labor&welfareSTATE

Early tracking and the misfortune of being young

by

Nicole Schneeweis

Martina Zweimüller

Working Paper No. 0920

October 2009

Supported by the
Austrian Science Funds

The Austrian Center for Labor Economics and the Analysis of the Welfare State

JKU Linz
Department of Economics
Altenberger Strasse 69
4040 Linz, Austria
www.labornrn.at

Corresponding author: martina.zweimueller@jku.at
phone +43 (0)70 2468 -5393, -8209 (fax)

Early tracking and the misfortune of being young*

Nicole Schneeweis
University of Linz
NRN Labor & Welfare State

Martina Zweimüller
University of Linz
NRN Labor & Welfare State

October 8, 2009

Abstract

In the Austrian (as well as the German) education system students have to choose between different school tracks at the age of 10. We argue that early tracking creates inefficiencies because the earlier the track choice has to be made, the more it is influenced by factors other than innate ability. Recent evidence suggests that the relative age of a student within a grade is related to his or her achievement, and that this effect is decreasing over grades. Thus, age-related achievement differences probably translate into age-related differences in track choice if track choice has to be made early. In this paper we estimate the effect of observed age on the track choice after grade 4 using register data for a major Austrian city for the period 1984-2006. Since observed age at track choice is endogenous, we exploit the exogenous variation in birth month to identify the causal effect of age. We find a strong and significant positive effect of age on track choice in grades 5–8. Since after grade 8, students again have to make a track choice, we use additional data from PISA 2003 and 2006 to show that the effect is long-lasting in urban areas. Therefore, the education system fails to provide a mechanism that leads to an efficient allocation of students to tracks.

JEL Classification: I21, I28
Keywords: Early tracking, school choice, age effect, instrumental variables, birth month

---

*Corresponding author: Martina Zweimüller, Johannes Kepler University of Linz, Department of Economics, Altenbergerstr. 69, 4040 Linz, Ph.: +43 70 2468 5393, Fax: +43 70 2468 8209, Email: martina.zweimueller@jku.at. For helpful discussion and comments we would like to thank Ludger Wößmann, Guido Schwerdt, Rudolf Winter-Ebmer and Martin Halla as well as seminar participants in Munich and Linz, and participants of ESPE 2008 in London and EALE 2009 in Tallinn. The usual disclaimer applies. We thank the Austrian Science Fund FWF (NRN Labor & Welfare State) for funding as well as the the municipality of Linz for providing us the data and a research grant. The usual disclaimer applies.

1 Introduction

Although all European countries allocate their students to different educational tracks at some stage of secondary education, in some countries, the decision about which track to attend has to be made at a relatively early stage of the education process, e.g. at the age of 10 in Austria and Germany.[1] In recent work, economists have shown that early tracking reinforces the role of parental background, thereby limiting intergenerational mobility in educational attainment and income (e.g. Ammermüller, 2005; Bauer and Riphahn, 2006; Brunello and Checchi, 2007; Pekkarinen et al., 2009b). For Germany, Dustmann (2004) provides evidence that secondary school track choice is heavily influenced by parental background and has lasting effects on further educational achievement and entry wages. Using a difference-in-difference approach, Hanushek and Wößmann (2006) show that countries that track their students before the age of 15 exhibit higher educational inequality and tend to have lower mean achievement.[2]

Apart from concerns about equality of opportunities, economists have stressed the effects of tracking on overall efficiency. Proponents of educational tracking emphasize that all students benefit from homogenous classrooms, which result from the placement of students into differing-ability schools or classes. They argue that heterogenous classrooms harm gifted students and less talented students alike because teachers may either divide attention among both groups or may adjust teaching to the proficiency level of the median ability student. In such a situation gifted students are not able to unfold their potential while less talented students get discouraged, resulting in lower aggregate achievement. In contrast, tracking may induce a teacher effect, i.e. teachers are more effective in teaching homogenous classes.

Exploiting a randomized experiment in Kenya, Duflo et al. (2008) provide evidence that tracking primary school students by prior achievement increased test scores of students in high-achievement and low-achievement classes because homogenous classrooms allowed teachers to focus their teaching. However, the authors admit that these results may only be obtained in developing countries, where students are very heterogenous and classes are large. In contrast, developed countries are characterized by smaller classes, lower achievement differences and a higher level of resources. Galindo-Rueda and Vignoles (2004) analyze the gradual abolition of

[1] Hungary, the Czech Republic, Slovakia and Turkey track at the age of 11, Belgium and Netherlands at the age of 12 and Luxembourg at the age of 13. All other European countries track their students at the age of 14 to 16 (Brunello and Checchi, 2007).

[2] Pischke and Manning (2006) show that a difference-in-difference approach is not able to eliminate the selection bias between students attending comprehensive and selective schools in England and Wales.

selective grammar schools in the UK. Using political affiliation of the county as an instrument of comprehensive school attendance they find some evidence that high ability students do worse under the comprehensive schooling system and low/middle ability students were not hurt by ability tracking. However, their estimates are imprecise, and Pischke and Manning (2006) show that their identification strategy is not able to remove the selection bias. As far as we know, there is no other direct evidence for efficiency gains through early tracking in developed countries.

On the contrary there are studies showing that early tracking is inefficient. Meghir and Palme (1995) find that the introduction of compulsory comprehensive schooling in Sweden induced on average an increase in schooling beyond the compulsory level and an increase in earnings for students with unskilled fathers. The mean effect on earnings for all students is positive but not significant. In a recent study, Pekkarinen et al. (2009a) investigate the impact of the Finnish comprehensive school reform in the 1970s on cognitive skills. The authors find small positive effects on mean achievement in verbal tests as well as positive effects in math for students with low parental education.

The literature on peer effects gives indirect evidence on the optimal allocation of students. If peer effects are non-linear, such that weak students benefit from high-ability students whereas the latter are less or not affected by less favorable peers, heterogenous classrooms should be more efficient as they lead to higher aggregate achievement. In contrast, if high-ability students are more sensitive to peers, aggregate achievement is maximized when classrooms are homogenous.

There is mixed evidence from the literature on peer effects, in particular with respect to non-linearities. While some studies show that students from less favorable social backgrounds and low achieving students are most affected by their peers (e.g. Lavy et al., 2008; Schindler-Rangvid, 2003; Schneeweis and Winter-Ebmer, 2007), other authors did not find any non-linearities (e.g. Ammermüller and Pischke, 2006; Hanushek et al., 2003). Carrell and Hoekstra (2008), on the other hand, found that peers from troubled families strongly impair the cognitive achievement of high income kids and the disciplinary behavior of low income kids.

To summarize the rationale: There are two channels how tracking might enhance efficiency, either through non-linear peer effects or through teacher effects. Both channels suggest that tracking should occur as soon as possible. However, tracking also comes at a cost: Ideally, track choice should be based on a student's innate ability. Actually, a student's ability is unobserved and track choice is based on an imperfect measure of ability, i.e. prior educational achievement (e.g. grades or test scores). Psychologists argue that the correlation between childhood and adult intelligence scores is low before 4th grade (Hopkins, 1990), and that at the age of 10 cognitive skills are still developing (Petersen, 1983). Therefore, the cost of tracking is the potential misallocation of students to tracks, and these cost are expected to be higher, the earlier the track choice has to be made.[3] Allen and Barnsley (1993) argue that the misallocation effect stems from the "impossibility of observing ability independent of maturity ..." (p. 649), resulting in achievement differences that are related to birth month.

Since school enrollment is always based on a certain cutoff date, the birth month of a student determines his or her position in the age distribution within a grade or class. Recent research has shown that this position is related to a student's achievement. For example, Bedard and Duhey (2006) show for a number of OECD countries that younger students perform significantly worse than their older peers in 4th and 8th grade.[4] However, the estimated effect is a combination of an age-at-test effect and a school-entry-age effect. Using IQ scores at the age of 18, Black et al. (2008) are able to disentangle these effects and find a strong positive age-at-test effect and a small negative effect of starting school one year later. Elder and Lubotsky (forthcoming) show that the age effect tends to be smaller in higher grades.

The main point of our paper is the following: If students are separated into different educational tracks very early, age-related achievement differences probably translate into age-related differences in track choice — irrespective of the exact origin of the age effect. Moreover, if age-related achievement differences are less important in higher grades, early tracking may contribute to their persistence whereas later selection could increase educational attainment and earnings.

We use register data from a major Austrian city for the period 1984 to 2006 to study the secondary school track choice of Austrian students. We estimate whether a student's observed age after 4th grade has any influence on the track choice thereafter. We propose that relatively younger students are more likely to choose a low track school instead of a high track school. Since observed age at track choice is endogenous, we exploit the exogenous variation in birth month to identify the causal age effect. After grade 8, students again have to make a track choice. We use additional data from PISA 2003 and 2006 to analyze whether the effect is long-lasting despite the possibility of track revision.

Related research has been done by Jürges and Schneider (2007), Puhani and Weber (2007) and Fertig and Kluve (2005) for Germany. Jürges and Schneider (2007) use data from the German PISA 2000 extension study and show that age at track choice has a sizeable positive effect on the probability to attend a high track school in grades

[3] Brunello et al. (2007) describe this trade-off in a theoretical model and denote the counteracting effects as "specialization" and "noise" effect.

[4] Similar results were obtained by McEwan and Shapiro (2008) for Chile.

5, 7 and 9. Puhani and Weber (2007) estimate age effects using register data for the state of Hessen. They find that students who are relatively young at school entry are more likely to choose the low track in 5th grade, but this effect disappears due to the possibility of track revision after 10th grade.[5] Fertig and Kluve (2005) use survey data and find no significant effect of enrollment age on track choice for students enrolled in the late 1960s and 70s.

Our study adds to the literature in several ways. First, as we use register data for 18 cohorts we are able to look at the development of the age effect on track choice over time. Second, we estimate the effect for boys and girls separately. Third, and most importantly, we investigate whether the importance of age diminishes due to the possibility of track revision after grade 8. Our results suggest that the age effect is reinforced in a system of early tracking.

2 The Austrian education system

The Austrian education system is characterized by early tracking, a multitude of different educational tracks and a strong vocational orientation. Figure 1 gives an overview.

Primary school starts at the age of six and takes four years. School enrollment is based on a cutoff date, children are enrolled in a given year if they turn six before September 1 of that year. Children turning six thereafter must delay enrollment by one year. Since children may differ in maturity, these enrollment rules are not strictly enforced, for example children who turn six between September 1 and December 31 may enroll early, if their parents apply for early enrollment, the health officer of the school confirms that the child is mature enough and the primary school principal agrees (*early enrollment*). On the other hand, if it turns out that a six-year-old child is not mature enough, he or she has to attend the pre-primary class instead of the first grade of primary school (*late enrollment*). Furthermore, if a student's achievement is insufficient in more than two subjects he or she has to repeat the whole grade (*grade retention*).

After primary school, i.e. at the age of 10, students can choose between two types of secondary education. Lower secondary (*low track*) schools comprise grades 5 to 8, provide basic general education and prepare students for vocational education

[5]However, the second result should be interpreted with caution because the estimations for grades 11 to 13 are partly based on simulated observations. For grades 11 to 13, the authors observe students who have chosen a high track school only. Therefore, they simulate the missing observations and assign them to the low track. For these students they impute birth month, enrollment age and all other individual characteristics based on the distributions of these variables in the previous year.

and training. Higher general (*high track*) schools comprise a first stage (grades 5 to 8) and a second stage (grades 9 to 12), provide advanced general education and conclude with a university entrance exam. These school types not only show differences in the curricula, but also in the qualifications and salaries of teachers.

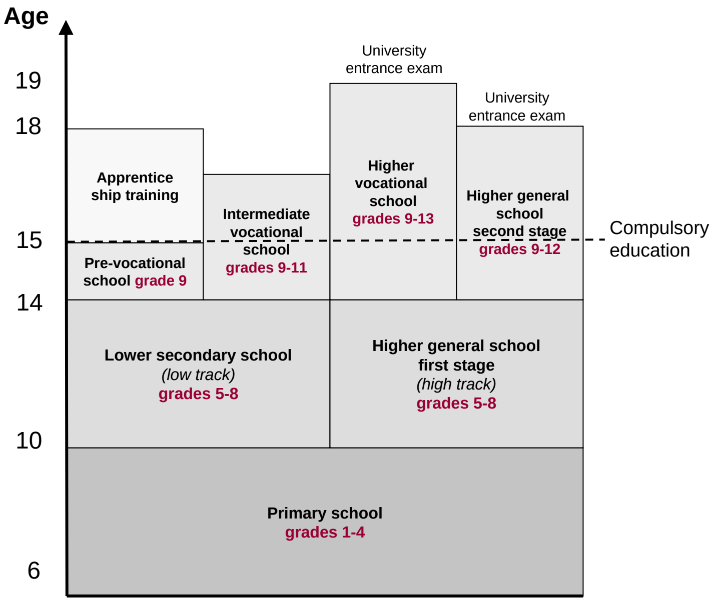

Figure 1: The Austrian education system

Admission to a high track school requires grades of "very good" or "good" in the core subjects of the primary school (German writing and reading, mathematics). If these requirements are not met, students have to sit an admission exam. Apart from that, track choice depends on parental choice and non-binding recommendations of primary school teachers. In principle, there is the possibility to switch from the low track to the high track, but depending on their performance, students may have to pass an admission exam. Upward mobility is virtually non-existent, whereas some downward mobility exists.

After grade 8, students again have the possibility to choose between different types of schools: a pre-vocational school, a range of intermediate and higher vocational schools or the second stage of a higher general school. Pre-vocational schools provide the last year of compulsory schooling for those students who intend to pursue an apprenticeship training. Intermediate vocational schools provide professional training and conclude with a final exam after three years. Higher vocational schools additionally provide advanced general education and university entrance qualifications. There are several types of intermediate and higher vocational schools with different professional orientations (e.g. business, technical, tourism, teacher training).

Although first tracking occurs very early, the education system provides some flexibility by allowing students to revise their track decision after grade 8. For example, students from low track schools have the possibility to go for a university entrance qualification by choosing a higher vocational or higher general school (*high track*) after grade 8. Depending on their grades, these students may have to pass an exam to be admitted to a high track school in grade 9. However, the difference in the quality of education between high and low track schools through the grades 5 to 8 hampers the transition to a high track school in grade 9 for low track students.

The majority of Austrian students attends a low track school in grades 5-8, e.g. in the school year 2006/07 about 67 percent of Austrian students attended a low track school in grade 8 (Statistik Austria, 2008). Figure 2 shows the transition of Austrian students after grade 8 separately for students attending high and low track schools in grade 8. The school choices of high and low track students are very different. While about 95% of high track students have chosen a track that provides university entrance qualifications, only about 35% of low track students changed to an academic track in grade 9.

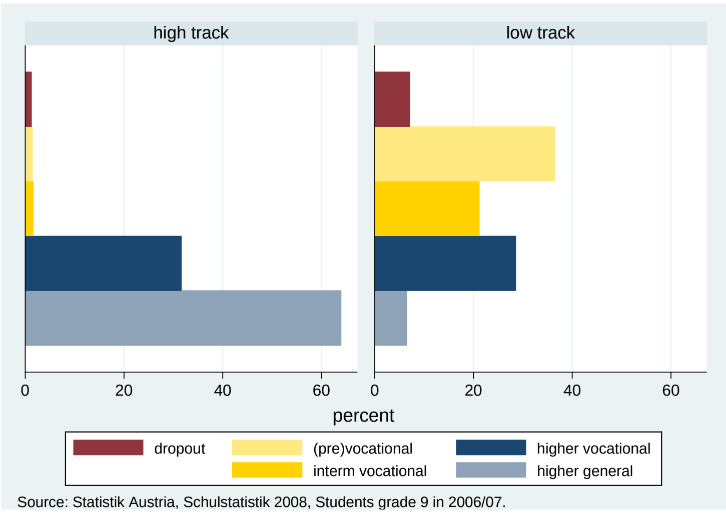

Figure 2: Transition of high- and low-track students after grade 8

3 Data

We analyze two sources of data: register data from the city of Linz, the third largest city of Austria with about 190,000 inhabitants, and data from two PISA studies. The register data cover all resident students who attended grade 5 in a public or a private school in Linz in the school years 1984/85 to 2001/02.[6] Students are observed until

[6]Our sample consists of 27 public schools and 6 private schools.

grade 8.[7] We observe some basic individual characteristics of the students (year and month of birth, sex, language) and their school career (school type, school, grade). In addition, we use survey data from the PISA studies 2003 and 2006, which cover a sample of Austrian students who were born in the years 1987 and 1990, respectively.

Table 1 presents summary statistics for our register data. Over the whole period, about 45 percent of students attended a high track school in grade 5. Because some students changed to a low track school, the percentage is somewhat lower in grade 8, indicating that downward mobility is greater than upward mobility. Girls were somewhat more likely to attend a high track school than boys in all grades. About 81 percent of students enrolled regularly, 1 percent enrolled early and 18 percent enrolled late.[8] Boys were more likely to enroll late, whereas girls were more likely to enroll early. Boys were also more likely to repeat a grade, both in primary school as well as in the first stage of secondary education (grades 5-8).

Table 1: Summary statistics

	Mean (%)		
Variable	All	Girls	Boys
High track (grade 5)	44.8	45.8	43.9
High track (grade 8)	41.4	42.9	39.8
Enrollment			
Regular	80.9	83.6	78.2
Late	18.0	14.9	20.9
Early	1.2	1.5	0.9
Repeated grade (grades 2-4)	3.6	3.1	4.0
Repeated grade (grades 5-8)	5.7	4.8	6.7
Immigrant background	5.2	5.1	5.2
N	25,232	12,469	12,763

NOTES: The sample consists of students observed in grade 5 between 1984-2001. We observe the same students until they reach grade 8.

As shown in Figure 3, the share of students who enrolled late was highest among students born in August, i.e. children born closely before the cutoff date (1st September). On the other hand, early enrollment is only an issue for children born closely after the cutoff date.

[7] Actually, our data also includes grade 9 students, but only those who have not repeated a grade or attended a pre-primary class. This is because the single purpose of the data collection is to report 9 years of compulsory schooling.

[8] Note that late enrollment means that children attend the pre-primary class of the primary school and enroll in first grade one year later.

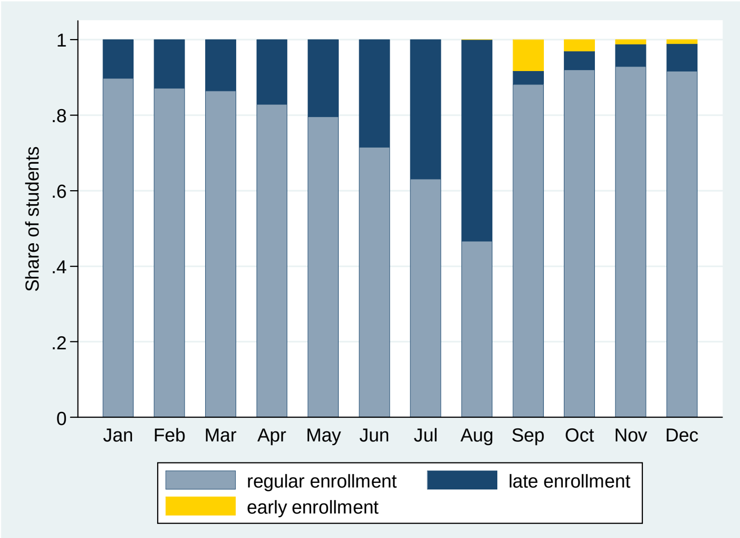

Figure 3: Regular, late and early enrollment by birth month

4 Estimation strategy

In a first step, we estimate whether observed age after 4th grade has any influence on the track choice thereafter. We begin with a simple model:

$$High\ track^{*}_{ig} = \alpha_{1g} + \alpha_{2g}\ Observed\ age_i\ + \alpha_{3g}\, X_i + \nu_{ig}$$

$$High\ track_{ig} = \begin{cases} 1 & \text{if } High\ track^{*}_{ig} > 0 \\ 0 & \text{otherwise} \end{cases}$$

where $High\ track^{*}_{ig}$ is the latent probability of student i to attend a high track school in grade $g = \{5, 6, 7, 8\}$, $Observed\ age_i$ is the observed age of student i after 4th grade (measured in years), X_i is a vector of student characteristics and ν_{ig} is the error term. We use observed age after grade 4 in each grade-level estimation because the track choice is actually made after grade 4 and not after each grade.

Variation in observed age arises from the following two sources: First, the distribution of births over the calendar year, and second, the non-compliance of some students to the school enrollment cutoff date. As our data suggest, some students enroll early and thus, are among the youngest within grade, whereas students who enroll late or repeat a grade in primary school are among the oldest within grade. Since we cannot assume that the reasons for irregular enrollment and grade retention are exogenous with respect to track choice, a simple probit model will give us a biased estimate of the age effect. The estimate is expected to be downward-biased if children who defer enrollment or repeat a grade tend to be negatively selected with respect to cognitive and non-cognitive skills, whereas children who start school early tend to be particularly skilled.

To identify the causal age effect, we only use the exogenous variation in observed age at track choice coming from the variation in birth month and the school enrollment cutoff date; i.e. we use the expected age at track choice as an instrument for the observed age at track choice. The expected age is the age a student should have if he or she had not deferred enrollment, started school early or repeated a grade. The first stage equation for observed age at track choice is the following:

$$\textit{Observed age}_i = \delta_{1g} + \delta_{2g}\, \textit{Expected age}_i \; + \delta_{3g}\, X_i + u_{ig}$$

where $\textit{Expected age}_i$ is equal to 0 for students born in August and equal to 1 for students born in September. The difference in expected age between August-born and September-born students corresponds to 11 months. The relationship between birth month and expected age is given by

$$\textit{Expected age}_i = \begin{cases} \frac{8-b_i}{11} & \text{if} \quad 1 \leq b_i \leq 8 \\ \frac{20-b_i}{11} & \text{if} \quad 9 \leq b_i \leq 12 \end{cases}$$

where b_i is the birth month of student i.

The identification of the causal effect of age at track choice is based on two assumptions. First, our instrument must be randomly assigned. This assumption requires that a student's birth month is random and not related to e.g. cognitive or non-cognitive skills or parental background. At least, we must assume that parents do not schedule births to fall either before or after the cutoff date. If, for example, high-ability parents are more likely to have their children in September than in August, because then they are among the oldest within grade, the estimated age effect would be upward-biased. Second, the instrument must not have any other direct effect on track choice. Since the register data does not provide us with any parental characteristics, we cannot check whether August-born and September-born students are different in characteristics that may affect track choice. However, we are confident that birth month is a valid instrument because the need for birth timing is less obvious in a system where the cutoff date rule is not strictly enforced (late and early enrollment is possible).[9] As a robustness check, we include quarter of birth in our regressions and show results for a regression discontinuity sample including only students born in August and September. In the PISA sample we control for an index of parental socioeconomic status and highest parental education.

[9]A birth month histogram for our sample of students shows that the distribution of birth months is relatively even, particulary for the birth months around the cutoff date.

We interpret our results in a local average treatment effect (LATE) framework (Angrist et al., 1996), implying that we estimate the causal age effect for compliers, i.e. for students who complied with the cutoff date rule and did not repeat a grade in primary school. As we have shown in Table 1 and Figure 3, this group is sizeable and should be relevant for policymakers.

Figure 4 presents the relationship between expected age (solid line) and observed age (dashed line) at track choice. The solid line shows that students born in August should be 10 years old when making their track choice, whereas students born in September should be 11 months older. The deviation of observed age from expected age is due to non-compliance with the cutoff date rule and grade retention in primary school. As expected, the highest deviation is found for students born closely before the cutoff date. These students are more likely to enroll late and to repeat a grade. Nevertheless, there is still a clear discontinuity in observed age at track choice between August-born and September born students.

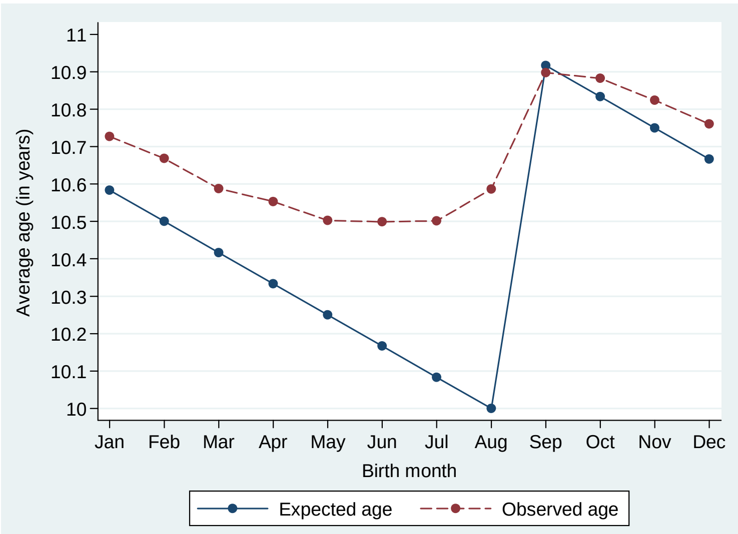

Figure 4: Birth month, expected age and observed age at track choice

From a policy point of view, we are also interested in the reduced-form relationship between expected age and track choice, which can be interpreted as the effect of the cutoff date rule net of grade retention in primary school and late/early enrollment (intention-to-treat effect). The model can be written as:

$$High\ track^*_{ig} = \theta_{2g} + \theta_{1g}\ Expected\ age_i\ + \theta_{3g}\ X_i + \epsilon_{ig}$$

Figure 5 shows the intention-to-treat effect with birth month instead of expected age at the x-axis. Even though August-born students are more likely to enroll late and to repeat a grade, which increases their age at track choice, those students are still significantly less likely to choose a high track school in 5th grade.

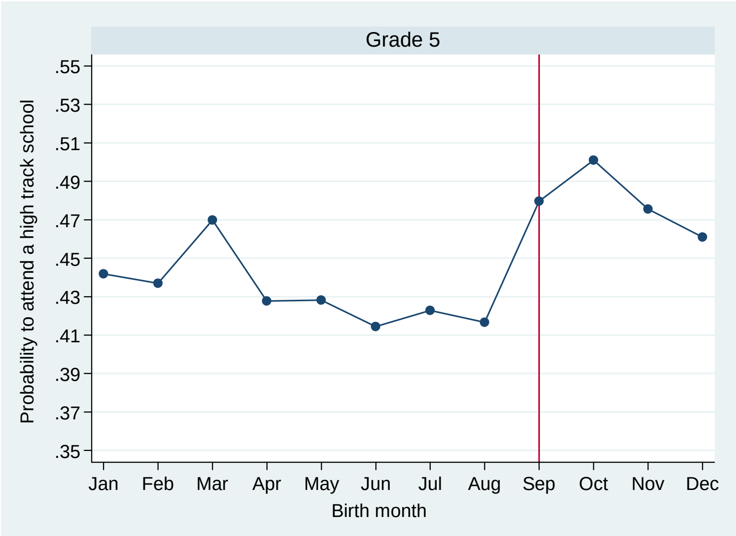

Figure 5: The reduced-form relationship between birth month and track choice

5 Results

5.1 Track choice in grades 5–8

In Table 2 we present our estimates of the effect of age at track choice on the probability to attend a high track school in grades 5 to 8. The table shows results from IV-Probit, first-stage, reduced-form and probit estimations for each grade. As the first-stage estimate and the F-statistics show, expected age seems to be a good instrument, in the sense that it is sufficiently correlated with observed age at track choice. The IV estimate suggests that being 11 months older at track choice increases a student's probability to attend a high track school in grade 5 by 17.5 percentage points, which is a substantial effect given that on average about 45 percent of students attend a high track school in grade 5. Table 2 also reports the results for grades 6–8 to show how the causal effect of age at track choice evolves over grades. We would expect the effect to diminish over grades if small differences in age become less and less important as the school career progresses. For grade 8, the point estimate is somewhat smaller (15.4 percentage points), but the difference is not significant. We conclude that the Austrian school system has no "self-correcting mechanism" between grades 5–8 that leads to a correct allocation of talents.

The reduced-form estimate shows the net impact of the cutoff date rule on track choice. An age difference of 11 months, i.e. being born in September instead of

Table 2: Results for track choice in grades 5–8

Grade	5	6	7	8
IV-Probit	0.175***	0.165***	0.160***	0.154***
	(0.021)	(0.021)	(0.021)	(0.021)
Reduced-form	0.077***	0.071***	0.068***	0.065***
	(0.010)	(0.010)	(0.010)	(0.010)
First-stage	0.424***	0.424***	0.424***	0.424***
	(0.009)	(0.009)	(0.009)	(0.009)
Probit	-0.237***	-0.241***	-0.240***	-0.238***
	(0.007)	(0.007)	(0.007)	(0.007)
F-statistic (first-stage)	147.3	140.5	140.5	140.1
Observations	25,232	25,232	25,232	25,232

NOTES: The sample consists of students observed in grade 5 between 1984-2001. Note that the same students are observed in grades 6–8. Robust standard error in parentheses. ***, ** and * indicate significance at the 1-percent, 5-percent and 10-percent level. Control variables are: gender, immigrant background and year dummies.

August, leads to a 7.7 (6.5) percentage points difference in the probability to attend a high track school in grade 5 (8). The reduced-form estimates are lower because non-compliance partly offsets the disadvantage created by the education system for children born closely before the cutoff date; for example delaying enrollment by one year and attending a pre-primary class instead may help those students to compensate for their initial disadvantage.

As expected, the estimated parameters from a probit model of observed age on track choice are downward-biased. Actually, the estimates are even negative, suggesting that students who are older because they enrolled late or repeated a grade in primary school are negatively selected with respect to cognitive skills.

We perform two sensitivity tests to show that we are not confounding the causal effect of age with season of birth effects. Recent research suggests that season of birth might be correlated with family background. Buckles and Hungerman (2008) find for the U.S. that children born in the first quarter are more likely to have a less favorable family background. To meet these concerns, table 3 presents results for a regression discontinuity sample and from regressions with quarter of birth dummies as additional control variables. The regression discontinuity sample includes only students born in August and September, i.e. students born closely before and after the cutoff date. The estimated effect in the RD sample is very similar to the effect in the sample including all birth months. Furthermore, including quarter of birth dummies does not significantly change our estimates.

Table 3: Sensitivity checks

	RD sample		+ Quarter of birth	
Grade	5	8	5	8
IV-Probit	0.196***	0.169***	0.154***	0.126***
	(0.043)	(0.044)	(0.031)	(0.032)
Reduced-form	0.065***	0.055***	0.061***	0.047***
	(0.015)	(0.015)	(0.013)	(0.013)
First-stage	0.309***	0.309***	0.380***	0.380***
	(0.015)	(0.015)	(0.012)	(0.012)
F-statistic (first stage)	31.42	30.02	162.9	155.8
Observations	4,260	4,260	25,232	25,232

NOTES: The regressions discontinuity sample only includes students born in August or September. The sample consists of students observed in grade 5 between 1984-2001. Note that the same students are observed in grades 6–8. Robust standard error in parentheses. ***, ** and * indicate significance at the 1-percent, 5-percent and 10-percent level. Control variables are: gender, immigrant background and school year dummies.

Table 4 presents separate estimations for girls (panel A) and boys (panel B). Compliance is significantly lower for boys than for girls. The IV and reduced-form estimates show that girls suffer more from being relatively young than boys.[10] The net impact of expected age on the probability to attend a high track school in grade 5 is 9.9 percentage points for girls and 5.6 percentage points for boys. Apparently, the compensation mechanism is more effective for boys than for girls. The estimates of the causal effect of age at track choice suggest that being 11 months younger at track choice decreases the probability to choose the high track by 19.4 percentage points for girls and 15 percentage points for boys. This finding may be due to gender differences in the composition of compliers reflected by the higher rate of non-compliance for boys, particularly for those born in August. It could be that, at the age of six, boys appear to be less mature than girls because they look less mature, and therefore, are more likely to be enrolled late. In fact, there is evidence in the psychology literature that the psychological and cognitive development of girls and boys is similar until the age of 10 to 12 and diverges thereafter (Petersen, 1988).[11]

[10] Reduced-form estimates from linear probability models are similar to the probit models and show that the effect is significantly higher for girls.

[11] Pekkarinen (2008) shows that the Finnish comprehensive school reform led to an increase in gender differences in the probability of choosing a high track secondary school because of gender differences in the timing of puberty.

Table 4: Results for track choice in grades 5–8 by gender

Grade	5	6	7	8
Panel A: Girls				
IV-Probit	0.194***	0.178***	0.172***	0.164***
	(0.026)	(0.026)	(0.026)	(0.027)
Reduced-form	0.099***	0.089***	0.085***	0.080***
	(0.014)	(0.014)	(0.014)	(0.014)
First-stage	0.484***	0.484***	0.484***	0.484***
	(0.013)	(0.013)	(0.013)	(0.013)
F-statistic (first-stage)	90.37	85.91	86.21	85.82
Observations	12,469	12,469	12,469	12,469
Panel B: Boys				
IV-Probit	0.150***	0.148***	0.144***	0.140***
	(0.035)	(0.035)	(0.035)	(0.035)
Reduced-form	0.056***	0.054***	0.052***	0.049***
	(0.014)	(0.014)	(0.014)	(0.014)
First-stage	0.365***	0.365***	0.365***	0.365***
	(0.013)	(0.013)	(0.013)	(0.013)
F-statistic (first-stage)	55.11	52.50	52.43	52.36
Observations	12,763	12,763	12,763	12,763

NOTES: Both samples consists of students observed in grade 5 between 1984-2001. Note that the same students are observed in grades 6–8. Robust standard error in parentheses. ***, ** and * indicate significance at the 1-percent, 5-percent and 10-percent level. Control variables are: immigrant background and school year dummies.

Since our data cover a fairly long period we are able to analyze whether the importance of age at track choice is only a recent phenomenon. Figure 6 shows the development of the estimated effects over time.[12] Each estimate is based on data covering a 3-year-period. The result is clear-cut: Both, the causal effect of age at track choice and the effect of expected age have been relatively stable over the period 1984–2004. The estimates for the causal effect range between 12 and 20 percentage points, and the reduced-form estimates are between 5 and 9 percentage points.

5.2 Track choice in grade 9

Between grades 5 to 8 upward mobility is virtually non-existent, whereas downward mobility is possible. If students perform poorly in the high track they can change to the low track without any formal requirements. In fact, upward mobility is only common after grade 8, where students again have to choose between different school

[12]These estimates come from a slightly different sample which covers the period 1984–2004 and includes all 5th grade students independent of whether we observe them in other grades or not (34,956 students).

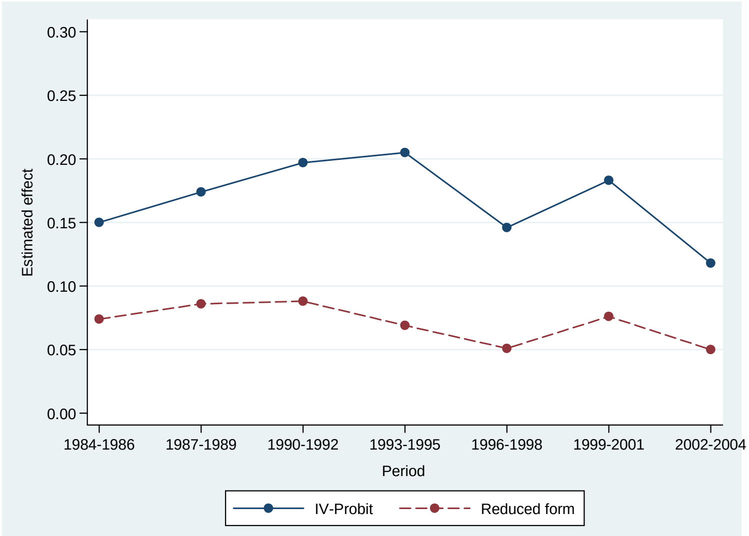

Figure 6: Development of the age effect over time (grade 5)

tracks. In a sense, the education system provides a mechanism that could lead to a correct allocation of talents. We would expect that the age effect disappears if students, who ended up in the low track because they were young at track choice, can compensate for their initial disadvantage and are more likely to change to the high track than their older peers.

We use survey data from the PISA studies 2003 and 2006 to test whether there is such a "self-correcting mechanism" after grade 8.[13] PISA does not sample whole grades, but students born in a certain year, i.e. birth cohorts 1987 and 1990 for PISA 2003 and 2006, respectively. Due to birth cohort sampling, students are observed in grade 9 or 10 depending on their birth month and their compliance to the cutoff date rule. Questions on the school career of those students allow us to reconstruct the attended school track in grade 8 and 9, as well as the observed age at track choice (after grade 4 and 8). Our estimation sample consists of all students observed in grade 9 and 10 for which we can reconstruct these variables.[14] Since PISA only samples students in educational programmes, we do not observe a small fraction of grade 10 students, i.e. those who dropped out after grade 9. If drop outs are more likely to come from the low track, we underestimate the true causal effect.

Table 5 presents the results for track choice in grade 9. We estimate two different specifications: The base specification controls for gender, immigrant background

[13]The register data do not cover the transition after grade 8 for students who have repeated a grade or attended a pre-primary class. We cannot use these data to investigate grade 9 because whether we observe a student in grade 9 is correlated with age and birth month.

[14] For about 10 percent of students we do not have information on the school career because of missing values in these variables. Table 7 in the appendix shows the share of students in low and high track schools and the transition after grade 8 for our estimation sample. The numbers are in line with official numbers from the federal bureau of statistics presented in the introduction.

and the pisa wave, whereas in the SES specification we add an index of of parental socioeconomic status and parents' highest education level measured in ISCED categories.

In the first two columns, the estimates are based on the whole sample of Austrian students. Our estimates show that the probability to attend a high track school in grade 9 is 10.6 percentage points higher for students being 11 months older at track choice after grade 8. To make the estimate comparable to those for Linz, we presents results from separate regressions for schools located in urban and rural areas in columns (3)–(6). We find no effect for students who attend schools in rural areas, whereas the effect for students attending schools in urban areas is quite high and suggests that the second tracking after grade 8 does not offset the initial disadvantage of relatively younger students.

Table 5: Results for track choice in grade 9

	All areas		Urban areas		Rural areas	
	Base	+ SES	Base	+ SES	Base	+ SES
IV-Probit	0.106*	0.125**	0.281***	0.283***	-0.043	-0.014
	(0.055)	(0.054)	(0.066)	(0.065)	(0.084)	(0.084)
Reduced form	0.047*	0.055**	0.119***	0.120***	-0.021	-0.008
	(0.025)	(0.025)	(0.030)	(0.029)	(0.040)	(0.040)
First stage	0.430***	0.429***	0.388***	0.389***	0.482***	0.480***
	(0.016)	(0.016)	(0.022)	(0.022)	(0.023)	(0.024)
F-statistic (FS)	162.9	77.44	95.38	43.13	122.5	60.28
Observations	7,114	7,114	3,912	3,912	3,202	3,202
% high track	60%	60%	67%	67%	52%	52%
Mean SES	49.32	49.32	51.39	51.39	46.79	46.79
St.Dev. SES	0.35	0.35	0.46	0.46	0.53	0.53

NOTES: Data from PISA 2003 and 2006. Standard error (in parentheses) account for complex survey design. ***, ** and * indicate significance at the 1-percent, 5-percent and 10-percent level. Control variables are: gender, immigrant background and a pisa wave dummy in the base specification and additionally an index of parental socioeconomic status (SES) and parents' highest education level (ISCED) in the SES specification. The urban (rural) sample includes only students whose school is located in a city with more (less) than 15.000 inhabitants.

We further investigate this hypothesis by estimating regressions for track choice in grade 8 in urban and rural areas separately. The results are presented in Table 6. We find that the age effect does not change between grade 8 and grade 9 and conclude that upward mobility of low track students does not lead to a correct allocation of talents in urban areas.

While there is some concern that we misclassify some of the students because we only know the location of the school a student attended in grade 9 and not whether the student lives in a rural or urban area, we are confident that these classification errors cannot explain the magnitude of our estimates. Our results would be biased if older rural students are more likely to change to high track schools in urban areas than younger rural students. We find no evidence for this hypothesis since the distributions of students across birth months for the urban and the rural sample do not indicate that there is a higher proportion of older students in the urban sample.

Table 6: Results for track choice in grade 8

	All areas		Urban areas		Rural areas	
	Base	+ SES	Base	+ SES	Base	+ SES
IV-Probit	0.123***	0.140***	0.271***	0.278***	0.007	0.027
	(0.044)	(0.044)	(0.062)	(0.064)	(0.049)	(0.043)
Reduced form	0.055***	0.062***	0.114***	0.117***	0.004	0.013
	(0.020)	(0.020)	(0.028)	(0.029)	(0.024)	(0.021)
First stage	0.442***	0.441***	0.399***	0.400***	0.495***	0.492***
	(0.016)	(0.016)	(0.022)	(0.022)	(0.023)	(0.023)
F-statistic (FS)	172.9	82.26	100.9	45.35	129.5	64.79
Observations	7,114	7,114	3,912	3,912	3,202	3,202
% high track	31%	31%	42%	42%	18%	18%
Mean SES	49.32	49.32	51.39	51.39	46.79	46.79
St.Dev. SES	0.35	0.35	0.46	0.46	0.53	0.53

NOTES: Data from PISA 2003 and 2006. Standard error (in parentheses) account for complex survey design. ***, ** and * indicate significance at the 1-percent, 5-percent and 10-percent level. Control variables are: gender, immigrant background and a pisa wave dummy in the base specification and additionally an index of parental socioeconomic status (SES) and parents' highest education level (ISCED) in the SES specification. The urban (rural) sample includes only students whose school is located in a city with more (less) than 15.000 inhabitants.

What are the reasons for the difference in the age effect between urban and rural areas? We argue that rural low track schools are similar to comprehensive schools since the majority of students (about 80 percent) from rural areas attends the local low track school until grade 8. Actually, first tracking occurs later in rural areas. In contrast, in urban areas, where almost 50 percent of all students attend a high track school until grade 8, early tracking leads to a persistent age effect.

One may object that comprehensive schools are more efficient only in rural areas because students are more homogenous there. In fact, we find the opposite pattern; the standard deviation of the index of parental socioeconomic status is higher for students in rural than in urban areas (see Table 6).

6 Conclusions

In this paper, we study the secondary school track choice of Austrian students. We argue that, in education systems where first tracking occurs very early, track choice is strongly influenced by factors other than innate ability and provide evidence that age at track choice is one such factor. Our estimation results show that relatively younger students are 15–18 percentage points less likely to choose a high track school in grades 5–8, and that the importance of age at track choice has been stable over the last 20 years. Moreover, there are gender differences in the age effect, with girls suffering more from being relatively young. We also look beyond grade 8, where students again have to make a track choice and find that the effect does not disappear. Apparently, the education system fails to provide a mechanism that leads to an efficient allocation of students to tracks.

We find significant differences between students in rural and urban areas. Since high track schools are mainly located in urban areas, most students from rural areas attend the local low track school until grade 8. For this reason, rural low track schools are similar to comprehensive schools and actual tracking occurs later. There is no age effect in rural areas in grade 8 or 9, suggesting that the effect is only long-lasting if students are tracked early. Thus, later selection of students could contribute to an increase in educational attainment.

A Appendix

Table 7: Transition of students after grade 8

School type in grade 9	All	By school type in grade 8 High track	Low track
Higher general	0.23	0.58	0.07
Higher vocational	0.37	0.38	0.37
Intermediate vocational	0.15	0.02	0.21
(Pre-)Vocational	0.24	0.01	0.35
High track	0.60	0.97	0.44
Low track	0.40	0.03	0.56
Share of students		0.31	0.69
Mean SES	49.32	58.42	45.23
St.Dev. SES	0.35	0.46	0.32
Observations	7,114	2,191	4,923

NOTES: Data from PISA 2003 and 2006.

References

Allen, J., Barnsley, R., 1993. Streams and tiers: The interaction of ability, maturity, and training in systems with age-dependent recursive selection. Journal of Human Resources 28 (3), 649–659.

Ammermüller, A., 2005. Educational opportunities and the role of institutionsCentre for European Economic Research (ZEW) Discussion Paper No. 05-44.

Ammermüller, A., Pischke, J.-S., 2006. Peer effects in European primary schools: Evidence from PIRLSInstitute for the Study of Labor (IZA, Bonn) Discussion Paper No. 2077.

Angrist, J. D., Imbens, G. W., Rubin, D. B., 1996. Identification of causal effects using instrumental variabels. Journal of the American Statistical Association 91, 444–472.

Bauer, P., Riphahn, R. T., 2006. Timing of school tracking as a determinant of intergenerational transmission of education. Economics Letters 91, 90–97.

Bedard, K., Duhey, E., 2006. The persistence of early childhood maturity: International evidence of long-run age effects. The Quarterly Journal of Economics 121 (4), 1437–1472.

Black, S. E., Devereux, P. J., Salvanes, K. G., 2008. Too young to leave the nest? The effects of school starting ageInstitute for the Study of Labor (IZA, Bonn) Discussion Paper No. 3452.

Brunello, G., Checchi, D., 2007. Does school tracking affect equality of opportunity? New international evidence. Economic Policy 22 (52), 781–861.

Brunello, G., Giannini, M., Ariga, K., 2007. The optimal timing of school tracking. In: Wößmann, L., Petersen, P. (Eds.), Schools and the Equal Opportunity Problem. MIT Press, pp. 129–156.

Buckles, K., Hungerman, D. M., 2008. Season of birth and later outcomes: Old questions, new answersNational Bureau of Economic Research (Cambridge, MA) Working Paper No. 14573.

Carrell, S. E., Hoekstra, M. L., 2008. Externalities in the classroom: How children exposed to domestic violence affect everyone's kidsUnpublished manuscript, University of Pittsburgh.

Duflo, E., Dupas, P., Kremer, M., 2008. Peer effects and the impact of tracking: Evidence from a randomized evaluation in KenyaNational Bureau of Economic Research (Cambridge, MA) Working Paper No. 14475.

Dustmann, C., 2004. Parental background, secondary school track choice, and wages. Oxford Economic Papers 56 (1), 209–230.

Elder, T. E., Lubotsky, D. H., forthcoming. Kindergarten entrance age and children's achievement: Impacts of state policies, family background, and peers. Journal of Human Resources.

Fertig, M., Kluve, J., 2005. The effect of age at school entry on educational attainment in GermanyInstitute for the Study of Labor (IZA, Bonn) Discussion Paper No. 1507.

Galindo-Rueda, F., Vignoles, A., 2004. The heterogeneous effect of selection in secondary schools: Understanding the changing role of abilityInstitute for the Study of Labor (IZA, Bonn) Discussion Paper No. 1245.

Hanushek, E. A., Kain, J. F., Markman, J. M., Rivkin, S. G., 2003. Does peer ability affect student achievement? Journal of Applied Econometrics 18, 527–544.

Hanushek, E. A., Wößmann, L., 2006. Does educational tracking affect performance and inequality? differences-in-differences evidence across countries. The Economic Journal 160 (510), C63–C76.

Hopkins, K. D., 1990. Educational and Psychological Measurement and Evaluation. Englewood Cliffs, NJ: Prentice-Hall.

Jürges, H., Schneider, K., 2007. What can go wrong will go wrong: Birthday effects and early tracking in the German school systemCESifo (Munich) Working Paper No. 2055.

Lavy, V., Paserman, M. D., Schlosser, A., 2008. Inside the black of box of ability peer effects: Evidence from variation in high and low achievers in the classroomNational Bureau of Economic Research (Cambridge, MA) Working Paper No. 14415.

McEwan, P. J., Shapiro, J. S., 2008. The benefits of delayed primary school enrollment. Discontinuity estimates using exact birth dates. Journal of Human Resources 43 (1), 1–29.

Meghir, C., Palme, M., 1995. Educational reform, ability, and family background. American Economic Review 95 (1), 414–424.

Pekkarinen, T., 2008. Gender differences in educational attainment: Evidence on the role of the tracking age from a Finnish quasi-experiment. Scandinavian Journal of Economics 110 (4), 807–825.

Pekkarinen, T., Uusitalo, R., Kerr, S., 2009a. School tracking and development of cognitive skillsInstitute for the Study of Labor (IZA, Bonn) Discussion Paper No. 4058.

Pekkarinen, T., Uusitalo, R., Pekkala, S., 2009b. School tracking and intergenerational income mobility: Evidence from the Finnish comprehensive school reform. Journal of Public Economics 93 (7-8), 965–973.

Petersen, A. C., 1983. Pubertal change and cognition. In: Brooks-Gunn, J., Petersen, A. (Eds.), Girls at puberty: Biological and psychosocial perspectives. New York: Plenum Press, pp. 179–198.

Petersen, A. C., 1988. Adolescent development. Annual Review of Psychology 39, 583–607.

Pischke, J.-S., Manning, A., 2006. Comprehensive versus selective schooling in England and Wales: What do we know?National Bureau of Economic Research (Cambridge, MA) Working Paper No. 12176.

Puhani, P. A., Weber, A. M., 2007. Does the early bird catch the worm? Instrumental variabel estimates of early educational effects of age of school entry in Germany. Empirical Economics 32 (2-3), 359–386.

Schindler-Rangvid, B., 2003. Educational peer effects. quantile regression evidence from Denmark with PISA 2000 dataChapter 3. Do schools matter? Ph.D. thesis, Aarhus School of Business, Denmark.

Schneeweis, N., Winter-Ebmer, R., 2007. Peer effects in Austrian schools. Empirical Economics 32 (2), 387–409.

Statistik Austria, 2008. Schulstatistik 2008. Statistik Austria, Vienna.