80***	2.40	17
All countries	**0.324***	**0.011**		**21.8***	**0.772**	

Notes. *, ** and *** denote significance at the 0.10, 0.05 and 0.01 level, respectively. The educational transmission and the test score outcome transmission represents the β-values from equation (8) and (9). Retrieved from PIAAC and TIMSS.

7.2 Question 2

The outcomes of the regressions presented in section 6.2 is shown below in table 12 and table 13. First, the values of the coefficients will be interpreted with words and continuously referring to the tables will be made. Recall the regressions which was presented in section 6.2:

(10) $E_i^{Child} = \alpha + \beta_1 \times E_i^{Parents} + \beta_2 \times Qual_c + \beta_3 \times Qual_c \times E_i^{Parents} + ControlVariables + \varepsilon_i$

(11) $TEST_i^{Child} = \alpha + \beta_1 \times E_i^{Parents} + \beta_2 \times Qual_c + \beta_3 \times Qual_c \times E_i^{Parents} + ControlVariables + \varepsilon_i$

The value of β_3 will tell us to which extent parents' investments into the child's education and the quality of the education system are complements to each other. As shown in Table 12, the coefficient of the interactive variable is -0.0800. The value is significant which means that it can be concluded that it is separated from 0. The interpretation of the result will now be explained.

The value of the coefficient of the first variable (β_1) shows the transmission of educational attainment or the relationship between test score outcome and parents educational attainment when the quality of the education system is low. To get the corresponding values for the countries with high-quality education system we add β_1 with the value of the coefficient of the interactive variable (β_3). The result shows that the intergenerational transmission of educational attainment decreases from 0.364 to 0.28 if the country has high-quality education system, which can be seen in table 13. This means that the transmission of educational attainment is lower in countries with high-quality education system, i.e. the intergenerational mobility in educational attainment is higher.

The value of the coefficient of the dummy variable for high-quality education system, 0.164, will be added to the intercept for the countries with high-quality education system. The value of the intercept in the countries with education system of high quality will be 1.627 and 1.463 in countries with education system of low quality. Based on the theory of utility maximizing parents this means that parental investments to some extent are complements to public investments i.e. the high-quality education system increases the rate of return to investment in the child's education. Then, for a child to reach one specific educational attainment, it requires a smaller amount of parental investment in countries with high-quality education system compared to countries with low-quality education system. This leads to higher intergenerational mobility in countries with high-quality education system than in low.

The results do not show the same kind of effect when it comes to the children's test score outcome, i.e. the quality of education system does not affect the test score outcome. On the contrary, the relationship between the parents' educational attainment and the children's test score outcome becomes slightly stronger if the quality of education system

is high. The value of the coefficient then increases from 21.74 to 22.34. The difference, though, is not significant so the difference could be negligible.

Table 12.
How Children's Educational Attainment and Test Score Outcome Is Affected by Different Variables.

	ChildEdu	Testscore
ParEdu	0.364***	21.74***
	(0.000)	(0.000)
Quality	0.164**	2.809
	(0.002)	(0.438)
ParEdu*Quality	−0.0800***	0.601
	(0.000)	(0.700)
native	0.0244	29.33***
	(0.489)	(0.000)
Parents natives	0.0824**	9.317***
	(0.004)	(0.000)
Gini	0.00964***	−0.427***
	(0.000)	(0.000)
GDP per capita	0.00000169*	0.000490***
	(0.043)	(0.000)
Spending	−0.0658***	−4.544***
	(0.000)	(0.000)
Constant	1.465***	235.4***
	(0.000)	(0.000)
Observations	5487	5490

Notes.*, ** and *** denote significance at the 0.10, 0.05 and 0.01 level, respectively. P-values in parentheses. ParEdu = Highest of mother or father's educational attainment. Quality = A dummy variable which shows if the country has high-quality or low-quality education system. Native = A dummy variable which shows if the child is born in the country or not. Parents natives = A dummy variable which shows if both of the child's parents are born in the country. Gini = The country's Gini coefficient (OECD 2018a & World Bank 2018a). GDP per capita = The country's GD per capita (World Bank 2018b). Spending = The country's spending on all educational levels measured as the percentage of all public spendings (OECD 2018b & World Bank 2018c).

Table 13.
Difference Between High-Quality and Low-Quality Education Systems

Coefficent	Educational attainment		Test Score Outcome	
	High Quality	Low Quality	High Quality	Low Quality
Intercept	1.627	1.463	238.21	235.40
Relationship between parents educational attainment and children's educational attainment/test score outcome	0.28	0.364	22.34	21.74

Notes. The interpretation will be that if e.g. the parents educational attainment increases by 1, the child's educational attainment will increase by 0.28 and its test score outcome will increase by 22.34, assuming the child lives in a country with high-quality education system.

7.3 Question 3

When running the LPM together with the probit model we will try to answer Question 3. The results will be explained for each of the child's educational attainment.

7.3.1 Children with Tertiary Education

The results, which is presented in table 14 and 15, show that the probability of a child receiving tertiary education increases with the parents' educational attainment. The coefficients' values of both the LPM and the probit model are close to each other. This indicates that LPM does succeed in providing values that can be trusted. When controlling for quality of the education system, the probability for a child to receive tertiary education increases for children with parents that have primary education from 0.189 to 0.222. For children with parents that have either secondary or tertiary education the probability decreases from 0.437 to 0.348 and 0.639 to 0.594.

Table 14.
Children with Tertiary Education

Variables	Coefficient	LPM	Sig.	Probit	Sig.
Constant	α	0.189	***		
Par.Sec	β_1	0.247	***	0.264	***
Par.Tert	β_2	0.449	***	0.457	***
High.Qual	β_3	0.032		0.036	
Par.Sec × High.Qual	β_4	-0.121	***	-0.124	***
Par.Tert × High.Qual	β_5	-0.077	**	-0.089	**

Notes. *, ** and *** denote significance at the 0.10, 0.05 and 0.01 level, respectively. Robust standard errors are used. Par.Sec = A dummy variable which show if the parents have secondary education or not. Par.Tert = A dummy variable which show if the parents have tertiary education or not. High.Qual = A dummy variable which shows if the country has high-quality education system or not.

Table 15.
Children with Tertiary Education

Parents educational attainment	Quality of education	Coefficient(s)	Probability (LPM)
Primary	low	α	0.189
Primary	high	$\alpha+\beta_3$	0.222
Secondary	low	$\alpha+\beta_1$	0.437
Secondary	high	$\alpha+\beta_1+\beta_3+\beta_4$	0.348
Tertiary	low	$\alpha+\beta_2$	0.639
Tertiary	high	$\alpha+\beta_2+\beta_3+\beta_5$	0.594

Notes. The coefficients refers to the coefficients from table 14.

7.3.2 Children with Secondary Education

The probability for a child to receive secondary education is greatest if the parents also have received secondary education. The probability becomes even higher if the quality of education system is high (increases from 0.432 to 0.533, see table 17). For the children that have parents with primary education the probability of receiving secondary education increases from 0.412 to 0.493. Children to parents with tertiary education have a probability of 0.269 to receive secondary education in countries with low-quality education system and 0.321 in the countries where the quality is high. In general, the values of the coefficients from both the LPM and the Probit model are similar in size.

Table 16.
Children with Secondary Education

Variables	Coefficient	LPM	Sig.	Probit	Sig.
Constant	α	0.412	***		
Par.Sec	β_1	0.020		0.018	
Par.Tert	β_2	-0.143	***	-0.158	***
High.Qual	β_3	0.081	***	0.078	***
Par.Sec × High.Qual	β_4	0.020		0.021	
Par.Tert × High.Qual	β_5	-0.029		-0.016	

Notes. *, ** and *** denote significance at the 0.10, 0.05 and 0.01 level, respectively. Robust standard errors are used. Par.Sec = A dummy variable which show if the parents have secondary education or not. Par.Tert = A dummy variable which show if the parents have tertiary education or not. High.Qual = A dummy variable which shows if the country has high-quality education system or not.

Table 17.
Children with Secondary Education

Parents educational attainment	Quality of education	Coefficient (s)	Probability (LPM)
Primary	low	α	0.412
Primary	high	$\alpha+\beta_3$	0.493
Secondary	low	$\alpha+\beta_1$	0.432
Secondary	high	$\alpha+\beta_1+\beta_3+\beta_4$	0.533
Tertiary	low	$\alpha+\beta_2$	0.269
Tertiary	high	$\alpha+\beta_2+\beta_3+\beta_5$	0.321

Notes. The coefficients refers to the coefficients from table 16.

7.3.3 Children with Primary Education

The probability to receive primary education is the highest if your parents also have primary education. In countries with low-quality education system the probability is 0.398 and in countries with high-quality education system the probability is 0.285, which can be seen in table 19. For the children that have parents with secondary education the probability is 0.131 if the quality of the education system is low and 0.118 if the quality of the education system is high. For the children that have parents with tertiary education the probability to receive primary education is 0.092 if the quality of education system is low and 0.085 if the quality is high.

With respect to children that receives primary education the results on Question 3 is not as reliable as in the first two models. All the values of the coefficients are higher in the LPM than the probit.

Table 18.
Children with Primary Education

Variables	Coefficient	LPM	Sig.	Probit	Sig.
Constant	α	0.398	***		
Par.Sec	β_1	-0.267	***	-0.140	***
Par.Tert	β_2	-0.306	***	-0.168	***
High.Qual	β_3	-0.113	***	-0.048	***
Par.Sec × High.Qual	β_4	0.100	***	0.039	**
Par.Tert × High.Qual	β_5	0.107	***	0.042	*

Notes. *, ** and *** denote significance at the 0.10, 0.05 and 0.01 level, respectively. Robust standard errors are used. Par.Sec = A dummy variable which show if the parents have secondary education or not. Par.Tert = A dummy variable which show if the parents have tertiary education or not. High.Qual = A dummy variable which shows if the country has high-quality education system or not.

Table 19.
Children with Primary Education

Parents educational attainment	Quality of education	Coefficient(s)	Probability (LPM)
Primary	low	α	0.398
Primary	high	$\alpha+\beta_3$	0.285
Secondary	low	$\alpha+\beta_1$	0.131
Secondary	high	$\alpha+\beta_1+\beta_3+\beta_4$	0.118
Tertiary	low	$\alpha+\beta_2$	0.092
Tertiary	high	$\alpha+\beta_2+\beta_3+\beta_5$	0.085

Notes. The coefficients refers to the coefficients from table 18.

7.3.4 Children's Test Score Outcome

The interpretation of the results with respect to the children's test score outcome is different than for educational attainment. The dependent variable is the test score outcome instead of a dummy variable. The coefficients should be interpreted as the expected value at the test score outcome for the children depending on their parents' educational attainment. This model is not comparable with the probit model. The results shows that the expected value with respect to each of the parents educational attainments if the quality of education system is high, however the differences is not significant. The expected value is 252.0 if the parents have primary education and the quality of education system is low and 253.8 if the quality of education system is high. If the parents have secondary education the expected value 278.4 in countries with low quality education system and 283.1 in countries with high quality. The expected value of a child's test score outcome is the highest if the parent have received tertiary education.

It is 296.2 if the quality of education system is low and 300.5 if the quality is high.

Table 20.
Children's Test Score Outcome

Parents educational attainment	Quality of education	Coefficient(s)	OLS
Primary	low	α	252.0
Primary	high	$\alpha+\beta_3$	253.8
Secondary	low	$\alpha+\beta_1$	278.4
Secondary	high	$\alpha+\beta_1+\beta_3+\beta_4$	283.1
Tertiary	low	$\alpha+\beta_2$	296.2
Tertiary	high	$\alpha+\beta_2+\beta_3+\beta_5$	300.5

Notes. The standard regression table can be found in Appendix B where the coefficients and significances are shown.

7.3.5 Summary of Question 3

To summarize the results from Question 3 it is possible to distinguish some patterns. For a child to a parent with primary education the probability to receive secondary or tertiary education increases if the quality of the education system is high. For children to parents with either secondary or tertiary education the probability to receive primary education or tertiary education decreases and the probability of receiving secondary education increases, when the education system is of high quality.

8 Discussion and Conclusions

The results demonstrate that there is a significant transmission of educational attainment across generations. This is the case for all of the 19 chosen countries included in the study. There is also significant results that suggest that there is a relationship between children's test score outcome and their parents' educational attainment. However, the magnitude of the transmission of educational attainment, as well as the relationship between the child's test score outcome and the parents' educational attainment, differs between countries. One possible explanation, as the second question tries to determine, could be that the level of transmission or relationship is different due to different quality levels of countries' education system. When a dummy variable for quality of the education system was included in the regression as well as an interactive variable consisting of both parents' educational attainment and quality of the education system, the transmission of educational attainment in the countries with high-quality education system was significantly lowered. This outcome emphasizes that the intergenerational mobility in educational attainment is higher in countries with high-quality education systems. However, the relationship between children's test score outcome and the parents' educational attainment does not seem do differ in the same extension.

The results from Question 3 complicate the conclusion made in Question 2. The results from Question 2 show higher intergenerational mobility in educational attainment in countries with high-quality education system. The results from Question 3 show that children to parents with secondary or tertiary education has a lower probability of receiving tertiary education if the quality of the education system is high. This could be explained by the fact that the high-quality education systems make the marginal utility of receiving tertiary education lower than in countries with low-quality education system. The quality of the secondary education in a country with high-quality education system could be high enough for parents to settle with that educational attainment for their children. In other words, it could be optimal for the parents to invest in the extent that makes the child to receive "only" secondary education. The results also show that for a child, to a parent with primary education, the probability of receiving both secondary and tertiary education increases. This implies that for parents with primary education, parental investments is a complement to quality of education system i.e. public investments. For parents with secondary or tertiary education they are substitutes.

Compared with the earlier research demonstrated in section 3 the results from this study differ in some way. Hertz et al. (2007) also did a cross-country study that demonstrated intergenerational transmission in education. The values however is not the same and the ranking of the countries do also differ to some extent. It is also worth to state that the measurement method is different from ours. Hertz et al. used years of schooling whereas we used educational attainment in this thesis. These differences could all be explanations to the different results. Checchi et al. (1997) findings emphasize that the US, that have lower public spending on education than Italy, still exhibits higher intergenerational mobility. In this thesis the result is the opposite, high public investment leads to higher intergenerational mobility compared to low public investments. The different results could be explained by the fact that high public spending, which is used in Checchi et al., does not equal high-quality education system. Hence, the US could have higher quality of education system than Italy even if the public spending is lower.

The results from this study give support to Becker's theories about offsetting effects as well as Solons model that showed that more public expenditure increases intergenerational mobility. Goldberger's criticism about the inability of economic theory to explain intergenerational mobility is not in line with the results in this thesis. Goldberger argues that the size of the parental investments is independent of parents' economic choices but we have concluded the opposite through economic theories.

To summarize, it is possible to increase educational attainment of children with low educated parents by increasing quality of the whole education system. However, it will not help those with higher educated parents due to offsetting effects.

9 References

Barro, R.J. and Lee, J.W. (2010). Barro-Lee educational attainment dataset. Electronic dataset. Viewed 7 May 2018, <http://www.barrolee.com/>.

Barro, R.J. and Lee, J.W. (2013). A new data set of educational attainment in the world, 1950-2010. *Journal of Development Economics*. vol. 104, p. 184-198.

Beaton, A.E., Gonzalez, E.J., Kelly, D.L., Martin, M.O., Mullis, I.V.S. and Smith, T.A. (1998). Mathematics and science achievement in the final year of secondary school: IEA's Third International Mathematics and Science Study (TIMSS). Chestnut Hill, MA: TIMSS International Study Center, Boston College.

Beaton, A.E., Gonzalez, E.J., Kelly, D.L., Martin, M.O., Mullis, I.V.S. and Smith, T.A. (1997a). Mathematics achievement in the middle school years: IEA's third international mathematics and science study (TIMSS). Chestnut Hill, Mass.: Center for the Study of Testing, Evaluation,and Educational Policy, Boston College.

Beaton, A.E., Gonzalez, E.J., Kelly, D.L., Martin, M.O., Mullis, I.V.S. and Smith, T.A. (1997b). Science achievement in the primary school years: IEA's third international mathematics and science study (TIMSS). Chestnut Hill, Mass.: Center for the Study of Testing, Evaluation,and Educational Policy, Boston College.

Beaton, A.E., Gonzalez, E.J., Kelly, D.L., Martin, M.O., Mullis, I.V.S. and Smith, T.A. (1996a). Mathematics achievement in the middle school years: IEA's third international mathematics and science study (TIMSS). Chestnut Hill, MA: TIMSS International Study Center, Boston College.

Beaton, A.E., Gonzalez, E.J., Kelly, D.L., Martin, M.O., Mullis, I.V.S. and Smith, T.A. (1996b). Science achievement in the middle school years: IEA's third international mathematics and science study (TIMSS). Chestnut Hill, Mass.: Center for the Study of Testing, Evaluation,and Educational Policy, Boston College.

Becker, G.S. & Tomes, N. (1979). An equilibrium theory of the distribution of income and intergenerational mobility. *Journal of Political Economy*. vol. 87. no. 6. p. 1153-1189.

Becker, G.S. & Tomes, N. (1986). Human capital and the rise and fall of families. *Journal of Labor Economics*. vol. 4. no. 3. p. 1-39.

Becker, G.S. (1991). A treatise on the family. Cambridge, Mass.: Harvard University Press.

Björklund, A. & Jäntti, M. (1997). Intergenerational income mobility in Sweden compared to the United States. *The American Economic Review*. vol. 87. no. 5. p. 10091018.

Blau, P., Duncan, O. & Tyree, A. (1967). The American Occupational Structure. New York: John Wiley.

Borjas, G.J. (2013). Labor Economics. 6th ed. New York: McGraw-Hill

Blanden, J. (2013). Cross-country rankings in intergenerational mobility: a comparison of approaches from economics and sociology. *Journal of Economic Surveys*. vol. 27. no. 1. p. 38-73.

Checchi, D., Ichino, A. & Rustichini, A. (1999). More equal but less mobile?: education financing and intergenerational mobility in Italy and in the US. *Journal of Public Economics*. vol. 74. no. 3. p. 351-393.

Corak, M. (2006). 'Do poor children become poor adults? Lessons from a cross-country comparison of generational earnings mobility' in Creedy, J. & Kalb, G. (red.). Dynamics of Inequality and Poverty Research on Economic Inequality. vol. 13. Emerald Group Publishing Limited. p. 143-188.

Corak, M. (2013). Income inequality, equality of opportunity, and intergenerational mobility. *Journal of Economic Perspectives*. vol. 27. no. 3. p. 79-102.

Dougherty, C. (2011). Introduction to econometrics. 4th. Oxford: Oxford University Press

Galton, F. (1886). Regression towards mediocrity in hereditary stature. *The Journal of the Anthropological Institute of Great Britain and Ireland*. vol. 15. p. 246-263

Goldberger, A.S. (1989). Economic and mechanical models of intergenerational transmission. *The American Economic Review*. vol. 79. no. 3. p. 504-513.

Hertz, T., Jayasundera, T., Piraino, P., Selcuk, S., Smith, N. & Verashchagina, A. (2007). The inheritance of educational inequality: intergenerational comparisons and fifty-year trends. *The B.E. Journal of Economic Analysis & Policy*. vol. 7. no. 2. p. 13-17.

Lindahl, M., Palme, M., Sandgren-Massih, S. & Sjögren, A. (2014). A test of the BeckerTomes model of human capital transmission using microdata on four generations. *Journal of Human Capital*. vol. 8. no. 1. p. 80-96.

OECD (1999). Classifying educational programmes: manual for ISCED-97 implementation in OECD countries. 1999 ed. Paris: OECD.

OECD (2016). Programme for the international assessment of Adult Competencies (PIAAC). Electronic dataset. Retrieved 14 April 2018, <http://www.oecd.org/skills/piaac/publicdataandanalysis/>.

OECD (2018a). Income inequality (indicator). doi: 10.1787/459aa7f1-en [Accessed on 7 May 2018]

OECD (2018b). Public spending on education (indicator). doi: 10.1787/f99b45d0-en [Accessed on 15 May 2018]

Rosen, H.S. & Gayer, T. (2014). Public Finance. 10th ed. New York: McGraw-Hill

Solon, G. (2004) 'A model of intergenerational mobility variation over time and place' in Corak, M. (red.). *Generational income mobility in North america and Europe.* Cambridge University Press, Cambridge, 2004, p. 38-47.

World Bank (2018a), Gini index (world bank estimate). [online] Available at: https://data.worldbank.org/indicator/SI.POV.GINI. [Accessed 7 May 2018].

World Bank (2018b), GDP per capita (current US$). [Online] Available at: https://data.worldbank.org/indicator/NY.GDP.PCAP.CD. [Accessed 7 May 2018].

World Bank (2018c), Government expenditure on education, total (% of GDP). [Online] Available at: https://data.worldbank.org/indicator/SE.XPD.TOTL.GD.ZS. [Accessed 7 May 2018].

10 Appendix

Appendix A.

Characteristics of the control variables.

Variable	N	Mean	SD	Min	Max
native	5814	0.88	0.32	0.00	1.00
parentsnatives	5970	0.78	0.41	0.00	1.00
ginicountry	5970	31.43	5.28	24.10	46.10
gdpcountry	5970	18878.51	11207.35	2169.00	43440.00
spendingcountry	5970	4.39	0.87	2.94	5.74

Notes. "speningcountry" represents the percentage of the country's GDP spent on all education levels.

Appendix B

Standard regression table with children's test score outcome as dependent variable.

Source	SS	df	MS				
Model	2499200.39	10	249920.039				
Residual	9626294.59	5479	1756.94371				
Total	12125495	5489	2209.05356				

Number of obs = 5490
F(10, 5479) = 142.25
Prob > F = 0.0000
R-squared = 0.2061
Adj R-squared = 0.2047
Root MSE = 41.916

Testscore	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
SECp	26.4134	2.201814	12.00	0.000	22.09697	30.72982
TERTp	44.27241	2.197687	20.15	0.000	39.96408	48.58075
qual	1.800669	2.581145	0.70	0.485	-3.2594	6.860738
SECp_qual	2.965804	3.152024	0.94	0.347	-3.213414	9.145022
TERTp_qual	2.437271	3.190464	0.76	0.445	-3.817306	8.691847
native	29.03386	2.423048	11.98	0.000	24.28372	33.78399
parentsnatives	8.903443	1.990014	4.47	0.000	5.002224	12.80466
ginicountry	-.3579456	.1242538	-2.88	0.004	-.6015324	-.1143589
gdpcountry	.0005099	.0000578	8.82	0.000	.0003966	.0006233
spendingcountry	-4.327805	.7812715	-5.54	0.000	-5.859408	-2.796203
_cons	251.975	6.436646	39.15	0.000	239.3566	264.5934

Note. SECp = A dummy variable which shows if the parents have secondary education or not. TERTp = A dummy variable which shows if the parents have tertiary education or not. qual = A dummy variable which shows if the country has high-quality education system or not.