Decreasing Compulsory School Leaving Age in Hungary:

Does it matter for regular students?

by

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Abstract

The aim of this thesis is to investigate if there is any connection between the compulsory school leaving age decrease from 18 to 16 implemented in Hungary 2011 and peer effects of low-ability students on regulars. The hypothesis is that there is a change in the behavior of the low-ability students due to the decreased age of leaving the education system. The methodology to estimate this connection is a two step procedure, the first stage is to establish that before and after time periods are significant predictors of students vanishing between 6^{th} and 8^{th} grade and that the peers have a possible effect on their class mates. The second stage is to estimate whether the effect of over-aged peers is significant and if there is a change in this effect by time periods. I find suggestive evidence for the underlying hypothesis implying that the implemented decrease non-directly affected regular students.

Contents

1. Introduction

There is need for compulsory education in a modern society according to the functionalist approach. It states that young people have to learn the basic social and mental skills to be a full member of their communities. It is obvious that governments should have the option to adjust these requirements to match the needs of changing times. There are two frequently used ways to establish these adjustments of demanded skills: by changing the curriculum or by changing the school entering and leaving age. Therefore, the minimum age that the students have to reach before leaving the educational system can be viewed as a suggestion from the states' side on what the demanded knowledge and level of maturity for each individual to be a full-fledged member of a society. Hence, an act of decreasing this age, as it happened in 2011 in Hungary, could be understood as a message towards the youth that studying is not as important as before. This could generate unintended spillovers for those who are not the targeted by the policy. Nonetheless, such a policy could have a drastic effect later on the low-skilled population as the compulsory school leaving age would be binding in their case.

In 2011 the Hungarian government accepted a regulation that decreased the Compulsory School Leaving Age (CSLA) fromm 18 to 16. The reason for such a change at that time was with the appropriate reforms to introduce students to the life of work would help the least motivated pupils to find their motivation that the schools could not provide. However, the idea of the reform itself was not welcomed equivocally by professionals, and even politicians of the government's side criticized such an education system for letting the students most in need of a proper education leave it.

To be able to make the appropriate reforms it would also be important to understand how compulsory schooling age changes can affect a student during her lifetime and the school outputs, and what the relation between school outputs and lifetime outcomes is. Even if this latter connection sounds trivial it is not a claim to be taken for granted. The most convincing research on the relation of schooling and pecuniary lifetime outcomes is related to Project STAR [Chetty et al. 2011] and it estimate the effects of kindergarten test scores on earnings. Another relevant Hungarian study [Hermann et al. 2019] estimates similar effect from the National Assessment of Basic Competencies(NABC) scores from 10^{th} grade. Several other studies based on the seminal paper of J. D. Angrist and Keueger 1991 estimate the return on an additional year of schooling by exploiting compulsory schooling changes. It would be reasonable to analogously assume a negative effect of decreasing the CSLA, although little research has been conducted on it. There is a study estimating the effect of the same policy on how it effects dropping out of students [Hermann 2019]. The main reason why this counterfactual change is not well researched is the rarity of such a policy change. My contribution is measuring the policy's effect on the school outputs of the students who are not directly affected by the policy through possible peer effects. Therefore, I also connect the two relevant literature of compulsory schooling change evaluations and peer effect estimations.

This thesis investigates how the 2011 decrease of the compulsory school leaving age from 18 to 16 in Hungary affected the school outputs of regularly proceeding primary school children's general competences in 8^{th} grade. As the regular students are not directly affected by such a change

I estimate the effect on them by their peers. I suggest measuring the ratio of over-aged students in the class, similarly to Lavy, Paserman, and Schlosser 2012 to proxy for the peer quality. My hypothesis is that due to the change in the limiting age the attitude of the students change and therefore there will be a difference in the peer effects on the regulars.

The thesis is structured as follows. Chapter 2 describes the policy change of interest and the antecedent policy with the institutional background. Chapter 3 summarizes the literature connected to compulsory schooling. The empirical methodology and the hypothesis are discussed in Chapter 4. Chapter 5 introduces the used data set and shows the descriptives in them. Chapter 6 discusses the results of the estimation, while Chapter 7 concludes the thesis.

2. Background of Decreasing CSLA in 2011

This chapter will thoroughly discuss the decrease if compulsory school leaving age that happened in 2011. First, I place the change in a historical context to discuss how it relates to the antecedent change of CSLA in 1996 in public reception and show some background motives for the change. Second, I compare the two concurrent Public Education Acts (1996 & 2011) on how severely they dealt with non-compliance of the students to form expectations about how the attrition rate could be affected. Finally, I show some descriptives about how PISA scores are changing relative to other countries with CSLA 16 to show that it is not a peculiar boundary and to see whether there are any changes in the trend of the outcomes of Hungary after 2012.

2.1 Historical Context

There were two changes in the CSLA in the past 30 years in Hungary. The first in 1996 increased the age by 2 years from 16 to 18. This change only affected those cohorts who started their education in 1998 or later. Furthermore, it was a widely accepted measure by both professionals and politicians [Mártonfi 2011]. The second change was to revert this increase in 2011 and it was a step disputed, if not opposed by professionals. This latter regulation, which is still in power, affected students by the 2012/13 AY for everyone who have not started their secondary education in previous years.

This translates in my data to be effective from 2013 as the NABC tests always taken in the second half of the year, in May. The uniqueness of this act is not that the CSLA became 16, as there are many countries even in Western Europe that has similar minimum age for school leaving but in the fact that the policy decreased it. Hence, my interest lies in the possible effects of the change of the CSLA on the school outputs of the students.

The new Public Education Act in 2011 stated that it is mandatory for every children to participate in the education system until they reach the age 16. This was modified in 2014 to the AY when the student reaches 16. This difference means that the student cannot drop out of the education system right on the day they turn 16 but have to finish that AY. This nuance can be important during the analysis as over-aged students could reach 16 before they are observed in the National Assessment of Basic Competences(NABC) measurement in 8^{th} grade, meaning that it was possible for students to drop out before the second measurement of NABC for 2 years of 2013/2014.

The idea for the change originates from the Hungarian Chamber of Commerce and Industry, as they urged the government to decrease the CSLA because of the emerging need for vocational workers. They wanted to reform the vocational system to be a more practice-oriented dual system similar to that of Germany. This realized starting from 2013 with a change in the curriculum of the vocational education system. The government also argued that this act would help a significant portion of the youths [Vorák 2011] as leading them towards the working life would help them find their motivation that the education system could not provide. Furthermore, they were on the view that the previous increase of CSLA put too much burden on institutions. This latter statement is debatable as the secondary education system had at least 8 years to prepare for welcoming the first cohort of students, who had to stay in school until they reached 18. This means that before the decrease, there were only a few cohorts who were finishing their primary education under the presumption that they would have to remain in the education system until they reach the age of 18.

2.2 Severity on Non-Compliance

To form expectations on the leniency of the regulations for school dropouts, the two sequential acts' harshness on non-compliance will be compared in this section. The baseline policy is the 1996 regulation and the Act of 2011 will be compared to it on how exceptions and sanctions due to missing classes were dealt with. Even though both Acts took several strong measures against dropping out, the data still shows that there were cases when the students vanished before reaching the legitimate age for leaving the educational system. However, these observations include students who left for any reason and not just dropping out because of losing interest in studying.

The act in 1996 defined or kept several standards on how to protect the pupils and what to do when they miss classes as Kazuska(2012) summarized it. It extended public education for children with special needs, even for those with severe mental or physical disability and also inhibited schools from expelling compulsory age students. There were also several defined exceptions that let students leave the system by the age of 16: if the student acquired the corresponding level of education early, or reached adulthood by marriage or needs to provide for his/her child.

On non-compliance it defined a thorough protocol where the institutions were required to keep records of students' absences and to inform the parents after the first unjustified absence. After repeated unjustified absences the school had to inform the parents about the consequences through the child welfare agency [Kazuska 2012]. This latter instruction meant to convince the parents to fulfill their responsibilities. When the number of unjustified absences reached 50 missed classes in total the school had to notify the corresponding authorities resulting in rule violation and fines even up to the monthly net minimum wage at that time. Furthermore, parents who would not let their children go to school for longer periods could even be imprisoned due to endangering a minor. [Kazuska 2012]

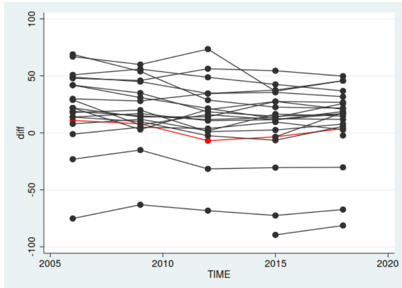
The new Public Education Act of 2011 kept most of the protocol on non-compliance defined in its antecedent. There was only an extension that added a category of 30 missed classes that would already count as rule violation compared to the prior 50 classes. Furthermore, it lifted the inhibit on expelling students that the schools could do due to severe repeated disciplinary misconducts.

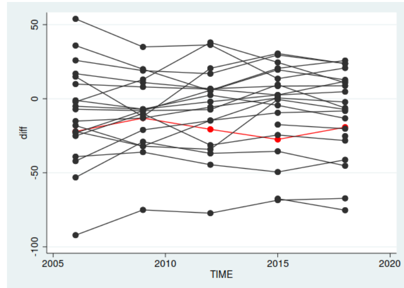
To sum up, there have been some changes on how to deal with over-aged and under-preforming students while the changes on non-compliance it did not affect the severity much. Therefore, I assume that there is no difference between the incentives of leaving the education system earlier before and after 2012. This means that for attrition rates the downgrade of the compulsory age would account for most of the effect.

2.3 CSLA 16 in the OECD

This section will compare how Hungary is achieving compared to OECD countries with CSLA 16. The comparison focuses on the OECD countries in this matter and excluding the countries where there is no national level regulation, such as the USA or Canada where there is difference in this matter across states. I found that 26 of the 36 OECD countries actually have the age of 16 as the upper boundary for compulsory education. This suggests that the Hungarian government's decision to decrease the compulsory leaving age was acceptable in the sense that there are role model countries where similar policy is implemented. However, the emphasis is on how unusual it is to decrease the boundary as almost every related policy increased it.

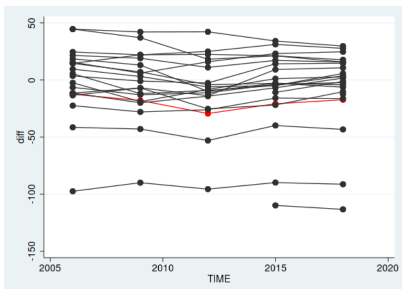
The PISA results of the corresponding countries with CSLA 16 across the years show

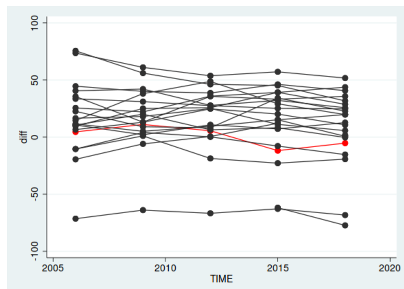




(a) PISA: boys' math results

(b) PISA: boys' reading results





(c) PISA: girls' math results

(d) PISA: girls' reading results

Figure 2.1: PISA scores of OECD countries with CSLA 16

Red line shows Hungary

slight evidence that the decrease was not helping in developing the competences of the children. The downward turning trend after 2012 could be a sign that the policy was affecting students competences in the wrong way. As the PISA takers should be 15 years old, it is compulsory for them to stay in the education system in Hungary under both reigning Acts. Therefore, even the compilers to be measured on the tests, except if they drop out even sooner. The fact that the observed scores are somewhat decreasing after 2012 is a sign that my hypothesis, that the decrease of CSLA to 16 has a positive effect on regular students who are not endangered of dropping out is false.

As Table 2.1 shows in each case, again there is a drop in the relative performance of

Table 2.1: Order of Hungary in the PISA performance

	Math				
	2006	2009	2012	2015	2018
All	34	33	34	36	37
U-HUN	10	11	6	8	9
	Reading				
	2006	2009	2012	2015	2018
All	33	33	34	36	36
U-HUN	11	12	9	6	11

The U-Hun row shows the numer of OECD countries which took part in the test and had poorer performance than Hungary.

Hungary in the short run and then there is some rebound. This can be seen by the sudden drop in the number of countries which performed worse than Hungary. The fact that the decline differs in the two measures can imply two things. First, the visible performance drop has no connection to the policy change as the two measures are not affected at the same time, or the reading competences are affected with a time-lag. This raises the question of heterogeneity in the effect of the policy that must be accounted for during the analysis.

3. Literature Review

In this chapter I will present the current standing of the literature on how schooling can affect labor market outcomes and discuss previous efforts on estimating peer effects. The former are important for me because the evidence in the literature gives relevance for why it is important to think about the effects related to schooling. The latter are important to learn about the previously estimated peer effects and to give an underlying for the methodology used for estimating them.

3.1 Schooling and labor market outcomes

There are two important factors when social scientists investigate the connection of schooling and labor market outcomes, the quantity and the quality of schooling. While the former was available for a long time it is proved to be unfit as a measure to explain within or across country differences [Hanushek 2009] , the latter is more relevant in the recent decades as standardized tests such as PISA and TIMSS offer a chance for quality comparisons. As the standardized measures are relatively new, in economics the literature on estimating the returns on the quantity of schooling is larger. These studies frequently use compulsory schooling law changes on estimating returns to schooling, both individual and social [J. D. Angrist and Keueger 1991, Oreopoulos 2006b, Oreopoulos 2006a, Acemoglu and Joshua D. Angrist 2000]. All together showing an appealing picture on how an extra year of schooling effects the life-time earnings and probability of unemployment of individuals. Therefore, tying more education to better labor market outcomes.

However, it is more important for this thesis to understand how the cognitive skills, measured on standardized tests are related to similar labor market outcomes. A large scale experiment in US, Tennessee called Project STAR uses randomly assigned students and teachers to evaluate many factors on academic achievement. An important research connecting this experimental data to administrative sources also evaluates how the test scores are related to earnings[Chetty et al. 2011]. They find that kindergarten scores are highly correlated to long-term pecuniary outcomes such as earnings at 27, retirement savings and home ownership. These results are showing the importance of standardized test scores in the future outcomes of individuals.

Another study[Lee and Newhouse 2012)] find that higher cognitive skills measured by international achievement tests are more likely to be enrolled in school and less likely to be unemployed using a cross country sample. Their results show some slight evidence on heterogeneity of effects across genders favoring women. They also provide specifications with both school attainment and test scores, where the test scores have stronger effects on unemployment and the attainment explained more of the job quality measures.

An even more related study is conducted on Hungarian data [Hermann et al. 2019]. They estimated the effect of the test scores in 10^{th} grade of the NABC data on the earnings and probability of unemployment. Finding that a standard deviation increase in the mathematics test scores would increase the earnings by at least 4%, while also decrease the probability of unemployment. This results is of extreme importance for me as I estimate the effect of the CSLA decrease on the same test's scores. Although I estimate the effects in 8^{th} grade, it is safe to assume that they would also have similar effects as the auto-correlation of standardized test scores is a well documented in case of repeated measures.

These three studies provide the relevance of why it is important to evaluate the effect of CSLA decrease effect on standardized tests too. They verify that the cognitive skills affect future labor market outcomes of the students positively. Therefore unintended effects on those who are not considered as a target for the decreased CSLA can be significant.

3.2 Peer effects

Estimating peer effects on students academic achievement is a difficult task because of the peers are simultaneously affecting each other. In the literature there are many attempts to find a correct measurement on peer quality that is unrelated to the subject students themselves [Joshua D Angrist and Lang 2004, Burke and Sass 2008, Hoxby 2000, Lavy, Paserman, and Schlosser 2012]. This is resolved usually by using a definition for peer quality that is plausibly related to the students cognitive capabilities such as variation in socioeconomic characteristics in adjacent cohort while also credibly unrelated.

There is a study from Anrist (2014) that is explaining the set backs of peer effect estimations such described above. The main point the author makes is that using group averages are frequently showing peer like effects due to rather a mechanical connection than behavioral consequences. Therefore, the estimated parameters reveal little about what to expect on policy induced changes. He also provides a theoretical framework in which the peer effect measures are connected to IV estimation with group averages being the result of a first stage equation on many weak instruments of group dummies. In this case a result of divergence between the estimates of an OLS using individual covariates and the 2SLS using the group averages can be explained by many things, from which peer effects is not the most likely.

Another point that Angrist (2014) makes is to consider that any broader grouping of observations is to be carefully evaluated as it is susceptible to causing weak instruments issues. The argument is that the difference between grouping should be similar to using many weak instruments to fewer. Therefore, the increasing group size produces less explanatory power in the first stage and such results in the inflation of the estimates and their standard errors.

There are two papers presenting immense value on understanding the background mechanisms of peer effects. They found two separate channels to explain peers effect on classes. The first is Duflo, Dupas, and Kremer 2011 using a randomize tracking experiment data from Kenya. Among several important results they find a positive peer effect for students with high achieving peers and that the low-achievers also benefited from tracking. Implying a mechanism that peer effects operate through teachers tailoring instruction levels to class composition, for further uses I will call this as composition channel.

The second is Lavy, Paserman, and Schlosser 2012 that uses survey data of schooling environment to shed light on background mechanisms of peer effects. They focused on the parts of the questionnaire that described pedagogical practices and class environment. The analysis of these variables show that low-ability students are more satisfied with teacher, while a relatively larger portion of them increases the chance for class disruptions and worsen the teacher-student relationships. The force responsible for class disruptions will be called disruption channel of the peer effects.

Another reason why the previously mentioned paper is important for this thesis is that the methodology used to identify the peer effects almost identical. Lavy, Paserman, and Schlosser 2012 uses the ratio of low-ability students in a grade level, defined as those who are born at least three month earlier than the cut-off date of school eligibility for their cohort. Therefore, the low-ability students are being older than their peers and most probably been held back at preschool or repeated first grade. The authors argue that this group is uncorrelated with high school, middle school characteristics of regular students as who is older is defined before elementary or in the first grades. Then they use a model with school fixed effects to estimate the effect of variation in the low-ability ratio in grades across cohorts.

In the thesis I use a similar age based definition of low-ability students considered over-aged if they reach 16 before the annual measurement of basic competencies in 8^{th} grade. That I use in a similar equation extended with time period interaction terms to see if there is a significant and persistent change in the peer effects of over-aged due to the implementation of decrease.

My contribution to peer effect measurements is to connect it to compulsory schooling literature with estimating the effect of peers before and after the implementation of a CSLA decrease. Previous CSLA studies were not concerned about such effects as they were more focused on measuring more exact relationships of how one extra year of studying would effect the local population of those who would have dropped out. However, such a decrease possibly could change the attitude of students that can change class composition if over-aged students chose to leave the education system while also can affect how disruptive their behavior is.

4. Methodology

The follow chapter will discuss the hypotheses on the data generation process and methodology that is used to estimate it due to the decrease of CSLA on those who are regularly proceeding with their studies. The method is a two step procedure to estimate an effect on the regular student population. They are regular in the sense that they neither lost between test observations or not over-aged at any point of their studies up to 8^{th} grade, therefore should not be targeted or affected by the change. The first stage is to test the hypothesis that the over-aged students leave the education system with a higher chance than regular students and that this mechanism gets stronger after the implementation of CSLA decrease. The second stage is to test that the assumed shift in composition of the classes due to the first stage relation affects the scores in a positive way. First, there is a discussion of the models that estimate the connection between being over-aged and losing the observation between 6^{th} and 8^{th} grade. Then, the thesis turns to describing the models of the second stage. Lastly, there is a discussion on the limitations of the described method.

4.1 Hypothesis on Data Generation Process

My hypothesis is that the compulsory school leaving age decrease affects the regular students through peer effects. There are two explanations for why would be a change in the peer effects of low-ability students. Either the low-ability students behavior changes or the behavior of regular students' change. There is not much reason for why would a regular student who anyway proceeded fine with her education change her behavior due to a decrease of compulsory schooling as she would not leave earlier under the new legislation. Therefore, I assume that the change is in the behavior of low-ability students. A possible explanation for that is already over-aged students would find the decrease in school leaving age more tempting. I test this assumption of difference in behavior between two periods in the first stage where I estimate a Difference-in-Differences like model on the connection of the group of over-aged students and losing the students between two observations.

To connect the previous change in attitude of over-aged students to test scores of the regular students I estimate the peer effects on the test scores of regular proceeding individuals in the second stage. This exercises requires a measure of peer quality, one that is exogenous of the characteristics of the regular students. I define my measure as the ratio of students in class at 6^{th} grade who would reach 16 before the NABC test in 8^{th} grade. To establish a link between the decrease in the CSLA and the peer effects it must be verified that the students are acting differently in the period before and after the implementation.

As the literature suggests there are two possible channels that explain peer effects, the disruption and composition channel. While there is no data available for me to measure disruption of the classes, I construct two measures of how class composition of students change between grade 6 and 8. The first is a change in over-age ratio the second is a transfer across deciles. These measures can help in understanding which channel is more prevalent in Hungary across the periods.

4.2 Identification of peer effects and change in peer effects

4.2.1 First stage: Over-aged students and CSLA decrease

In the first stage, the estimation is focused on how being over-aged would affect the probability of a student not showing up in 8^{th} grade observations if she is present at 6^{th} grade. Later the descriptives show that the over-age ratios of the classes are not much affected by the change in CSLA, while students in the classes that belong to higher deciles of the over-age ratio distribution have higher ratio of students vanishing. However, it is not clear from the descriptives how the timing of decrease affected these connections. I suggest the following two model(Eq. 4.1 & 4.2) to estimate the relationship between the two. I expect that this relation to be positive with even stronger effects after the policy change as with the change of the minimal age the boundary is much closer for an already over-aged student after the decrease and so it is more tempting for them to leave.

The first setup (Eq. 4.1) is a before-after approach on estimating the relationship. Therefore the parameters of interest are α and ρ. The interaction term in this case meant to catch the difference between the attitude to leaving the education system of the over-aged students before and after the change.

$$Lost_{ist} = \gamma_s + \lambda_t + \alpha OA_{ist} + \rho OA_{ist} \times D_t + \beta X_{ist} + \epsilon_{ics} \tag{4.1}$$

Where Lost is a dummy variable indicating if the student is not observed during any year of the 8 grade test between 2009-2017, γ_S is the site fixed effects, λ_t is the time fixed effects, OA indicates if a student is over-aged, D indicates if the student is in the after decrease period in grade 8 and X accounts for background characteristics of the students. The latter includes the education of the parents, mother's age, grades of the student in mathematics and reading in the previous AY, previous test score polynomials, family type, gender, number of siblings, special curriculum of the class, indicator for students who repeated in the first four grades, indicator for disadvantaged children and indicator for special needs, while also include indicators for missing values of the above.

The second equation is very similar to the first one, the only difference is that the over-aged variable is not interacted with a dummy signing in which period the student are. It is rather interacted with which year they took the test in 8^{th} grade. Everything else is matching the first setup. My expectation in this case is again a positive effect generally with the over-aged (α), while no or small effect on the pre-decrease period of before 2013 (δ) and a significantly higher positive effect turning on after 2013 (ρ).

$$Lost_i = \gamma_s + \lambda_t + \alpha OA_i + \sum_{\tau=-\underline{T}}^{-1} \delta_\tau OA_i \times D_{\tau t} + \sum_{\tau=1}^{\overline{T}} \rho_\tau OA_i \times D_{\tau t} + \beta X_i + \epsilon_{ics} \tag{4.2}$$

To test the relation between a regular student and the ratio of over-aged peers I estimate the above models with using over-age ratio instead the indicator variable. However, as it is suggested Joshua D. Angrist 2014 the explanation of this difference to be due to peer effects is just one of the many possibilities. With a significant difference that I use only the sub-sample of the students who are not over-aged in either grades. These specifications would tell if there are any peer effects of the over-aged students, while also show how the decrease in the CSLA could changed the peer effects on attrition.

The described Linear Probability Models(LPMs) main shortcomings is the possibility of predictions based on the estimates can be nonsensical. However, this bears with small importance for me as I do not use such predictions during the estimations or for interpretation of the estimates. I only need a verification on the hypothesized relationship between losing track of a student and she being over-aged and that the relative number of over-aged students are affecting the regular students possibility of attrition. Thus, as it easier to estimate and interpret the coefficients, than other non-linear models as logit or probit, it is a plausible approach to investigate the connection.

4.2.2 Second stage: Estimating peer effects on school outputs

The second stage consists of estimating the effect of class over-age ratio on the reading and math scores of the students. This is based on the assumption that the over-age measure is independent from the timing of the policy and positively correlated with the probability that the student is not observed in 8^{th} grade that would be verified by the first stage estimates and descriptives. According to the assumption a high measure of over-age ratio in a class would mean that the students in that class has a higher ratio of low-achievers, less motivated peers. The effect of these peers expected to be significantly different after introducing the decrease to age of 16.

The sample for these equations is only the observations who are not over-aged at the point of neither observations. This means that I filter out the observations who have not regularly proceeded with their education. Thus, concentrating on a sample that I consider as less, or even not, directly affected by the policy. To the analogy of the previous stage I estimate again two separate models for a before-after setup (Eq. 4.3) and a time-interacted version(Eq. 4.4).

In the before-after setup(Eq. 4.3) the parameters of interest are α and ρ as they together capture the effects to test my hypothesis. I expect a negative effect on α as considering a ceteris paribus interpretation according to Lavy, Paserman, and Schlosser 2012 more low-ability students in a class would negatively influence a students scores due to peer effects. As for the other parameter, a significant and positive ρ would tell me that after the change the baseline negative effect is somewhat decreased this favorable change could be explained as a shift in the composition of the class towards less over-aged, while a negative effect would tell that after the change the low-ability students peer effect is further intensified probably through the disruption channel.

$$Y_i = \gamma_s + \lambda_t + \alpha OAR_c + \rho OAR_c \times D_t + \beta X_i + \epsilon_{ics} \quad (4.3)$$

In the time-interacted version(Eq. 4.4) the coefficients that are important for testing the hypothesis are α, the δs and the ρs. According to my hypothesis α should be negative for the same reasons as above, the δs should not cause a significant difference across the classes, while ρs should have positive estimates to tune down the estimates from α.

$$Y_i = \gamma_s + \lambda_t + \alpha OAR_c + \sum_{\tau=-\underline{T}}^{-1} \delta_\tau (OAR_c * D_\tau) + \sum_{\tau=1}^{\overline{T}} \rho_\tau (OAR_c * D_\tau) + \beta X_{ics} + \epsilon_{ics}. \quad (4.4)$$

4.2.3 Limitations

As Joshua D. Angrist 2014 and Lavy, Paserman, and Schlosser 2012 suggest the above estimation only identify the effect of the peers if the variation of over-aged is exogenous on a school level across cohorts. The credibility of this assumption is not as well embedded in my case than in Lavy, Paserman, and Schlosser 2012 for two attributes of the Hungarian education system. First, the academic redshirting in Hungary is dominant as a large portion of students start their schooling at the age of 7. Therefore, there is no such a clear cutoff date for which I can say that the students were either held back in kindergarten or repeated a grade early on. This results in a measure that indicates rather if a student repeated a grade during their studies until 6^{th} grade. Second, the output is measured in 8^{th} therefore there is no reshuffle of the peers as most pupils in Hungary spend the first 8 grades in the same class environment. These limitations mean that the estimates in the best case scenario should be taken as suggestive evidence.

5. Data & Descriptives

In this chapter the National Assessment of Basic Competencies (NABC) data set will be introduced, which has been used throughout the analysis. I accessed it from the Hungarian Academy of Sciences Institute of Economics'(HAS IE) Data Bank. First, I describe how to deal with issues that have arisen due to the structure of the data, reveal the shortcomings of the available observations. Then, I show descriptive evidence to underlay the connections under investigation.

5.1 National Assessment of Basic Competencies

The National Assessment of Basic Competencies(NABC) data contains the appropriate measures to investigate my hypothesis. It is a test yearly taken in May by all 6^{th}, 8^{th} and 10^{th} graders across Hungary since 2008. There were measures before 2008 however, those were only representative samples taken from these grades, thence I did not use this first two years during the analysis. As the processing of the data takes up much time the latest year of observations available for me was 2017, therefore my sample contains data from 2008-2017.

It should be noted that the year of the observations always denote the year in which the test was taken thus they note the second half of the AY. This is important as the year from the decrease is effective on students modifies in the data to 2013. As it is a mandatory test, it should include all students from the given grades, however it is possible that students are not showing up due to several reasons. The most common and obvious reason is that children are absent because of illness. However, hypothetically it is possible that a teacher might want to manipulate the scores by persuading a few low achievers not to go to school that day. As there are no such complete studies, that measures such an effect I know of, I assume this is a negligible effect in most of the cases. However, one could assume that a teacher wants to take these efforts to earn her school a better position in the national ranking based on the tests and therefore the site fixed effects should account, at least partially, for such a manipulation.

I created the samples for measuring the effect from 6 to 8. In the regular case the students observed 2 years later from their previous test, therefore I use 2008-2015 for the earlier measure(6^{th} grade) and 2010-2017 for the later one(8^{th} grade). Later on I dropped the last year of observations as it was noisy in several cases because of those students who lagged behind and reached 8^{th} grade later would be defined as missing observations. I also, updated the student background variables with the 8^{th} grade values to possibly increase the coverage of the background variables.

However, there were still a portion of background characteristics missing. This is the consequence of this part of the data is acquired from a background survey that students fill out and it is not mandatory to answer all the questions for two obvious reasons. First, students might not know the answers for them. Second, they might not want to answer them as there are questions on some sensitive topics, even though it is stated that the answers are anonymous and only for research purposes. Therefore, I defined a missing category for all the variables that is used in the analysis to not to lose observations.

The mapping between the observations in the two grades gave rise for the second technical issue with the data, that is how to take care of the students who are repeatedly observed in the same grade but in different AYs. There are several reasons why a student would be observed multiple times across consecutive years in the same grade. Firstly, is the most trivial that they under achieved and so they did not meet the requirements to pass on to the next grade. Secondly, it is possible to obligate a student to take an exam at the end of the year to repeat a year if she missed too many classes in one year because of illness or other reasons and did not pass an exam at the end of the AY. This multiplicity in the observations give rise to a mapping issue namely that the students' unique identifiers would be multiple in each repeated cross section that forbids to make a perfect mapping between the different grades. I overcome it with filtering the data based on which occurrence it is separately. For the observations in the earlier test(6^{th} grade) I kept the last available year while for the later test(8^{th} grade) results I kept the first available observation.

The third issue, that came into sight was that the scores were measured in a different scale in the first few years of testing. In the first period the scores were measured according to a standard normal random variable with mean of 500 and standard deviation of 50, while in the second one it was measured with different mean(1600) and standard deviation(200). It is a scaling issue but still has to be noted as without accounting for this just by switching from one paradigm to the other would show significant differences. To solve this issue, I normalized the scores of each year to have mean of 0 and standard deviation of 1. This also helped in understanding the estimates as they are measured in standard deviations.

The fourth issue to note, is how to identify institutes for calculating site fixed effects. For this problem I used a translation table, also granted by HAS IE's Data Bank, which identifies each site geographically with one unique identifier over the year and the identifiers of the institute. This kind of identification is not accounting for changes in the name of the institute or the institute using the given site as the geographic parameters of the site are usually not modified by such a change.

Finally, and most importantly, there is an issue with the observational data that all pupils who left the education system are observed as missing and obviously not just those who dropped out willingly. This means that in the data all students who left for different reasons are treated the same way whether they moved to a different country, or could not continue their studies due to health issues, or dropped out willingly are each treated as a missing observation. This makes it is hard to correctly classify between the subgroups of the leavers and instead I estimate the peer effects caused by over-aged students to see how the policy affected the regular ones.

There is still one more problem with the observational data that is if a student is missing for the 8^{th} grade observation than there is obviously no year for them either. Therefore, to be able to use year FE-s for the equations in 8^{th} grade I updated the years of the observations from 6^{th} grade for the lost students. I added two years to the last year they were observed meaning they will account for the year when they should be in 8^{th} grade if they proceeded regularly.

Before continuing with the descriptives I must also discuss how the over-aged and the over-age ratios were defined for the analysis. There are four different measures I constructed, in each case the idea is to see whether someone reaches 16 by grade 8 before the test month. I use this definition because this way the previously mentioned change in 2014 that extended the leave from the day a student turns 16 until the end of the AY causes no discrepancy between the measures over time. It is important to note that this group is not just made up from repeaters as it was used in Lavy(2012), because the directly affected are not just those who are over-aged because of repetition. Therefore, the group is not that homogeneous as it includes those who had to skip due to any reason like health issues or family matters. The main results on school outputs are shown for calculating over-age ratio in the class in grade 6, while the other three includes a site average in grade 6 and the same measures in grade 8.

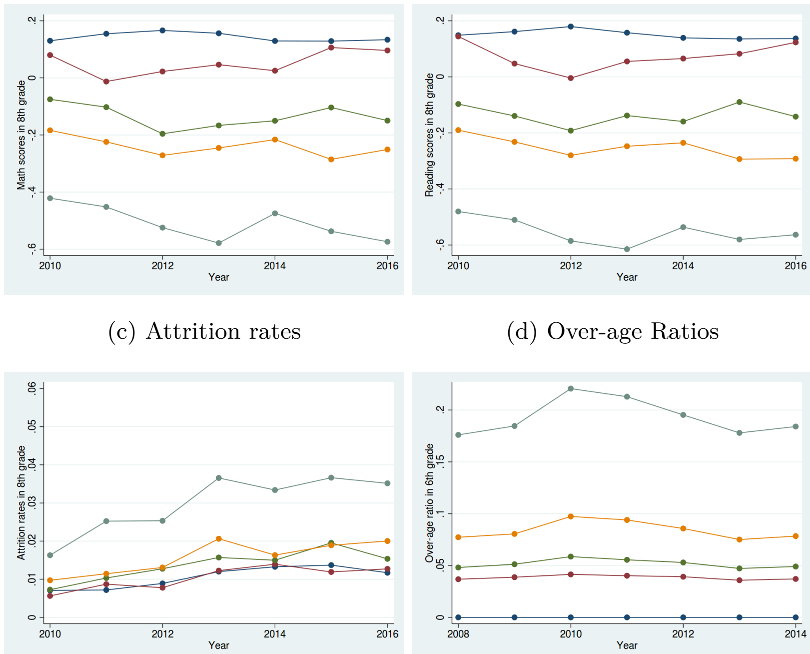
5.2 Descriptives

The following descriptives are demonstrating the general trends and connections between the main variables used in the analysis (definitions in Table A.1). Starting with the yearly mean variations of the four main variables of the analysis: the math and reading scores in 8^{th}, the average attrition rate between the two observations and the change of mean over-age ratio across deciles of the over-age ratio distribution. Followed by KDEs of the distribution of the change in class composition between 6^{th} and 8^{th} grade. Finally, presenting tables on the means and standard deviations of the variables.

The main variables are displaying a diverse picture on how the decrease in CSLA 16 affects them (see Figure 5.1). The averages of the scores by deciles do not show any clear negative effect by the time the decrease become effective (2013). However, there are some downward jumps after the decrease but they are not persistent and vary across the different deciles too much. Nonetheless, the changes in attrition rate depicts a clearer picture of difference between the period before and after the change. There is a persistent increase for every decile starting in 2013, that is according to the expectations as the limit is effective from that year on. The over-age ratio seems to be not affected either, but that is favorable for further analysis as it seems to be exogenous from the reform implementation. This is an evidence supporting that the over-age ratio is less dependent of time trends.

The class composition measured as the over-age ratio shows no difference between the two periods, while generally pictures a distribution with higher frequency for positive changes than negative (Figure 5.2a & 5.2b). Such positive changes mean that in the 8^{th} grade observation of the class the over-age ratio has become larger more frequently. Considering the class composition

Figure 5.1: Yearly trends of main variables



(a) Math score (b) Reading scores

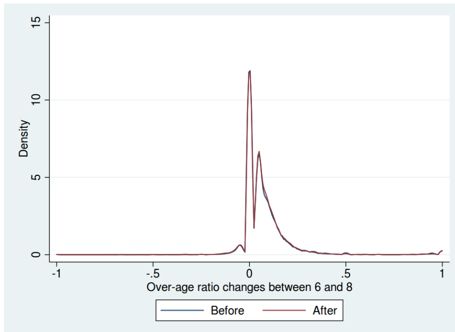
(c) Attrition rates (d) Over-age Ratios

The colors in order mean: blue-first 6 deciles, red-seventh decile, green-eighth decile, orange-ninth decile, grey-tenth decile

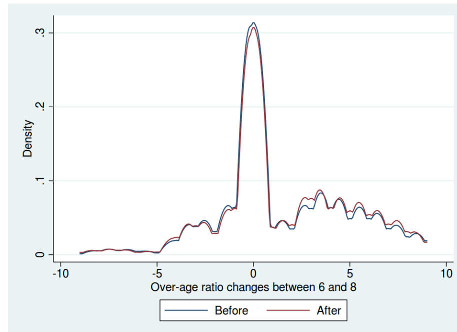
channel a tendency to have a positive change, meaning more low-ability students in the class would lead to negative effects on the outputs. However, it has to be noted that the largest portion has minimal or no change between the two tests. Therefore, it is hard to form a definitive expectation about the estimates on the outputs, while the negative results are more probable.

The averages of the outcome and independent variables show that over-aged students are low-achievers compared to the regulars and their background characteristics are significantly different (see Table 5.1). The most important is background characteristic is the ratio of early repeaters across over-aged. It is measured in the variable repeat1_4 and demonstrates that a

(a) Class composition change KDEs



(b) Class decile change KDEs



large ratio of over-aged students are repeated an early grade verifying that they are of low-ability similarly to Lavy, Paserman, and Schlosser 2012. Some further relations about background variables are showing that over-aged students are typically from a larger family, have lower educated parents and more frequently disadvantaged.

There are two further points to notice, first is that the two periods do not have much effect on background variables and on the over-aged measure neither. Which is also supportive for the analysis because then the observed characteristics are interfering less with the time related estimates of over-aged measures. And the second implies that the measure defined in either 6^{th} or 8^{th} grade is not affected by the implementation of the decrease on average.

Table 5.1: Mean and Standard Deviation of Variables Over Implementation Period and Over-age

	Non. Over-aged				Over-aged			
	Before		After		Before		After	
	mean	sd	mean	sd	mean	sd	mean	sd
OAR	.03	.05	.02	.05	.15	.15	.15	.15
OAR8c8	.08	.10	.08	.10	.20	.20	.18	.20
Math6	.06	.98	.05	.98	-.94	.87	-.96	.86
Math8	.04	.98	.03	.98	-1.04	.91	-1.12	.88
Read6	.07	.96	.06	.97	-1.05	.85	-1.06	.83
Read8	.04	.98	.03	.98	-1.14	.89	-1.21	.85
Lost	.01	.09	.015	.12	.18	.38	.26	.44
numSib	1.66	1.37	1.70	1.40	3.16	2.18	3.28	2.23
motherEd	2.59	1.03	2.65	1.04	1.62	.91	1.62	.91
fatherEd	2.50	.97	2.52	.99	1.78	.94	1.79	.96
hhh	.09	.29	.10	.30	.38	.49	.41	.49
math_prev	3.61	1.07	3.63	1.07	2.19	.81	2.13	.79
read_prev	3.45	1.09	3.48	1.10	2.24	.85	2.22	.85
rep1_4	.04	.20	.03	.18	.75	.43	.78	.42

6. Results and Discussion

This chapter will present the estimates of the aforementioned equations. First, I discuss the results on the first stage of the estimation and how they corroborate the connection of over-aged to losing and the possibility of peer effects. Second, the results of the school outputs will be presented that show some puzzling results but also verify that there is a change in the peer effects around the implementation of decrease. Finally, the robustness checks verify that the estimated results in both stages do not depend on the definition of the over-age measure or the way the missing variables were treated.

6.1 First stage

The first stage estimates are corroborating with the assumption that over-aged students are more probable to leave the education system and that the 2011 decrease of CSLA intensified this connection. The results in Table 6.1 show that students who are over-aged in 6^{th} grade generally have a higher chance to leave the education system before the NABC test in 8^{th} grade. The two panels picture a similar effect for the period after the decrease to the age of 16 came into power (from 2013). It is interesting that the added background characteristics decreased the effect of being over-aged in itself but did not affect the estimates of the interaction term. This means that the effect due to the decrease is less dependent on the background characteristics of the over-aged students. Such an effect could arise because of the defining factors on who becomes over-aged are not included in the background characteristics. In the last two columns the magnitude of the effects of the over-aged dummy and the interaction term are almost evenly matched, meaning that the over-aged students after the changed limit have drastically increased probability of vanishing between test measures.

The estimates of the effect of over-age ratio on the regularly proceeding students are different. This difference in estimates is a favorable as it can be interpreted as an evidence for peer effects. It is interesting that the over-age ratio itself is not significant in either case and that in Panel B of Table **??** it shows even negative effect for 2012. This could mean that before the decrease the students' over-aged peers are not affecting the regulars' attitude towards continuing their studies. The positive sign of the interaction terms however, implies that the higher the ratio of low-ability students is in class, the larger the chance that a regularly proceeding student drops out of school under the CSLA 16. This is a cardinal change caused by the decrease of the school leaving minimal age.

These results verify two important parts of my hypothesis. The former matches my assumption that over-aged students tend to leave the education system more frequently. The latter results show slight evidence for peer influence as the low-ability students affect differs from the standard OLS estimates. It is to be noted that regularly proceeding students are affected differently by the before and after period of the CSLA 16 implementation. There only seems to be an effect of low-ability peers on chances to drop out after the decrease in the CSLA.

6.2 Second stage

Lavy, Paserman, and Schlosser 2012 estimates behave similarly

Table 6.1: Estimates on the relationship of over-aged and leaving

Panel A: Before-After setup						
	Lost	Lost	Lost	Lost	Lost	Lost
OA	0.210***	0.168***	0.154***	0.0903***	0.0874***	0.0866***
OA ×After		0.0778***	0.0811***	0.0762***	0.0855***	0.0857***
Panel B: Time-interaction setup						
	Lost	Lost	Lost	Lost	Lost	Lost
OA	0.210***	0.163***	0.150***	0.0837***	0.0776***	0.0762***
OA ×2011		0.00910	0.00878	0.00750	0.00752	0.00878
OA ×2012		0.00517	0.00493	0.0112	0.0205	0.0214
OA ×2013		0.0383**	0.0404**	0.0381**	0.0484***	0.0496***
OA ×2014		0.0757***	0.0803***	0.0828***	0.0946***	0.0954***
OA ×2015		0.125***	0.126***	0.120***	0.137***	0.139***
OA ×2016		0.102***	0.107***	0.0996***	0.111***	0.112***

The columns present different estimated specifications, column 1 has only the over-age dummy, column 2 extends it with the interaction terms, column 3 adds site FE, column 4 uses further background controls, column 5 broadens with previous scores, column 6 augments it with up to 4^{th} degree polynomials of previous scores.

Table 6.2: Estimates on over-age ratio and leaving probability

Panel A: Before-After setup						
	Lost	Lost	Lost	Lost	Lost	Lost
OAR	0.118***	0.0976***	0.0417***	0.0129	0.0104	0.00855
OAR ×After		0.0378**	0.0480***	0.0481***	0.0528***	0.0531***
Panel B: Time-interaction setup						
	Lost	Lost	Lost	Lost	Lost	Lost
OAR	0.118***	0.0816***	0.0217	-0.0102	-0.0135	-0.0178
OAR ×2011		0.0335	0.0315	0.0299	0.0302	0.0338
OAR ×2012		0.0138	0.0249	0.0333	0.0352	0.0383*
OAR ×2013		0.0484*	0.0617**	0.0677**	0.0716***	0.0748***
OAR ×2014		0.0413	0.0623*	0.0620**	0.0665**	0.0690**
OAR ×2015		0.0557*	0.0583**	0.0578**	0.0624**	0.0655**
OAR ×2016		0.0722**	0.0918***	0.0982***	0.109***	0.111***

The columns present the same extensions of controls as in Table 6.1.

The second stage is even more interesting because the results are unexpected in both, outputs and the differences between the before-after and time-interacted setup. There are differences even between how the two measures are affected by the over-age ratio. However, the heterogeneity in the what measures effect numeracy and literacy is explained in the literature with the mathematics competences are more dependent on the school's contribution to the student. This explanation matches my estimates since the over-age ratio is a class related measurement that affects reading scores less significantly.

The overall effect of the before-after scenarios are negative for the after period in both output measures, however the interaction term is not significant in the case of reading (Table 6.3). Even if this means that my hypothesis, that the decrease in CSLA changes the peer effects, does not hold in this scenario, it is still interesting to see how mathematics competences are influenced by the after decrease period. The meaning of such a negative estimate on the interacted term is that the effect due to over-age ratio in class is amplified after the decrease of the CSLA. The reason for this is ambiguous as the amplification can be due to a change in the attitude and behavior of the over-aged (disruption channel), the regular or both types of students.

As for the time-interacted specifications, Table 6.4 has some differences in the estimates of time-interacted specification compared to the before-after scenario. The three most interesting differences are: the lost significance and puzzling sign of over-age ratio, the change in effect starting from 2012, the estimates on year 2014.

First, the over-age ratio itself has lost its significance showing a similar development to the first stage estimates on the regular students. This again, implies that just the sheer ratio of over-aged students is not affecting much their peers who are regularly proceeding in the before period. However, the sign of it is showing some positive effects due to the larger portion of low-

Table 6.3: Before-After School Output Estimates

Panel A: Math Scores						
	Math	Math	Math	Math	Math	Math
OAR	-3.734***	-3.590***	-1.317***	-0.438***	-0.135*	-0.154*
OAR ×After		-0.267*	-0.271**	-0.198*	-0.300***	-0.302***
Panel B: Reading Scores						
	Reading	Reading	Reading	Reading	Reading	Reading
OAR	-4.021***	-3.975***	-1.446***	-0.523***	-0.142**	-0.161**
OAR ×After		-0.0847	-0.104	-0.0189	-0.124	-0.124

The columns present the same extension of controls as in Table 6.1.

ability students. It is possible that this estimate is because it accounts for the baseline year of 2010 at the same time.

Second, the periodically interacted terms show similarity to the previous estimation. However, the negative effect starts from one year earlier than it is expected for both scores, in 2012 instead of 2013. It would be clearer with starting in 2013 since the decrease affected children from then on. This is a crucial point as this one year earlier decrease generates ambiguity in the interpretation of the estimates. However, there is a possible and favorable explanation that the attitude of students changed earlier as they would start their secondary education in a cohort that has the decreased age as a limit.

Third, is to mention what happened in year 2014 because in that one year there is a noticeable departure in the magnitude and significance of the estimated coefficients compared to the rest. This is clearly a sign of the given year being an outlier for estimating the effect by the over-age ratio. Other then the significant difference here, I did not find anything leading on why there is such an increase in the scores for classes with a higher over-age ratio. Even if the timing matches the modification of the act that changed the limit from the original date of birth to the end of AY, that would only mean that there would be more students staying in school and taking the test, who would have dropped out otherwise. Therefore, the modification in 2014 could not explain a rise in the scores of the regular students.

6.3 Robustness Checks

The aim of the robustness checks is to evaluate how differences in sampling and in the definition of over-age measure affects the previously presented estimates. First, I present and discuss the estimates with variations on how the over-age measure is defined. Then, I consider how removing

Table 6.4: Time-interacted School Output Estimates

Panel A: Math Scores

	Math	Math	Math	Math	Math	Math
OAR	-3.734***	-3.467***	-1.143***	-0.233	0.271*	0.245
OAR ×2011		-0.139	-0.117	-0.125	-0.296	-0.284
OAR ×2012		-0.202	-0.337	-0.407**	-0.769***	-0.760***
OAR ×2013		-0.251	-0.409*	-0.455**	-0.893***	-0.877***
OAR ×2014		0.0557	0.0540	0.0257	-0.147	-0.154
OAR ×2015		-0.751**	-0.674***	-0.579**	-0.785***	-0.778***
OAR ×2016		-0.706**	-0.828***	-0.644***	-1.015***	-1.013***

Panel B: Reading Scores

	Reading	Reading	Reading	Reading	Reading	Reading
OAR	-4.021***	-3.952***	-1.381***	-0.420***	0.0771	0.0275
OAR ×2011		-0.0539	-0.0174	-0.0575	-0.208	-0.162
OAR ×2012		-0.0155	-0.146	-0.207	-0.378**	-0.338*
OAR ×2013		0.0710	-0.0719	-0.108	-0.411**	-0.375**
OAR ×2014		0.195	0.126	0.117	-0.114	-0.0807
OAR ×2015		-0.490*	-0.444*	-0.363*	-0.422**	-0.384**
OAR ×2016		-0.292	-0.357*	-0.172	-0.439**	-0.423**

The columns present the same extension of controls as in Table 6.1.

observations from the sample due to missing background characteristics affects the estimation of the connection between leaving the education system and being over-aged. Finally, I examine the results on how removing observations combined with the variations of the over-age measure affect the results.

The differences arising from the definitions of over-age measures are not changing the nature of the estimates presented above, thus proving the estimates to be robust to the choice of over-age measures. However, it has to be noted that these measures are overlapping sometimes as those who are observed in 6^{th} grade as over-aged should also be included in the group if measured in 8^{th} grade. The same is the case with the class or site definitions: although the results vary the sign and significance of some coefficients, the interpretation stays the same.

The estimates of the before-after setup with variations of over-age measures have some slight differences compared to the original one, but none of those make differences in the interpretation(Table 6.5). The main difference between the estimates should be grouped as measuring in 6^{th} grade or 8^{th} grade. I motivate this as the magnitude of the estimates greatly varies by the grade the measure uses. It is also clear from how the coefficients vary that using the site measures produces larger estimates for second stage equations. This is in line with an explanation of Angrist(2014) on how larger groups would inflate the estimates. Considering the first stage results with an over-age ratio the 8^{th} grade class measures show lower estimates.

The robustness test of the interacted versions show interesting and cardinal difference in the interpretation of the second stage, while not influencing the first stage results much (Table A.3). The previously stated observations seem to hold for these results too as the second stage results are larger if the ratio is measured earlier and the first stage results are differing across whether it is measured in class or site. However, the overall effect of over-age ratio before 2012 on the

Table 6.5: Robustness checks on Over-Aged measures

Panel A: Over-age measure 6^{th} site			
	Math	Reading	Lost
OAR	0.0876	0.0364	-0.0153
OAR ×After	-0.458***	-0.224*	0.0525***
Panel B: Over-age measure 8^{th} class			
	Math	Reading	Lost
OAR	-0.0221	-0.0225	-0.00356
OAR ×After	-0.150**	-0.0290	0.0181***
Panel B: Over-age measure 8^{th} site			
	Math	Reading	Lost
OAR	0.0866	0.0606	-0.0149**
OAR ×After	-0.255***	-0.0980*	0.0296***

In each estimation the controls of column 6 of Table 6.1 was used.

scores has positive effects which does not support the assumption that low-ability students have a downgrading effect on the regulars. Nonetheless, this change in interpretation of the preperiod does not change that the results verify the change in peer effects after 2013.

The second exercises was to check how limiting the sample due to missing observations in the background characteristics affects the estimates. I split this exercise into two parts: first, I checked how the first stage is affected by limiting the sample to those for whom all the background variables are available; the second, I checked the same limited sample combined with different over-age ratio measures effecting the second stage estimations. Table 6.6 presents the first part of this exercise and shows that the results are practically no different than in the original setting. The second part is displayed in Tables A.4 & A.5, where again the estimates are not much different than in the previously discussed cases.

6.4 Discussion

To sum up, the overall estimates approved my hypothesis on how the decrease of CSLA could influence peer effects, while also show that these are influenced for the worse. This negative effect can be explained some attitude change in either over-aged, regulars or both. It is clearly shown that if there is any peer-related effect, it negatively influences the regular students' competences especially after the decrease. The effects vary across years, ranging between -.76 and -1.01 standard deviation of the scores for mathematics, while for reading the effects are much smaller ranging from -.34 to -.38 standard deviation.

These results verify that a compulsory school leaving age modification can affect not only those who are on the boundary of the age limit but also students who are regularly proceeding with their studies are also affected by such a change. Unfortunately in this case of decrease of the

Table 6.6: First Stage for the sample without missing background

Panel A: Before-After setup	
	Lost
OA	0.0662***
OA ×After	0.0820***
Panel B: Time-interaction setup	
	Lost
OA	0.0591***
OA ×2011	0.00133
OA ×2012	0.0187
OA ×2013	0.0480***
OA ×2014	0.0759***
OA ×2015	0.140***
OA ×2016	0.106***

In each estimation the controls of column 6 of Table 6.1 was used.

limiting age, the estimates show negative effects.

A possible explanation for the negative effects would be through the disruption channel, that is the students' motivation for studying further diminishes and behavior on the classes changes after the CSLA decrease. This could increase the intensity of the influence they have on their peers explaining why peer effect coefficients become significant after the implementation.

7. Conclusion

This thesis investigates if there is any possible connection between the compulsory school leaving age decrease from 18 to 16 implemented in Hungary 2011 and peer effects of low-ability students on the regulars. The hypothesis is that there is a change in the behavior of the low-ability students, defined as over-aged due to the decreased age of leaving the education system. The methodology to estimate this connection is a two step procedure, the first stage is to establish that before and after time periods are significant predictors of students vanishing between 6^{th} and 8^{th} grade and that the peers have a possible effect on their class mates. The second stage is to estimate whether the effect of over-aged peers is significant and if there is a change in this effect by time periods.

The results of the first and second stage show suggestive evidence for the hypothesis that there is a change in over-aged students behavior. The first stage results demonstrate that for over-aged students the after period has a significant effect on leaving the education system before 8^{th} grade, while also establishes a possibility for peer effects as the results estimated with over-age ratio instead of a dummy is significantly different then the previous OLS estimates. The second stage estimates display that there is a significant difference in the effect of peers between the time periods. These factors together could imply a change in student behavior that lead to changes in the peer effects.

This evidence implies that there are further possible unintended effects of a compulsory schooling policy through affecting cognitive skills of students measured in standardized test scores, especially if it is a decrease. As the literature find large scale evidence for labor market outcomes and test scores, Chetty et al. 2011 establishes the connection of kindergarten test scores and pecuniary outcomes in the US, Lee and Newhouse 2012 extends it for a cross-country sample with the fact that international standardized tests related to labor market outcomes and locally, for the case of Hungary Hermann et al. 2019 show that competencies at 10^{th} grade are significantly effect the future earnings.

Future research should be devoted to entangling the heterogeneity behind the suggested connection. There are numerous ways to approach this topic such as using geodata to find which regions and municipalities are the most effected or using ethnicity to account for estimating intra-race peer effects that could differ significantly due to the roma population's larger potion in the left tail of the ability distribution in Hungary. There are even chances [Joshua D Angrist and Lang 2004, Hoxby 2000] that genders are affected differently by their peers.

Another possible route to extend the current research is to estimate affects on life-time outcomes. Similarly to Hermann et al. 2019 using administrative data to find the regular students labor market outcomes and estimate either the effects of peers on them directly, or indirectly measure the score's effect as the authors did and combine it with the peer effect to get an estimate on the magnitude of peers. I think that the latter is a more plausible approach as the scores relation on wages is well established due to Mincer equations in the literature and the peer effects are also usually measured as effects on academic achievement .

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A. Appendix

Table A.1: Definitions of the Used Variables

Variable	Definition
OAR	Over-age ratio on class level measured in 6^{th} grade
OAR6s	Over-age ratio on site level measured in 6^{th} grade
OAR8c	Over-age ratio on class level measured in 8^{th} grade
OAR8s	Over-age ratio on site level measured in 8^{th} grade
Math6	Math scores on the test in 6^{th} grade, standard-normalized yearly
Math	Math scores on the test in 8^{th} grade, standard-normalized yearly
Read6	Read scores on the test in 6^{th} grade, standard-normalized yearly
Read	Read scores on the test in 8^{th} grade, standard-normalized yearly
Lost	Indicator variable of lost observations between the two grades
numSib	Categorical variable for number of sibling [1]
motherEd	Categorical variable for mother's education[2]
fatherEd	Categorical variables for father's education[2]
hhh	Indicator variable of cumulatively disadvantage students
math_prev	Categorical variable of earned math grade in the previous AY. [3]
read_prev	Categorical variable of earned reading grade in the previous AY. [3]
repeat1_4	Categorical variable on the number of repeated grades in the first 4.

[1]Categories: 0, 1, 2, 3 and 4 or more.

[2]The categories are 8 grade or less, vocation diploma, high school diploma, high education degree

[3]Range: 1-5

Table A.2: Mean and Standard Deviation of Variables Over Deciles of Over-Age Ratio

deciles	1		7		8		9		10	
	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
OAR			.04	.00	.05	.01	.08	.02	.18	.08
OAR8c	.05	.07	.09	.06	.12	.08	.15	.10	.26	.16
Math6	.16	.96	.06	.95	-.12	.96	-.19	.961	-.45	.98
Math8	.14	.97	.04	.95	-.13	.96	-.24	.97	-.50	.98
Read6	.18	.95	.08	.94	-.12	.95	-.21	.95	-.51	.97
Read8	.15	.96	.06	.94	-.14	.96	-.25	.97	-.55	.99
Lost	.01	.10	.01	.10	.01	.12	.02	.12	.03	.17
numSib	1.59	1.28	1.62	1.31	1.77	1.45	1.91	1.55	2.30	1.83
motherEd	2.77	1.01	2.63	1.00	2.39	1.01	2.23	1.00	1.95	.97
fatherEd	2.63	.97	2.49	.94	2.30	.93	2.17	.91	1.96	.90
hhh	.07	.26	.08	.27	.13	.34	.18	.38	.27	.44
math_prev	3.72	1.040	3.62	1.06	3.46	1.07	3.38	1.08	3.14	1.07
read_prev	3.56	1.08	3.46	1.09	3.32	1.10	3.24	1.10	3.04	1.08

The deciles are defined on the 6^{th} grade class over-age ratio distribution, for the first 6 deciles of it the over-age ratio is the same(0) and therefore there is no separate group for them.

Table A.3: Robustness checks for different over-age measures

	6^{th} **site**			8^{th} **class**			8^{th} **site**		
	Math	Reading	Lost	Math	Reading	Lost	Math	Reading	Lost
OAR	0.776***	0.372**	-0.0585***	0.229**	0.0642	-0.0101	0.531***	0.258**	-0.0310***
OAR ×2011	-0.454*	-0.287	0.0494**	-0.233*	-0.123	0.00571	-0.396**	-0.215*	0.0244*
OAR ×2012	-1.284***	-0.580***	0.0643***	-0.437***	-0.120	0.0118	-0.737***	-0.296**	0.0204
OAR ×2013	-1.395***	-0.699***	0.0938***	-0.501***	-0.0914	0.0317***	-0.838***	-0.287**	0.0554***
OAR ×2014	-0.421	-0.172	0.0872***	-0.190*	-0.0350	0.0238**	-0.323*	-0.120	0.0435***
OAR ×2015	-1.268***	-0.673***	0.0753***	-0.460***	-0.146*	0.0141	-0.788***	-0.371***	0.0294*
OAR ×2016	-1.491***	-0.695***	0.126***	-0.480***	-0.206**	0.0299**	-0.858***	-0.413***	0.0550***

In each estimation the controls of column 6 of Table 6.1 was used.

Table A.4: Robustness checks for sample without missing and over-age measure variations I.

Panel A: Over-age measure 6^{th} class			
	Math	Reading	Lost
OAR	0.244	0.00921	-0.0286**
OAR ×2011	-0.287	-0.150	0.0385*
OAR ×2012	-0.751***	-0.327*	0.0471**
OAR ×2013	-0.888***	-0.367*	0.0750***
OAR ×2014	-0.161	-0.0860	0.0715***
OAR ×2015	-0.793***	-0.387**	0.0620***
OAR ×2016	-1.003***	-0.384**	0.104***
Panel B: Over-age measure 6^{th} site			
	Math	Reading	Lost
OAR	0.781***	0.361**	-0.0629***
OAR ×2011	-0.465*	-0.277	0.0553***
OAR ×2012	-1.287***	-0.583***	0.0668***
OAR ×2013	-1.405***	-0.693***	0.0910***
OAR ×2014	-0.444	-0.192	0.0902***
OAR ×2015	-1.302***	-0.689***	0.0719***
OAR ×2016	-1.483***	-0.660***	0.116***

In each estimation the controls of column 6 of Table 6.1 was used.

Table A.5: Robustness checks for sample without missing and over-age measure variations II.

Panel A: Over-age measured in 8^{th} class			
	Math	Reading	Lost
OAR	0.227**	0.0675	-0.0127*
OAR ×2011	-0.230*	-0.132	0.00782
OAR ×2012	-0.423***	-0.121	0.0162*
OAR ×2013	-0.500***	-0.0965	0.0294***
OAR ×2014	-0.192*	-0.0393	0.0256**
OAR ×2015	-0.458***	-0.147*	0.0159*
OAR ×2016	-0.478***	-0.210**	0.0271**
Panel B: Over-age measured in 8^{th} site			
	Math	Reading	Lost
OAR	0.532***	0.266**	-0.0337***
OAR ×2011	-0.395**	-0.231*	0.0296**
OAR ×2012	-0.722***	-0.306**	0.0263**
OAR ×2013	-0.841***	-0.301**	0.0513***
OAR ×2014	-0.326*	-0.131	0.0483***
OAR ×2015	-0.796***	-0.382***	0.0319**
OAR ×2016	-0.861***	-0.427***	0.0510***

In each estimation the controls of column 6 of Table 6.1 was used.