The Evolution of the School-Entry Age Effect in a School Tracking System

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A B S T R A C T

In Germany, students are streamed at age ten into an academic or non-academic track. We demonstrate that the randomly allocated disadvantage of being born just before as opposed to just after the cutoff date for school entry leads to substantially different schooling experiences. Relatively young students are initially only two-thirds as likely to be assigned to the academic track. The possibility to defer tracking to age 12 does not attenuate school-entry age's effect on track attendance. Some mitigation of the effect occurs only at the second time when educational institutions facilitate track modification when students are about age 16.

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I. Introduction

Recent research in education suggests that early human capital investment is crucial because of dynamic self-productivity and the complementarities of acquired skills and abilities (Cunha et al. 2006). This role of the path dependencies of human capital investment is particularly important for the case of education in countries tracking students early in their secondary schooling career to different—more or less academic—school types. Tracking ages differ widely across industrialized countries. Several central European countries have very early tracking at ages ten or 11 like Germany (Brunello and Checchi 2006, p. 45). Some countries track at ages 12 or 13 (among them China and Mexico). Other countries track later, in the middle or toward the end of adolescence, for example, at ages 15 and 18 (like Japan and the United States, respectively).

In this paper, we view the school-entry age effect as a randomly allocated disadvantage (via birth month) and analyze in what way segregation of students after grade four (at age ten) creates path dependency in Germany where "tracking" means selection of students into academic or vocational secondary schools. We show that early tracking leads to substantially different schooling experiences for younger school entrants for at least six years of secondary schooling. After grade four, when tracking occurs, early school entrants are only two-thirds as likely to enter the highest track as late entrants. Attending the highest track is associated with a more academic curriculum, a higher-ability peer group and academically more qualified (higher paid) teachers. We also find that the fact that some schools offer to defer the tracking decision to age 12 (after Grade 6) has no impact on the school-entry age effect on track attendance. Only at age 16 (after Grade 10) when the German school system generally facilitates mobility between tracks, the school-entry age effect on track attendance is mitigated both through disproportionate upgrading of younger school entrants and disproportionate downgrading of older school entrants.[1] However, even in this period—corresponding to the senior high school period in the United States—young German school entrants are still less likely to attend a highest track school than late school entrants. It is only through a special type of higher track schools that younger school entrants manage to catch up in terms of college entry certificates with older school entrants. Unlike the highest track schools, these schools typically offer restricted (by subject of degree) access to universities. In sum, we find that early tracking in Germany leads to different experiences between disadvantaged (younger school entrants) and advantaged students (older school entrants) that persist throughout secondary schooling.

Recent evidence for a wide set of countries suggests that later school entry raises test scores in elementary and secondary school or improves the quality of school attended (Allen and Barnsley 1993; Bedard and Dhuey 2006; Black, Devereux and Salvanes 2008; Fredriksson and Öckert 2006; McEwan and Shapiro 2008; Puhani

1. None of these patterns are driven by interactions between school-entry age and compulsory schooling requirements. The minimum required duration of schooling in Germany is determined by years in school and not by an age limit, as is the case in the United States (Angrist and Krueger 1992).

and Weber 2007a).[2] There is also evidence that school-entry age effects on test scores or other educational outcomes become smaller or even disappear with the duration of schooling (Angrist and Krueger 1992; Dobkin and Ferreira 2007; Elder and Lubotsky 2009). However, there is little evidence on which institutional factors might be responsible for perpetuating or potentially eliminating the school-entry age effect. If, however, test score differences related to school-entry age tend to dissolve over the educational career, early tracking is likely to perpetuate these differences by limiting the scope for convergence through less challenging curricula and peers for disadvantaged students.

We are not aware of any study that explicitly traces the school-entry age effect for given cohorts in a tracking system. There is some evidence that tracking increases test score inequality (Hanushek and Wößmann 2006) and increases the impact of family background on educational outcomes (Bauer and Riphahn 2006; Brunello and Checchi 2006, Dustmann 2004; Meghir and Palme 2005). However, these findings have been challenged recently by Waldinger (2007) questioning the robustness of some of the estimated effects as well as by Maurin and McNally (2007) who find no such evidence. The study by Fredriksson and Öckert (2006) is also of interest for our purpose since it shows that the school-entry age effect on years of schooling is larger for earlier cohorts, who were still subject to a school tracking system (similar to the current German one), which was replaced in the late 1960s with a comprehensive school system. However, their cross-cohort comparison may be confounded by other time-varying factors. Probably for this reason, Fredriksson and Öckert (2006) do not put emphasis on the relationship between tracking and the school-entry age effect in their study.

Rigorous tracking with a later second chance to revise the choice of educational path is an interesting setup for studying the school-entry age effect, which is driven by birth month and an enrollment cutoff (end of June). As shown below, an early school-entry age can be viewed as a randomly allocated disadvantage concerning track choice. Observing how educational institutions interact with this disadvantage is important, because it has a bearing on the implications of tracking on other disadvantages like those driven by family background. The latter may be harder to isolate from innate ability than pure relative age or maturity effects. This is not only relevant for applied econometricians, but also for elementary school teachers, who make recommendations on school choice, and for parents, who in most German states have the final word on that choice. Therefore, an educational system that does not eliminate the school-entry age effect is also unlikely to neutralize other disadvantages such as disadvantaged family background.

This paper is structured as follows. Section II describes the administrative data sets. As only the German state of Hessen has provided us with all the required information on students in all types of schools, we focus on analyzing the effects for students in this state.[3] We begin with stylized facts drawn from the database, preceded by a short overview of key institutional features of the Hessen school

2. Norwegian IQ test data used by Black, Devereux, and Salvanes (2008) suggest that this finding is explained by an older testing age of late school entrants.

3. Among the 16 German states, Hessen, which includes the city of Frankfurt/Main, has the fifth largest population and the seventh largest area.

system as they compare to Germany as a whole. Section III presents the estimates of the causal impact of school-entry age on track attended, with separate estimates for each school-entry cohort and each school year. Section IV concludes the paper.

II. Institutional Facts and the Administrative Data Source

A. Segregated Schools as an Extreme Form of Tracking in Germany

In general, "tracking" in Germany means that at a relatively early point in their educational career (Grade 4, age ten), students are streamed into three types of secondary school. Thus, in Germany, unlike the United States, tracking implies the physical segregation of students into different schools. The underlying rationale is that a student's proficiency and elementary school performance will determine the choice of secondary school track. At the end of elementary school, teachers make a recommendation as to the type of school the student should attend from Grade 5 onwards. Parents, however, may override that recommendation in most states.[4]

Figure 1 stylizes the key features of the German secondary education system and the possible transitions to tertiary education. Supposedly, the most proficient students attend the highest secondary track, the academic *Gymnasium* (grammar school), which lasts for nine years and prepares students for tertiary studies at institutions like five- or four-year universities or "Universities of Applied Sciences" (the latter are the equivalent of the former British polytechnics).[5] Alternatively to the highest secondary track, lower and intermediate level secondary school tracks lasting five or six years are provided by schools called *Hauptschule and Realschule*, respectively. Education at the latter two school types is nonacademic and typically prepares students for apprenticeships, which implies subsequent parttime secondary education at vocational schools. The conceptual differences between the lower and intermediate level tracks are small: Students in the lower-level track may simply stay another year to obtain the same certificate as students in the intermediate track, and recent political tendencies even combine the two.[6]

4. Regulations differ between the 16 German states regarding the importance of parents' preferred choices, school marks, and potential entry exams for the possibility of a child to deviate from the elementary school's recommendation concerning choice of educational path. For example, parents have the final word in ten out of 16 states (Berlin, Brandenburg, Bremen, Hamburg, Hessen, Mecklenburg-Vorpommern, Niedersachsen, Nordrhein-Westfalen, Rheinland-Pfalz, and Schleswig-Holstein). In the remaining six states (Baden-Württemberg, Bayern, Saarland, Sachsen, Sachsen-Anhalt, and Thüringen), students have to fulfil a requirement concerning school marks or otherwise pass a special test if they want to deviate from the teacher committee's recommendation concerning school choice (information retrieved from http://www.kmk.org/doc/publ/ueberg.pdf on November 27, 2008).

5. Recently, there has been a tendency to shorten the traditional higher track duration to eight years.

6. In addition, the modern German school system includes comprehensive schools (*Gesamtschule*), developed as an alternative to the three traditional institutions. Some of these schools have within-school tracking similar to the traditional system. In this case, they are coded in the data just as the traditional tracks and cannot be identified as comprehensive schools. Comprehensive schools without internal tracking are coded as intermediate rather than highest track. In fact, information provided by the Federal Statistical Office indicates that only 7 percent of students in integrated comprehensive schools attain a highest track certificate, partly because many of these schools only provide education until tenth grade. Hence, measuring integrated comprehensive schools as intermediate track when in or below tenth grade seems justified.

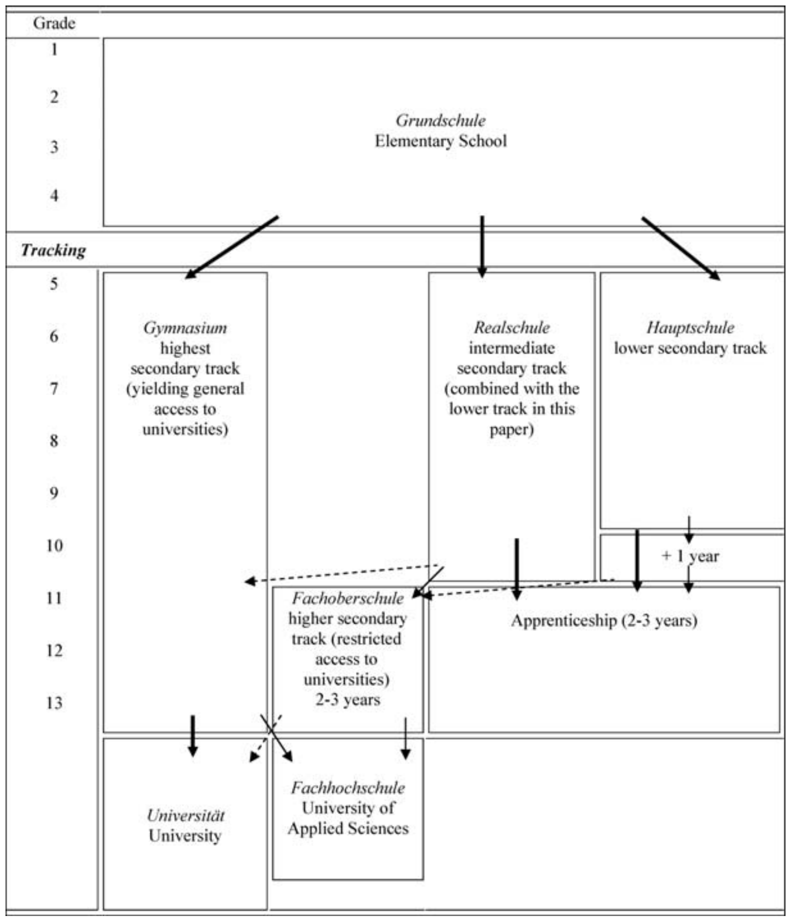

Figure 1
Stylized Representation of the Education System in Germany

Note: Bold arrows indicate traditional pathways. In some schools offering so-called "support stages" tracking takes place after Grade 6 instead of Grade 4. Additionally, comprehensive schools exist (not shown here for simplicity). As indicated in Table 1, about 31 percent of students attend Gymnasium, 26 percent Realschule and 22 percent Hauptschule in Grade 8. The rest are in comprehensive or special types of schools. From the 2004 German Socio-Economic Panel, we find that among 26–40 year olds, 40 percent of persons with an unrestricted higher track certificate have obtained a university degree and 14 percent have obtained a degree from a "University of Applied Sciences" (Fachhochschule). Of those persons who have obtained a higher track certificate restricted by subject of specialization, only 4 percent hold a university degree, but 32 percent have obtained a degree from a "University of Applied Sciences." Of those who graduated from the lower secondary track, Realschule or Hauptschule, 92 and 77 percent have obtained an apprenticeship certificate, respectively. The share of graduates from the higher track with apprenticeship certificates is also high: 49 and 83 percent for highest track and the higher track awarding restricted degrees respectively. The latter number is so high because many graduates from lower track schools complete an apprenticeship and then go on to a higher track secondary school and tertiary studies. Hence, in Germany, it is not uncommon to have both a tertiary and an apprenticeship degree.

The highest track substantially differs from the lower two tracks in several ways. The Programme for International Student Assessment (PISA) score differences between ninth graders in the highest and the lower tracks are between 1.2 and 1.3 standard deviations for reading, math, and science (according to own calculations based on the sample for Hessen in the “Extended Programme for International Student Assessment” (PISA-E 2000) data for Germany). Apart from different peer groups associated with the tracking outcome, there are also marked differences in the curricula. Although the subjects taught are almost the same, there are distinctions concerning the academic level. Salient differences in mathematics up to Grade 10 in the state of Hessen are, for example, that statistical inference and mathematical proofs are only taught at the highest track (information obtained from publicly available curricula published by the Hessen Ministry of Education).

In terms of expenditure per student, they are even higher in the lowest track: at the highest track school in Hessen in 2002, expenditure (personnel and other) per student was €6,917, whereas it was at €6,816 and €7,884 in the lower intermediate and lowest secondary track, respectively. However, the high expenditure per student in the lowest track is more than explained by differences in class sizes: They were 28.0, 26.1, and 19.5 in the highest and the two lower tracks in Hessen in 2002/03, respectively (probably because of fewer disciplinary problems in the higher track schools). Personnel costs per teacher are in fact higher in the highest track schools (€49,530 per teacher in 2007) than in the two lower track schools (€46,872 per teacher).[7] Hence, at least to the extent that teaching has a public good character, students in the highest track experience higher quality teaching.

To illustrate the importance of the different educational paths, Table 1 displays the shares of different school types attended in eighth grade during the 2005/2006 school year. The shares of the three traditional tracks range between one-fifth for the lower-level secondary schools to one third for the highest level schools, while a minority of about 15 percent of all German students attend comprehensive schools. The distribution for the West German state of Hessen (the focus of this study) is representative of the pattern for Germany as a whole, although compared to the average *West* German state, Hessen’s proportion of comprehensive school graduates is relatively high (15, 15, and 9 percent in Hessen, Germany, and West Germany, respectively). In addition, Hessen is known for the flexibility of its secondary school system. That is, some Hessen schools offer so-called “support stages” that provide comprehensive education during the fifth and sixth grades, thereby delaying tracking for two years. Hence, these children are given two more years to mature before reaching an appropriate tracking decision. According to our calculations from the administrative data, nearly 30 percent of all fifth graders in Hessen attend these delayed tracking schools.

Besides, Hessen’s tracking system includes two other important sources of flexibility. First, according to school law, students may modify track selection in all grades and all types of secondary school; however, in practice, such modification is complicated because school curricula differ and the school *from* which the student is transferring must agree to the transfer. Nonetheless, the tracking system potentially

7. All statistics in this paragraph were provided by the Ministry of Education in Hessen.

Table 1
Eighth Grade Attendance in German School Tracks in 2005/2006 (in percentages)

	Germany	West Germany	Hessen
Lower track (*Hauptschule*)	22	26	17
Intermediate track (*Realschule*)	26	29	27
Highest track (*Gymnasium*)	31	31	35
Comprehensive schools (*Gesamtschule*)	15	9	15
Special schools (*Sonderschule*)	1	1	1
Free Waldorf schools (private)	5	5	5

Source: Federal Statistical Office (2006), Fachserie 11.1.
Note: Comprehensive schools include further combined school types. Special Schools support children with special needs, mostly due to physical or mental disabilities. Free Waldorf schools follow a special educational philosophy and may lead to different secondary diplomas.

provides further flexibility in that successful students may correct their initial choice by deciding after graduation from a lower or intermediate secondary school to continue their education at either a highest track school (*Gymnasium* or *berufliches Gymnasium* in German) or another type of higher track school (called *Fachoberschule*).[8] The latter higher track schools award a similar degree, which gives access to so-called "Universities of Applied Sciences" and gives restricted (by subject of specialization) access to general universities. These higher track schools also have a slightly different curriculum. In mathematics, for example, the product, quotient, and chain rules of calculus are not part of the mandatory curriculum, neither is hypothesis testing. In this paper, we include all types of higher track schools in our definition of the "*higher* track," whereas the term "*highest* track school" indicates that we explicitly consider those higher track schools which award unrestricted access to all universities.

B. Administrative Student-Level Data for the State of Hessen

This present study draws on five waves of administrative data from the state of Hessen that cover the universe of students in this state (both in general and in vocational schools) for the school years 2002/2003 through 2006/2007. In our data, the following variables are collected for each student: grade level and school type, grade level and school type in the previous school year, region, gender, nationality,

8. We aggregate two types of highest track schools, which are the traditional *Gymnasium* and the polytechnic version (the so-called *berufliches Gymnasium*) which formally yield the same degree. Results are robust if the polytechnic schools are not aggregated into the "highest track" category. Similarly, the higher track also includes schools called (*Berufs-*)*Fachschule* if the student attending (*Berufs-*)*Fachschule* indicates to hold a certificate from an intermediate secondary school called *Realschule*. In this case, the (*Berufs-*)*Fachschule* can act like a *Fachoberschule* and award the same higher track certificate. But the students have to take an extra exam to obtain that certificate. Not all students do so (we cannot tell from the data who does), but, in any case, our results are robust to the exclusion of all students attending (*Berufs*) *Fachschule* from the "higher track" definition.

month and year of birth, and month and year of school entry. Because there is no person identifier across years, we do not have panel data; however, based on the previous school type variable, we can retrospectively observe changes in track. This information on previous track, gleaned by combining the administrative data on general and vocational schools and following cohorts in all tracks, provides insight into track modification that may be crucial for determining the educational effects of school starting age.

The information contained in the Hessen administrative data is exceptionally valuable for analyzing the effects of school-entry age during the period of secondary schooling. We group students by school-entry cohort and follow these cohorts over time, until 12 or 13 years after school entry. This technique is equivalent to following cohorts across grades if students do not repeat or skip them.[9] To give an example for the school-entry cohort 1997, nine years after school entry, 67.5 percent of June-born and 70.1 percent of July-born students reached Grade 9 as they were supposed to; 26.4 and 24.5 percent of these June- and July-born students were in Grade 8, respectively. The remaining students either jumped a grade (not quite 2 percent) or lag further behind (around 4 percent).[10]

The different cohorts and grades studied are summarized in Table 2, which shows that (ignoring grade repetitions and grade skipping) the cohort of students entering school in 1998 (Cohort 1 in the table) is in fifth grade by the 2002/03 school year and can be tracked up to ninth grade in 2006. Similarly, the cohort of students that started first grade in 1993 (Cohort 6) should have reached the tenth year of schooling in the 2002 data wave and can be tracked up to the thirteenth year of schooling (when some students are still in general schools but others are in vocational schools).

It should be noted, however, that individuals who leave the school system drop out of our data set. Given that Hessen's school law requires students to attend at least nine years of general schooling plus, for those not attending the higher track, two or three years of vocational schooling (depending on the length of the apprenticeship chosen), those dropping out of the data before the thirteenth grade will generally not be students in higher secondary schools. Such a student is typified by an individual who completes the lowest secondary track after ninth grade and a two-year apprenticeship after eleventh grade. Students may also drop out after the ninth or tenth grade if they are not even doing an apprenticeship (this would be contrary to the law but is not strictly enforced).

In order to account for students who are part of our cohorts of interest, but leave the data set because they are not in school any more, we simulate these observations back into our data. Due to the nature of our empirical analysis (a regression discontinuity design based on students born in either June or July, around the school enrollment cutoff June 30th, see Section III below), this simulation has to take account of the birth month and the age of school entry of the students. Hence, in a

9. In general schools, we also know the actual grade a student attends, but for some vocational schools after Grade 9 or 10, the grade accounting changes and so it is difficult to simulate a continuous grade accounting after Grade 9.

10. Students in the higher track are more likely to reach Grade 9 in time: Of the 1997 school-entry cohort, 79.8 percent of higher track and 63.4 percent of lower track students are in Grade 9 at the time corresponding to nine years after school entry.

Table 2
Grade Levels for School Entry Cohorts

	(Entry Year)	2002/03	2003/04	2004/05	2005/06	2006/07
Cohort 1	(1998)	5	6	7	8	9
Cohort 2	(1997)	6	7	8	9	10
Cohort 3	(1996)	7	8	9	10	11
Cohort 4	(1995)	8	9	10	11	12
Cohort 5	(1994)	9	10	11	12	13
Cohort 6	(1993)	10	11	12	13	—

Note: Grades refer to the supposed grade levels (if grades are not repeated or skipped) of students who entered school in the indicated year and are observed between 2002/03 and 2006/07.

first step, we define four cells by birth month (June/July) and early/late school entry (age six or earlier and age seven or later). Table 3 displays the growth rates of the number of observations in these cells over time (which is measured as years since school entry). Ideally, these growth rates should consistently be zero. This would be the case if we were able to observe the same set of students over time, like in a balanced panel. As the first three columns of the table show, the cell growth rates until Grade 9 are at least very close to zero.[11] After Grade 9, but even more so after Grade 10, cell growth rates turn consistently negative due to student drop out. Ten years after school entry, it is systematically the case that students who entered school late (age seven or later) have higher dropout rates. In addition, July-born students who did not comply with the assignment rule by entering school too early (at age six instead of age seven), have the lowest dropout rates. As these are likely to be more proficient students, this is an expected result. In the following, we add dropouts back into the data such that growth rates in the four cells are set to zero after ten

11. Especially after six years of schooling, cells with students who entered school at seven years of age (or later) grow somewhat more than those with students who entered at age six or earlier. This would be consistent with weaker students, who tend to enter school later, having a tendency to immigrate as students into Hessen. Especially in the south of Hessen, state borders cross metropolitan areas, so that it would be possible for a student living in another south German state to switch to a school in Hessen. Because the Hessen school system traditionally has the image of being easier to pass than the one of the neighboring south German states, this could be an explanation of small differences in cell growth grates. Unfortunately, our data contain no information on the location of the school the student attended in the previous year. Hence, migrants cannot be identified.
Data from the population registers indicate a net-migration rate for the age group 6–17 years in Hessen as −1 percent compared to +12 percent for ages 18–25. The high net-immigration rate for ages 18–25 is probably driven by college/university students and young workers. Note, however, that these figures do not include educational migrants who might not be residents, but cross state borders only for school attendance.

Table 3
Cell Growth without Simulated Dropouts

Years after School Entry	6–7	7–8	8–9	9–10	10–11	11–12	12–13
Born June / Entry at 6	−0.003	−0.004	−0.004	−0.015	−0.046	−0.041	−0.095
Born June / Entry at 7	0.022	0.006	0.012	−0.032	−0.108	−0.193	−0.149
Born July / Entry at 6	0.005	−0.004	−0.005	−0.028	−0.028	−0.026	−0.048
Born July / Entry at 7	0.015	0.011	0.000	−0.031	−0.107	−0.141	−0.113
Number of Cohorts	2	3	4	4	4	3	2

Source: Student-level data of the statistics on general and vocational schools for the state of Hessen 2002/03 to 2006/07 provided by the Bureau of Statistics of the State of Hessen (Hessisches Statistisches Landesamt). Authors' own calculations.
Note: Growth rates for the number of observations refer to four cells defined by birth month (June or July) and school-entry age (about age six or seven) observed in the Data Waves 6–13 years after school entry for school-entry cohorts 1993–98.

years of schooling.[12,13] Dropouts who are added back in are always allocated to the lower track (under the presumption that they would be in the data if they attended a higher track secondary institution).

Table 4 summarizes the entry and exit rates to and from the higher track schools. Entry rates are defined as the number of students entering the higher track schools (from a lower level) in a given grade divided by the total number of students in the higher track in the previous grade.[14] Exit rates are defined as the number of students leaving the higher track in a given grade divided by the total number of students in the higher track in the previous grade.

As shown in Table 4, the entry rate for the 1998 school-entry cohort amounts to 9 percent, while between school years 2002/03 and 2003/04 (corresponding to the time when students have attained five and six years of schooling respectively), 2

12. In fact, we work with eight cells: we refine the way to add dropouts back into the data by splitting each of the four cells into two groups. Within each cell, we define two subcells according to the track students are reported to have attended in the previous year. The number of observations in each of these subcells is then simulated to match the number of observations actually observed in the highest/higher (lower) track in the data wave of the preceding school year for the same school-entry cohort. This refinement to eight cells is only necessary for the regressions with "track upgrading" and "downgrading" as the outcome variable. Unlike the four cells shown in Table 3, the eight cells would not have zero growth rates even in the absence of dropouts. The reason is that because of the way these eight cells are defined, their growth rates between Grades 11 and 12, for example, are affected by the amount of upgrading and downgrading between Grades 10 and 11. Hence, Table 3 is based on data from eight cells where we build pairs of two cells to report growth rates of the remaining four cells. The growth rates of these four cells can be compared to a benchmark of a zero growth rate and are more easily interpreted.
13. Because adding in dropouts already after nine years of schooling would make us lose one cohort for our analysis and because there is no crucial difference in our results when starting adding dropouts back in only after ten years of schooling, we will in the following present results based on data with the latter method.
14. This definition of entry rate makes the difference between the entry rate and the exit rate equal to the rate of increase of students in the higher track. It also should be noted that as defined the entry rate may in theory exceed one.

Table 4
Higher Track Entry and Exit Rates

Entry Rates	(Entry Year)	2002/03	2003/04	2004/05	2005/06	2006/07
Cohort 1	(1998)	—	0.09	**0.17**	0.02	0.01
Cohort 2	(1997)	0.13	**0.23**	0.02	0.01	0.01
Cohort 3	(1996)	**0.17**	0.03	0.01	0.01	**0.42**
Cohort 4	(1995)	0.04	0.01	0.01	**0.44**	0.18
Cohort 5	(1994)	0.00	0.02	**0.46**	0.17	0.08
Cohort 6	(1993)	0.01	**0.44**	0.16	0.07	—
Exit rates	**(Entry Year)**	**2002/03**	**2003/04**	**2004/05**	**2005/06**	**2006/07**
Cohort 1	(1998)	—	0.02	**0.02**	0.02	0.02
Cohort 2	(1997)	0.04	**0.02**	0.02	0.03	0.03
Cohort 3	(1996)	**0.03**	0.02	0.03	0.03	**0.04**
Cohort 4	(1995)	0.04	0.03	0.03	**0.04**	0.05
Cohort 5	(1994)	0.05	0.04	**0.06**	0.05	0.13
Cohort 6	(1993)	0.05	**0.06**	0.05	0.13	—

Note: The entry rates into higher track schools are so high between grades ten and 11 because they also capture students from comprehensive schools who stay on to obtain the university entry certificate. Entry rates are defined as the ratio of students entering the higher track (from a lower track level) in a given grade related to the total number of students who had been in the higher track in the previous grade. Exit rates are defined as the number of students leaving the higher secondary track in a given grade divided by the total number of students in this track in the previous grade. All rates refer to the estimation sample (students born in June or July).
Source: Student-level data of the statistics on general and vocational schools for the state of Hessen 2002/03 to 2006/07 provided by the Bureau of Statistics of the State of Hessen (Hessisches Statistisches Landesamt). Authors' own calculations. Data on students who are supposed to be in Grades 11–13 include imputed observations (see Section IIB).

percent of students previously in the higher secondary track decided to switch to a lower track. Switching rates are especially high between the sixth and seventh year of schooling (the entry rate is between 17 and 23 percent for the observed cohorts) because in some Hessen schools support stages allow deferral of tracking until Grade 6 (age 12). Similarly, students in their eleventh year of schooling show relatively high entry rates (42–46 percent) to the higher track because graduates from the intermediate or lower-level tracks may decide to continue education at any type of the higher track schools to seek a university entry certificate. The fact that entry rates into the higher track also seem relatively high (between 16 and 18 percent) between the eleventh and twelfth grades results from the grouping of students according to school-entry year rather than actual grade levels. Hence, track upgrading (switching to school types that allow access to academic tertiary institutions like universities) is related to institutional flexibility in the school system after the tenth grade.[15]

Given our central research problem of the effect of school-entry age on track level as students progress through the secondary school system in the German state of Hessen, any relationship between track mobility and school-entry age would be of particular interest.

III. School-Entry Age Effects on Educational Paths in Secondary School

A. Compliance with the Enrollment Cutoff

In the following subsections, we present two-stage least squares estimates of the school-entry age effect on higher track attendance for six different cohorts over the course of five school years.

As in most other OECD countries, in Germany the school-entry age is effectively assigned by an enrollment cutoff set by the school law. It says that children should start school in August of the year in which they turn six years of age, as long as their birthday is before the end of June. Children turning six in the second half of the calendar year (between July and December) are supposed to wait until the following year before entering school. The law, however, explicitly allows early or late school entry if the status of the child's development warrants it. The possibility to deviate from the school-entry rule suggests that the actual school-entry age is endogenous, implying that even if birth month and thus *assigned* school-entry age were randomly assigned across children, the *actual* school-entry age would correlate with the child's proficiency (with less proficient students entering later). For this reason, we follow the literature in using assigned school-entry age as an instrument for actual school-entry age thus estimating the school-entry age effect by two-stage least squares. As shown in Imbens and Angrist (1994), the instrumental variables estimator identifies the effect of interest for compliers with the enrollment cutoff.[16,17]

15. High exit rates from the higher track (13 percent) shown in Table 4 between the twelfth and thirteenth year of schooling result from the fact that some higher track schools may finish and award their certificates after Grade 12. Their students subsequently drop out of the secondary school data. For this reason, we later on focus on the estimates relating to 12 rather than thirteen years after school entry, because (virtually) all higher track students are still in the data at this time.

16. Imbens and Angrist (1994) consider the case in which both the instrument and the impact variable are binary. In this case, the first-stage coefficient would be a consistent estimate of the share of compliers in the population even though no single observation can be identified as a complier. In our application, the situation is slightly more complicated because each person can vary the age at school entry discretely by one or more years in either direction. Thus, the first-stage estimate also is influenced by students who would generally enter school too early but who would enter at age five (rather than six) if born in June and at age six (instead of seven) if born in July. As only 6 percent of students enter school very early (at age five) or very late (at age eight), we expect the first-stage coefficient to be roughly equal to the share of enrollment cutoff compliers in the population of June- or July-born children.

17. Although the distinction between the average and local average treatment effects is not very important in our context, we carried out some checks in this respect. Empirically, this question cannot be answered without further assumptions because individual complier status cannot be determined from the data and

Figure 2 displays the assigned and actual school-entry age, as well as the probability to attend the higher level secondary track, by birth month for all the school-entry cohorts used in this paper as they are observed during the 2005/2006 school year. As the figure shows, children born in June (who are supposed to enter school at age six) tend to enter school later than assigned, whereas children born in July (who are supposed to enter school at age seven) tend to enter earlier. In addition, within the share of students who deviate from their assigned school-entry age, the closer a student's birth month to the cutoff date, the larger the deviation. Moreover, not only does the actual school-entry age based on birth month jump upward between June and July (albeit not to the same degree as assigned by the enrollment cutoff), so too does the probability to attend the higher track.[18] This latter suggests that school-entry age drives track choice.

In order to estimate the causal effect of school-entry age on track attendance, we apply a two-stage least squares estimator, where assigned school-entry age acts as an instrument for the actual entry age. A binary indicator for higher track is the outcome variable. For assigned school-entry age to be a valid instrument for actual school-entry age, birth month has to be randomly assigned. If, however, birth month (and thus assigned school-entry age) were correlated with characteristics driving the outcome "higher track attendance," assigned school-entry age would not be a valid instrument for the actual entry age and the two-stage least squares estimates would be inconsistent. In order to limit this possibility, we restrict the estimation sample to the population of students born in a narrow window around the enrollment cutoff, in this case to students born in June or July, and apply the same two-stage least squares procedure as just described to this restricted population. This is equivalent to a fuzzy regression discontinuity design identification strategy (Campbell 1969; Hahn, Todd, and Van der Klaauw 2001).[19]

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because such assumptions are needed for identification of the average treatment effect in the population. The control function approach discussed in Garen (1984) and Card (2001) proposes a random coefficients model that assumes the deviation of the school-entry age effect from the average treatment effect for an individual to be a linear function of the residual of the first stage equation; that is, a linear function of the amount of noncompliance. However, we believe that this assumption is too strong for our application because of the symmetry restriction—that is, late entry benefits those entering school too late in the same linear way as it would have harmed those entering too early. Nonetheless, we did produce control function estimates (not shown), which were only slightly larger than (and in some cases identical to) the local average treatment effects given here.

Alternatively, we may compare the estimates for cohorts with higher compliance to those for cohorts with lower compliance. However, such comparison (see the estimation results given below) gives no clear directional indication, even though theoretically those who comply with the school-entry rule should be least affected by the school-entry age, thereby biasing the local average treatment effect toward zero relative to the average treatment effect.

18. The fact that the average outcome does not change linearly with birth month is likely to be related to the fact that students are not forced to comply with the enrollment cutoff. The law says that school and parents can agree on a different school-entry age (decision-making is decentralized). This effectively leads to a situation where some schools are generous in allowing many July or August-born children to enter school in the year they turn six (too early). This fact is illustrated by looking at the first stage (Figure 2A): actual school-entry age should decline as birth month moves from July to September, but in fact it rises from July to August and declines only a little from August to September. Only after September, it declines at about the rate it should. This enrollment behavior can explain why the average outcome (higher track attendance) increases up to September.

19. Results for the full population of students (born in any month of the year) do not alter the conclusions

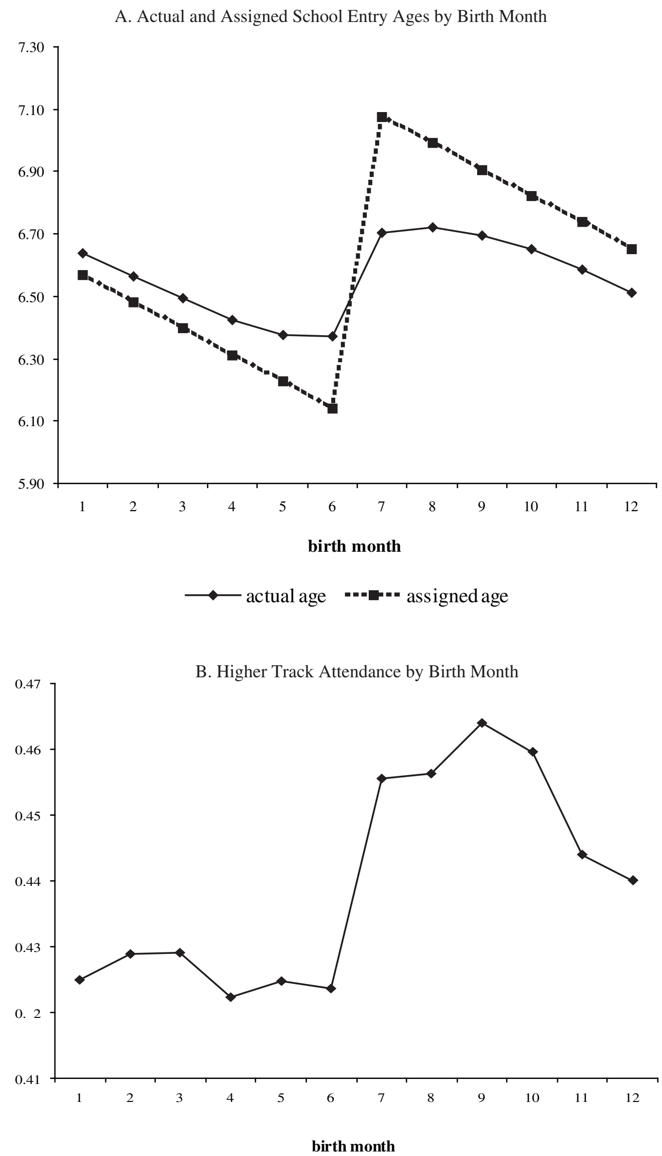

Figure 2

Birth Month and Attendance of Any Type of Higher Track School

Source: Student-level data of the statistics on general and vocational schools for the state of Hessen 2005/06 provided by the Bureau of Statistics of the State of Hessen (Hessisches Statistisches Landesamt), cohorts entering elementary school in 1993–98. Authors' own calculations.

Table 5 presents coefficients of separate regressions of observed student characteristics, such as gender, region (county), and country of citizenship on the instrument (assigned school-entry age) for the first two cohorts (that are not affected by missing data). Results are shown for all five school years for the discontinuity population (June- or July-born). It shows that there are no economically significant effects of the instrument on these student characteristics, which tentatively indicates that birth month is random.

Coefficients of the first-stage regressions for the population of students born in June or July are displayed in Table 6. Here, and in the following section, we show only the specifications without control variables because the estimates with and without control variables are almost identical.[20] Results also do not differ systemically by gender or immigrant status (not shown here, but see Puhani and Weber 2007a for such evidence), so that we confine ourselves to estimates for the student population as a whole.

Estimates for the first stages of the two-stage least squares regressions are provided by cohort and school year together with the *F*-statistics, which, if below ten, indicate potential weak-instrument problems (Staiger and Stock 1997; Stock, Wright, and Yogo 2002). As shown in the first column of Table 6, for the 2002/03 school year, there is some variation in the degree of compliance across cohorts, but—as expected—virtually not within cohorts. Whereas the 1995 school-entry cohort (Cohort 4 in the table) shows the lowest compliance with a first-stage coefficient of 0.31, the 1997 school-entry cohort (Cohort 2) shows the highest with a coefficient of 0.41. Nonetheless, none of the first-stage *F*-statistics point to a weak-instrument problem.

B. School-Entry Age and Attendance of Highest Track Schools

The regression discontinuity design estimates (two-stage least squares based on the population of students born in June or July) are provided in Table 7. The binary outcome variable refers to attendance of the *highest* secondary track schools. Thus, students attending the type of higher track schools yielding restricted access to universities are coded as being in the low track. It is remarkable that, in contrast to the significantly negative OLS estimates,[21] all estimates for up to the tenth year of schooling (shown in the grey shaded areas) are positive and different from zero in terms of statistical significance. As the table shows, the regression discontinuity point estimates up to the tenth year of schooling range between 0.08 and 0.19, but the variation in the estimates is larger between than within cohorts (for example the

from this paper and are in fact very similar even with respect to the point estimates. They are provided in the appendix of the discussion paper version (Puhani and Weber 2007b).

20. If birth month, and therefore the assigned school-entry age as the instrument, is completely random, no control variables are needed. Indeed including control variables that are not exogenous could even make the two-stage least squares estimator inconsistent. On the other hand, exogenous controls improve the estimator's precision.

21. The OLS estimates are shown in Table A1 in the Appendix for a broader definition of the outcome variable (all types of higher track schools; note that the higher track school types awarding limited access to tertiary institutions exist only from Grade 11 onwards so that up to Grade 10, the estimates are not affected by the definition of the outcome variable).

Table 5
Regressions of Observed Variables on Instrument; Means of Observables

	2002/03	2003/04	2004/05	2005/06	2006/07	All Years' Mean
	Coefficient (Standard Error)					
Cohort 1						
Male	−0.01	0.00	0.00	0.00	0.00	0.50
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	
Regional indicators						
Darmstadt	0.00	0.00	0.00	0.00	0.00	0.03
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	
Frankfurt	0.00	0.00	0.00	0.00	0.00	0.08
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	
Offenbach, Offenbach-Land	0.00	0.00	0.00	0.00	0.00	0.07
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	
Wiesbaden, Main-Taunus, Rheingold-Taunus	0.00	0.00	0.00	0.00	0.00	0.10
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	
Bergstraße, Odenwald, Dieburg, Groß-Gerau	0.00	0.00	0.00	0.00	0.00	0.15
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	
Hochtaunus, Wetterau	0.00	0.00	0.01	0.01	0.01	0.09
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	
Main-Kinzig	0.00	0.00	0.00	0.00	0.00	0.07
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	
Gießen, Lahn-Dill, Limburg-Weilburg	0.00	−0.01	−0.01	−0.01	−0.01	0.13
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	
Marburg-Biedenkopf, Vogelsberg	0.00	0.00	0.00	0.00	0.00	0.06
	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	
Kassel	0.00	0.00	0.00	0.00	0.00	0.03
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	
Fulda, Hersfeld-Rotenburg	0.00	−0.01	−0.01	−0.01	−0.01	0.06
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	
Kassel-Land and remaining areas	0.00	0.00	0.00	0.00	0.00	0.12
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	
Nationality indicators						
German-speaking country	0.01	0.01	0.01	0.01	0.00	0.85
	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	
Turkey	−0.01	−0.01	−0.01	−0.01	−0.01**	0.06
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	
Italy, Greece	0.00	0.00	0.00	0.00	0.00	0.02
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	
Remaining countries	0.00	0.00	0.00	0.00	0.00	0.06
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	
Observations	11,077	10,780	10,842	10,824	10,624	54,147

(continued)

Table 5 *(continued)*

	2002/03	2003/04	2004/05	2005/06	2006/07	All Years' Mean
	Coefficient (Standard Error)					
Cohort 2						
Male	−0.01	−0.02*	−0.02	−0.01	−0.02	0.50
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	
Regional indicators						
Darmstadt	0.00	0.00	0.00	0.00	0.00	0.03
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	
Frankfurt	0.00	0.00	0.01	0.01	0.00	0.08
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	
Offenbach, Offenbach-Land	0.00	0.00	0.00	0.00	0.00	0.08
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	
Wiesbaden, Main-Taunus, Rheing.-Taun.	0.00	0.00	0.00	0.00	0.00	0.09
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	
Bergstraße, Odenwald, Dieburg, Groß-Gerau	−0.01	−0.01	−0.01*	−0.01**	−0.01	0.14
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	
Hochtaunus, Wetterau	0.00	−0.01	−0.01	−0.01	0.00	0.09
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	
Main-Kinzig	0.00	0.00	−0.01	−0.01	0.00	0.07
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	
Gießen, Lahn-Dill, Limburg-Weilburg	0.02**	0.02**	0.02**	0.02**	0.02**	0.13
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	
Marburg-Biedenkopf, Vogelsberg	0.00	0.00	0.00	0.00	0.00	0.06
	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)	
Kassel	0.00	0.00	0.00	0.00	0.00	0.04
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	
Fulda, Hersfeld-Rotenburg	−0.01	0.00	0.00	0.00	0.00	0.07
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	
Kassel-Land and remaining areas	0.00	0.00	0.00	0.00	0.00	0.13
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	
Nationality indicators						
German-speaking country	0.00	0.00	0.00	0.00	0.00	0.86
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	
Turkey	0.00	0.00	0.00	0.00	0.00	0.06
	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	
Italy, Greece	0.00	−0.01**	−0.01	−0.01*	0.00	0.02
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	
Remaining countries	0.01	0.01*	0.01**	0.01**	0.01	0.06
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	
Observations	10,318	10,412	10,476	10,512	10,192	51,910

Source: Student-level data of the statistics on general and vocational schools for the state of Hessen 2002/03 to 2006/07 provided by the Bureau of Statistics of the State of Hessen (Hessisches Statistisches Landesamt). School-entry cohorts of 1998 and 1997. Authors' own calculations.
Note: Population of students born in June or July (estimation sample).
* Significant at the 10 percent level. ** Significant at the 5 percent level.

Table 6
First-Stage Results—Population of Students Born in June or July

		2002/03	2003/04	2004/05	2005/06	2006/07
Cohort 1	Coefficient	0.40**	0.42**	0.42**	0.41**	0.41**
(1998)	(*F*)	(1,225)	(1,306)	(1,216)	(1,147)	(1,121)
	Observations	11,077	10,780	10,842	10,824	10,624
Cohort 2	Coefficient	0.41**	0.41**	0.42**	0.42**	0.41**
(1997)	(*F*)	(1,150)	(1,084)	(1,146)	(1,110)	(1037)
	Observations	10,318	10,412	10,476	10,512	10,192
Cohort 3	Coefficient	0.33**	0.33**	0.33**	0.33**	0.31**
(1996)	(*F*)	(796)	(780)	(694)	(667)	(599)
	Observations	10,923	10,934	11,044	10,902	10,902
Cohort 4	Coefficient	0.31**	0.31**	0.31**	0.31**	0.33**
(1995)	(*F*)	(693)	(655)	(672)	(656)	(629)
	Observations	11,061	11,069	10,787	10,787	10,787
Cohort 5	Coefficient	0.33**	0.34**	0.34**	0.34**	0.34**
(1994)	(*F*)	(853)	(820)	(771)	(764)	(686)
	Observations	10,744	10,396	10,396	10,396	10,396
Cohort 6	Coefficient	0.34**	0.34**	0.34**	0.33**	—
(1993)	(*F*)	(784)	(754)	(723)	(684)	—
	Observations	10,248	10,248	10,248	10,248	—

Source: Student-level data of the statistics on general and vocational schools for the state of Hessen 2002/03 to 2006/07 provided by the Bureau of Statistics of the State of Hessen (Hessisches Statistisches Landesamt). Authors' own calculations. Data on students who are supposed to be in Grades 11–13 include imputed observations (see Section IIB).
Note: Ordinary least squares (OLS) regressions of school-entry age on assigned school-entry age.
* Significant at the 10 percent level. ** Significant at the 5 percent level. Documented coefficients refer to specifications without control variables. Effects are robust if available control variables (gender, region, and nationality) are included.

range is between 0.11 and 0.16 for the 1998 school-entry cohort and between 0.08 and 0.10 for the 1997 school-entry cohort). The median estimate in the grey-shaded region (fifth to tenth grade) is 0.13, implying that the effect of entering school at age seven instead of age six increases the probability of attending the highest secondary school track by 13 percentage points, which is large given that only slightly over a third of all students attend the highest track. This effect comes into full force for an enrollment cutoff complier whose birthday is changed from June 30 to July 1.[22] The standard deviations of these estimates lie between 2 and 3 percentage points. Including additional control variables changes the point estimates only slightly and in all cases by less than one standard deviation of any estimate (not shown here).

22. Estimates at the mean obtained from probit instrumental variable models are almost numerically identical to the linear probability model estimates presented here.

Table 7
Second-Stage Results for Attendance of Highest Track Schools—Population of Students Born in June or July

		2002/03	2003/04	2004/05	2005/06	2006/2007
Cohort 1	Coefficient	0.13**	0.15**	0.16**	0.12**	0.11**
(1998)	(standard error)	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)
	Observations	11,077	10,780	10,842	10,824	10,624
Cohort 2	Coefficient	0.10**	0.09**	0.08**	0.08**	0.08**
(1997)	(standard error)	(0.02)	(0.03)	(0.02)	(0.02)	(0.03)
	Observations	10,318	10,412	10,476	10,512	10,192
Cohort 3	Coefficient	0.13**	0.13**	0.12**	0.14**	0.11**
(1996)	(standard error)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
	Observations	10,923	10,934	11,044	10,902	10,902
Cohort 4	Coefficient	0.19**	0.15**	0.14**	0.09**	0.07**
(1995)	(standard error)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
	Observations	11,061	11,069	10,787	10,787	10,787
Cohort 5	Coefficient	0.14**	0.14**	0.12**	0.08**	0.07**
(1994)	(standard error)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
	Observations	10,744	10,396	10,396	10,396	10,396
Cohort 6	Coefficient	0.16**	0.06**	0.05*	0.08**	—
(1993)	(standard error)	(0.03)	(0.03)	(0.03)	(0.03)	—
	Observations	10,248	10,248	10,248	10,248	—

Source: Student-level data of the statistics on general and vocational schools for the state of Hessen 2002/03 to 2006/07 provided by the Bureau of Statistics of the State of Hessen (Hessisches Statistisches Landesamt). Authors' own calculations. Data on students who are supposed to be in Grades 11–13 include imputed observations (see Section IIB).
Note: Two-stage least squares regressions of a binary indicator for attending highest track schools (leading to an unrestricted university entry certificate) on school-entry age, instrumented by assigned school-entry age.
* Significant at the 10 percent level. ** Significant at the 5 percent level. Documented coefficients refer to specifications without control variables. Effects are robust if available control variables (gender, region, and nationality) are included.

The reason for this seemingly large effect of school-entry age on track attendance can be found in the impact of school-entry age on test scores at the end of elementary school, just before the track choice is made. Bedard and Dhuey (2006) find such effects on mathematics and science test scores for almost all industrialized countries they study (Germany is not included in their sample). In Puhani and Weber (2007a), we show that entering school at age seven instead of age six increases reading literacy test scores in Germany by 0.4 standard deviations at the end of elementary school (Grade 4). Hence, with such large differences in performance between early and late school entrants, the large effect on track choice after elementary school is not surprising. The question is, however, how persistent these effects of school entry are during the course of secondary education.

From the two grade transitions for which the tracking system exhibits the largest mobility—that is, from the sixth to the seventh grade and the tenth to the eleventh grade—there emerges a clear pattern. First, the later-tracking support stages provided by some Hessen schools do not lead to a distinct change in the point estimate of the school-entry age effect between the sixth and seventh year of schooling (see the estimates for the 1997 and 1998 school-entry cohorts in Table 7). Hence, the institutional mobility offered by these support stages in the form of a deferred track choice at the age 12 instead of ten does not attenuate the school-entry age effect on track choice.

In contrast, the possibility of correcting the tracking decision after tenth grade has significant consequences. Because we group students according to year of school entry, due to grade retention, some students are still in tenth grade 11 years after school entry. Therefore, we focus on the estimates for 12 years after school entry. Table 7 shows that 12 years after school entry, the possibility of revisiting the educational path decision made after elementary school about halves the school-entry age effect. The estimates decline from 0.14 to 0.07, from 0.14 to 0.08, and from 0.16 to 0.05 in the 1995, 1994, and 1993 school-entry cohorts, respectively. However, the effect of school-entry age on track choice is still significant at between 5 to 8 percentage points, although attenuated by institutional flexibility.

C. School-Entry Age and Attendance of the Higher Track in General

In the following, we include all types of higher track schools in our definition of the outcome variable in the two-stage least squares regressions while only the *highest* track schools awarding unrestricted access to universities have been included in the previous section. Based on this more general definition of higher track schools, Table 8 demonstrates that the school-entry age effect becomes mostly insignificant 12 years after school entry (with point estimates between −1 and 6 percentage points). Indeed, the decreases in the point estimates between ten and 12 years of schooling are very large and range between 8 and 17 percentage points, depending on the school-entry cohort. No significant school-entry age effect is observed for pupils in their thirteenth year of schooling.

Despite the fact that school-entry age seems to have almost no significant effect on obtaining *any* type of higher track certificate, the findings imply that the young school entrants attend higher track schools of lower quality. They are still less likely to attend *highest* track schools (awarding a university entry certificate unrestricted to subject of degree). This implies that the school-entry age effect would show a higher degree of persistence if the possibility of track revision through the other types of higher track schools awarding restricted access to universities would not exist.

Table 4 has shown that there is massive "upgrading" starting ten years after school entry with more limited "downgrading." This raises the question of the roles played by upgrading and downgrading in the attenuation of the school-entry age effect. We can directly answer this question because the administrative data register the school type attended in the previous year.

In Tables 9 and 10, we present two-stage least squares estimates with track upgrade and downgrade as the binary outcome variable, respectively. According to

Table 8
Second-Stage Results for Attendance of Higher Track Schools—Population of Students Born in June or July

		2002/03	2003/04	2004/05	2005/06	2006/07
Cohort 1	Coefficient	0.13**	0.15**	0.16**	0.12**	0.11**
(1998)	(standard error)	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)
	Observations	11,077	10,780	10,842	10,824	10,624
Cohort 2	Coefficient	0.10**	0.09**	0.08**	0.08**	0.08**
(1997)	(standard error)	(0.02)	(0.03)	(0.02)	(0.02)	(0.03)
	Observations	10,318	10,412	10,476	10,512	10,192
Cohort 3	Coefficient	0.13**	0.13**	0.12**	0.14**	0.08**
(1996)	(standard error)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
	Observations	10,923	10,934	11,044	10,902	10,902
Cohort 4	Coefficient	0.19**	0.15**	0.14**	0.10**	0.06*
(1995)	(standard error)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
	Observations	11,061	11,069	10,787	10,787	10,787
Cohort 5	Coefficient	0.14**	0.14**	0.10**	0.04	0.00
(1994)	(standard error)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
	Observations	10,744	10,396	10,396	10,396	10,396
Cohort 6	Coefficient	0.16**	0.03	−0.01	0.02	—
(1993)	(standard error)	(0.03)	(0.03)	(0.03)	(0.03)	—
	Observations	10,248	10,248	10,248	10,248	—

Source: Student-level data of the statistics on general and vocational schools for the state of Hessen 2002/03 to 2006/07 provided by the Bureau of Statistics of the State of Hessen (Hessisches Statistisches Landesamt). Authors' own calculations. Data on students who are supposed to be in Grades 11–13 include imputed observations (see Section IIB).
Note: Two-stage least squares regressions of a binary indicator for attending any kind of higher track school (leading to an unrestricted or a restricted university entry certificate) on school-entry age, instrumented by assigned school-entry age.
* Significant at the 10 percent level. ** Significant at the 5 percent level. Documented coefficients refer to specifications without control variables. Effects are robust if available control variables (gender, region, and nationality) are included.

these estimates, the German tracking system is more likely to allocate students who enter school at a relatively older age to the higher secondary track after elementary school and does not start to reassess this decision until six years later. That is, the regression discontinuity estimate for five years of schooling (the upper left dark-shaded figure) suggests that entering school at age seven instead of six increases the probability of entering the higher track in the fifth grade (when tracking begins) by 13 percentage points (Table 9). As might be expected, these estimates correspond to those for track level given in Table 8. In the subsequent years (sixth to tenth year of schooling), the school-entry age has barely any effect on track upgrading: the point estimates are close to zero (2 percentage points, maximum) and often insignificant. This finding is not surprising given that curriculum differences and other requirements make it difficult to change tracks during the middle of secondary

Table 9
Second-Stage Results for Upgrade to Higher Track—Population of Students Born in June or July

		2002/03	2003/04	2004/05	2005/06	2006/07
Cohort 1	Coefficient	0.13**	0.01	0.02	−0.01**	0.00
(1998)	(standard error)	(0.02)	(0.01)	(0.01)	(0.00)	(0.00)
	Observations	11,077	10,780	10,842	10,824	10,630
Cohort 2	Coefficient	0.02**	0.00	0.00	0.00	0.00
(1997)	(standard error)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)
	Observations	10,318	10,412	10,476	10,512	10,192
Cohort 3	Coefficient	0.00	0.02**	0.00	0.01	−0.08**
(1996)	(standard error)	(0.01)	(0.01)	(0.00)	(0.00)	(0.02)
	Observations	10,923	10,934	11,044	10,902	10,902
Cohort 4	Coefficient	0.01*	−0.01**	−0.01*	−0.04	−0.03*
(1995)	(standard error)	(0.01)	(0.00)	(0.00)	(0.02)	(0.02)
	Observations	11,061	11,69	10,787	10,787	10,787
Cohort 5	Coefficient	0.00	0.01*	−0.05**	−0.03*	−0.01
(1994)	(standard error)	(0.00)	(0.00)	(0.02)	(0.02)	(0.01)
	Observations	10,744	10,396	10,396	10,396	10,396
Cohort 6	Coefficient	0.00	−0.06**	0.00	0.01	—
(1993)	(standard error)	(0.00)	(0.02)	(0.02)	(0.01)	—
	Observations	10,248	10,248	10,248	10,248	—

Source: Student-level data of the statistics on general and vocational schools for the state of Hessen 2002/03 to 2006/07 provided by the Bureau of Statistics of the State of Hessen (Hessisches Statistisches Landesamt). Authors' own calculations. Data on students who are supposed to be in Grades 11–13 include imputed observations (see Section IIB).
Note: Two-stage least squares regressions of a binary indicator for upgrading to a higher track school on school-entry age, instrumented by assigned school-entry age. Higher track students are included in the regressions, although they cannot upgrade, to make the coefficients comparable with changes in coefficients of regressions with attending higher track school as the outcome variable.
* Significant at the 10 percent level. ** Significant at the 5 percent level. Documented coefficients refer to specifications without control variables. Effects are robust if available control variables (gender, region, and nationality) are included.

school. However, when students enter their eleventh year of schooling, successful graduates from the nonacademic (lower) tracks may decide whether to enter apprenticeship training or to move to any type of higher track school. It is at this time that the German tracking system facilitates track upgrading providing access to further academic tertiary institutions.

As the estimates in Table 9 show, in the eleventh year of schooling, track upgrading is influenced by school-entry age: students who entered school at a relatively young age (age six instead of seven) are more likely to upgrade. Indeed, the point estimates indicate that entering school at age seven instead of six decreases the probability of upgrading to the higher level track by between −4 and −8 percentage points. A year later, in the twelfth year of schooling, the effect is still between 0

Table 10
Second-Stage Results for Downgrade from Higher Track—Population of Students Born in June or July

		2002/03	2003/04	2004/05	2005/06	2006/07
Cohort 1	Coefficient	0.00	0.00	0.01	0.01	0.01
(1998)	(standard error)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	Observations	11,077	10,780	10,842	10,824	10,630
Cohort 2	Coefficient	0.02	0.00	0.00	0.01	0.00
(1997)	(standard error)	(0.01)	(0.00)	(0.00)	(0.01)	(0.00)
	Observations	10,318	10,412	10,476	10,512	10,192
Cohort 3	Coefficient	0.01	0.02	0.01	0.00	0.00
(1996)	(standard error)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
	Observations	10,923	10,934	11,044	10,902	10,902
Cohort 4	Coefficient	0.02	0.01	0.01	0.00	0.00
(1995)	(standard error)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
	Observations	11,061	11,069	10,787	10,787	10,787
Cohort 5	Coefficient	0.01	0.01	−0.01	0.03**	0.03*
(1994)	(standard error)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
	Observations	10,744	10,396	10,396	10,396	10,396
Cohort 6	Coefficient	0.01	0.06**	0.04**	−0.02	—
(1993)	(standard error)	(0.01)	(0.01)	(0.01)	(0.02)	—
	Observations	10,248	10,248	10,248	10,248	—

Source: Student-level data of the statistics on general and vocational schools for the state of Hessen 2002/03 to 2006/07 provided by the Bureau of Statistics of the State of Hessen (Hessisches Statistisches Landesamt). Authors' own calculations. Data on students who are supposed to be in Grades 11–13 include imputed observations (see Section IIB).
Note: Two-stage least squares regressions of a binary indicator for downgrading from a higher track school on school-entry age, instrumented by assigned school-entry age. Lower track students are included in the regressions, although they cannot downgrade, to make the coefficients comparable with changes in coefficients of regressions with attending higher track school as the outcome variable.
* Significant at the 10 percent level. ** Significant at the 5 percent level. Documented coefficients refer to specifications without control variables. Effects are robust if available control variables (gender, region, and nationality) are included.

and −3 percentage points, which adds up to an effect between −6 and −8 percentage points in each cohort. Comparing the effects of school-entry age on track attendance and track upgrading (Table 8 and Table 9) shows that—depending on the cohort—track upgrading explains more than half or almost all of the attenuation of the school-entry age effect on attending the higher track. For the 1994 and 1993 school-entry cohorts (cohorts 5 and 6, respectively, in the tables), a later school-entry age also has a significant effect on track downgrade (Table 10, which—together with the Table 9 results on track upgrade—explains the size of the declines in the estimates presented in Table 8.

The finding of large effects of school-entry age on track attendance up until ten or 11 years after school entry, as well as their subsequent mitigation due to increased opportunities for revision of educational paths, raises the question of gender differences. In results not shown here, but available on request, we show that for both genders, there is a significant school-entry age effect until ten years after school entry, which becomes insignificant for higher track attendance in general 12 years after school entry at the latest.

D. Higher Secondary School Tracks and Wages

The fact that the available data measure track attendance only until the end of secondary school raises two important questions. First, what impact does track attendance have on the labor market? After all, differences in educational experiences for several years may have lasting effects for early and late school entrants (see the study by Hilmer 2000, on college transfer students). Second, in what ways are different types of higher level secondary schools economically, rather than formally, comparable? For lack of available data, we cannot take the direct route and estimate the effects of birth month on wages.[23]

Instead, we provide a back-of-the-envelope calculation with some descriptive regression results. From a comparison of Table 7 and Table 8 we retrieve that, averaged over three cohorts, 12 years after school entry about 4 percent of all students who enter school at age six instead of seven obtain a lower quality higher track school certificate. However, this quality cost of early school entry comes with the benefit of entering the labor market a year earlier ceteris paribus. Over a 40-year working life, one year makes up 2.5 percent of lifetime earnings (if the present discounted value of any year of work is assumed constant for simplicity). We now ask which wage differential would have to exist between workers with a highest track general certificate and those with a restricted higher track certificate to eliminate the 2.5 percent gain in lifetime earnings through earlier labor market entry: in the Appendix, we derive that this differential must be at least 32 percent, probably higher. However, the real return is likely to be much lower.

To show this, we run descriptive regressions using the 2004 German Socio-Economic Panel (GSOEP) and Mikrozensus (a one-percent census of the population, MZ) to estimate the difference in wages associated with the certificate awarded by highest track schools and the restricted higher track certificate. We start by regressing the log gross hourly wages (GSOEP) or log net hourly income (MZ) on a dummy variable that indicates any type of higher track certificate. The only control variables are age and age squared (the population includes only West German workers aged 26 to 40 who attended school from the 1970s onwards, when the current German schooling system was already in place). As Table 11 shows, for men, the estimated "return" to completing a higher track school (which potentially involves attending university, which is not controlled for in the regressions) amounts to 21 (GOESP) or 25 (MZ) percent; for women, it is 24 (GSOEP) or 26 (MZ) percent. Similar regressions with higher education as the outcome variable (not shown) suggest that completion of the higher track raises the probability of obtaining a university or

23. The German Socio-Economic Panel (GSOEP) provides birth month but is too small in terms of sample size to analyze wage effects of birth month.

Table 11
Returns to a Higher Track Certificate

	Men GSOEP		MZ		Women GSOEP		MZ	
Any higher track certificate	0.21**	0.19**	0.25**	0.20**	0.24**	0.24**	0.26**	0.17**
(Standard error)	(0.04)	(0.07)	(0.01)	(0.01)	(0.05)	(0.08)	(0.01)	(0.02)
Highest track schools	—	0.03	—	0.08**	—	—0.01	—	0.11**
(Standard error)	—	(0.08)	—	(0.01)	—	(0.09)	—	(0.02)
Age	0.15*	0.15*	0.09**	0.09**	0.07	0.07	0.03**	0.03**
(Standard error)	(0.08)	(0.08)	(0.01)	(0.01)	(0.10)	(0.10)	(0.01)	(0.01)
Age squared	0.00	0.00	0.00**	0.00**	0.00	0.00	0.00**	0.00**
(Standard error)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Constant	−0.65	−0.65	0.33	0.33	1.07	1.06	1.15**	1.16**
(Standard error)	(1.31)	(1.32)	(0.18)	(0.18)	(1.61)	(1.60)	(0.24)	(0.24)
Observations	1,462	1,462	32,507	32,507	1,172	1,172	23,459	23,459
R^2 (GSOEP)/Pseudo-R^2 (MZ)	0.13	0.13	0.02	0.02	0.06	0.06	0.01	0.01

Source: German Socio-Economic Panel (GSOEP) and Mikrozensus (MZ) 2004. Authors' own calculations.
Note: The dependent variable is the natural logarithm of the gross hourly wage rate (GSOEP) or net hourly income (MZ). Only West Germans aged 26 to 40 are included in the sample. Any higher track certificate is a dummy variable that equals one if a person holds a diploma obtained from any type of higher track school. Highest track schools is a dummy variable that equals one if a person holds a higher level certificate allowing unrestricted access to universities. Estimates are obtained using sampling weights and robust standard errors. Because income in the Mikrozensus is given in intervals, we estimate interval regressions (ordered probit with known boundaries) instead of ordinary least squares regressions.
* Significant at the 10 percent level. ** Significant at the 5 percent level.

"University of Applied Sciences" degree by 51 (GSOEP) or 52 (MZ) percentage points for men and 48 (GSOEP) or 46 (MZ) percentage points for women.

As regards the question of "returns" to different types of higher track schools, estimating similar hourly wage/income regressions as above, we test whether the labor market "returns" between the two types of higher track school certificates differ (also shown in Table 13). For men, the difference in the "return" between a highest track certificate and the restricted higher track certificate is a statistically insignificant 3 percent in the GSOEP, but a statistically significant 8 percent in the large MZ data set. For women, it is a statistically insignificant −1 percent in the GSOEP but a significant 11 percent in the MZ.[24] If these descriptive results were interpreted as causal average treatment effects, younger school entrants would obtain academic secondary school certificates of lower quality, although the school-entry age effect on obtaining any type of higher track school certificate is not significantly different from zero according to most of our estimates in Table 8.

Note, however, that because of selection into school types based on unobserved abilities we expect the average treatment effect to be lower than the estimated coefficients of these descriptive regressions. Therefore the return (average treatment effect) to a highest track versus restricted higher track certificate is plausibly much lower than 32 percent, which is lower than the lower bound of the required financial return warranting late rather than early school entry (see the simulation in the Appendix).

Beyond considerations concerning the wage effects of entering school early or late, further outcomes might be lastingly affected by the type of school attended. For example, the development of the personality is likely to be influenced by peer group effects associated with different types of schools. Similarly, family income might be influenced through assortative mating: in estimations based on the GSOEP not shown here, we find that partner income is about 19 percent lower for both men and women who have a restricted higher track instead of the (general) highest track certificate. Again, these estimates do not account for selection: in the natural experiment we consider here (being born in June or July) ability is held constant. Therefore, the effect of track attended on partner income may be much lower for the compliers in our natural experiment than the effect estimated from observational data (the latter is likely to be biased away from zero by sorting according to ability).

IV. Conclusions

We demonstrate that being born in June rather than July generates a randomly allocated disadvantage through a school enrollment cutoff that suggests July-born children to enter school at age seven in the German state of Hessen, whereas June-born children are supposed to enter school at age six. Although previous literature has already presented similar findings, our study of the whole popu-

24. The large discrepancy between the GSOEP and MZ results, especially for women, may be a result of the small sample size in the GSOEP (only 138 women are observed with a certificate awarding restricted access to universities, *Fachoberschule*). In addition, the outcome variable is measured differently (gross hourly wages versus net hourly income) in both data sets.

lation of students in a German state shows how the school-entry age effect interacts with a school tracking system at different stages of secondary education.

As discussed in Bedard and Dhuey (2006, p. 1140f., 1457ff.) differences in school-entry age effects across countries may be related to many factors, but the type, timing, and duration of ability grouping may play an important role in explaining the degree of persistence of the school-entry age effect. We focus on all students in a state in Germany, a country with early tracking and different degrees of flexibility for track change along the secondary educational career. Consistent with Bedard and Dhuey's (2006) reasoning, we illustrate how early tracking, as practiced by several countries, can lead to persistent differences in educational experiences of disadvantaged students.

Our results show that entering school at age seven rather than six raises the probability to attend a highest track secondary school by about 13 percentage points, which is a large effect, implying that young school entrants (age six) are only two-thirds as likely to attend the highest track schools than old school entrants (age seven). Although about 30 percent of students in Hessen attend schools that allow deferral of school choice to age 12 (rather than age ten), the school-entry age effect is not affected by this later tracking possibility. Instead, the school-entry age effect on highest track attendance remains virtually constant until ten years after school entry. Only then is the school-entry age effect mitigated, which occurs mainly by upgrading of early school entrants to higher track schools, although partly to higher track schools awarding a lower-quality certificate implying access to universities restricted by subject of specialization. The mitigation of the effect occurs at a time when students are around age 16 and the school tracking system gives students a second chance by facilitating track upgrade or downgrade. In sum, school-entry age exerts a significant effect on educational experiences for at least six years in secondary school in the early tracking system we have studied.

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Appendix 1

Simulation of Required Return to a Highest Track Certificate to Keep Lifetime Earnings Constant

Model lifetime earnings V as the product of the expected wage rate $E(W)$ and the number of periods worked T. Ignore discounting by assuming that the real growth rate in wages equals the discount rate:

$$(1) \quad V = E(W) \times T.$$

The aim of our simulation is to find the wage differential between a highest track certificate awarding unrestricted access to universities and a certificate obtained from a higher track school yielding restricted access to universities that would make an individual indifferent between entering school at six or seven years of age. Hence, we have to set the total differential of lifetime earnings equal to zero

$$(2) \quad dV = T \times dE(W) + E(W) \times dT = 0.$$

In relative terms, this yields,

$$(3) \quad \frac{dV}{V} = \frac{dE(W)}{E(W)} + \frac{dT}{T} = 0.$$

Entering the labor market a year later reduces the duration of work life by about one over 40, so that

$$(4) \quad \frac{dT}{T} \approx -0.025.$$

Next, consider the change in the expected wage rate. This depends on the school-entry age A by influencing whether one earns a wage associated with a highest secondary certificate W_G, a higher track certificate with restricted access to universities W_L, or no higher secondary school certificate W_N:

$$(5) \quad E(W) = \Pr(W_G|A) \times W_G + \Pr(W_L|A) \times W_L + \Pr(W_N|A) \times W_N.$$

The total derivative is:

$$(6) \quad dE(W) = \frac{\partial \Pr(W_G|A)}{\partial A} \times W_G \times dA + \frac{\partial \Pr(W_L|A)}{\partial A} \times W_L \times dA + \frac{\partial \Pr(W_N|A)}{\partial A} \times W_N \times dA.$$

In the paper, we show that school-entry age does not significantly affect the probability of obtaining any type of higher secondary certificate. Hence,

$$(7) \quad \frac{\partial \Pr(W_N|A)}{\partial A} \approx 0 \text{ and } \frac{\partial \Pr(W_G|A)}{\partial A} \approx -\frac{\partial \Pr(W_L|A)}{\partial A}.$$

The latter equality follows from the fact that

$$(8)\quad 1=\Pr(W_G|A)+\Pr(W_L|A)+\Pr(W_N|A).$$

Therefore,

$$(9)\quad \frac{dE(W)}{E(W)}=\frac{\partial\Pr(W_G|A)}{\partial A}\times\frac{(W_G-W_L)}{\Pr(W_G|A)\times W_G+\Pr(W_L|A)\times W_L+\Pr(W_N|A)\times W_N}.$$

In Table 7 we estimate the school-age entry effect on attending a highest track school 12 years after school entry. For this simulation, we take the estimates obtained for Cohorts 4 through 6 in Table 7 and subtract from them the mostly insignificant point estimates for the general definition of the higher track as displayed in Table 8. When we average the three differences, we conclude that entering school at age seven instead of age six increases the probability of obtaining a highest track certificate by 4 percent. Hence,

$$(10)\quad \frac{\partial\Pr(W_G|A)}{\partial A}\approx 0.04.$$

Combining Equations 2, 3, 4, 9, and 10, we obtain

$$\frac{dE(W)}{E(W)}=-\frac{dT}{T}\approx 0.025=0.04\times\frac{(W_G-W_L)}{\Pr(W_G|A)\times W_G+\Pr(W_L|A)\times W_L+\Pr(W_N|A)\times W_N}.$$

Hence,

$$(11)\quad \frac{(W_G-W_L)}{\Pr(W_G|A)\times W_G+\Pr(W_L|A)\times W_L+\Pr(W_N|A)\times W_N}\approx 0.63.$$

Therefore, a wage differential of 63 percent would be required for entering school a year later having no effect on lifetime earnings. In order to compare that simulated number with regression-adjusted estimates of that return, note that the coefficient estimated by regressions is not Equation 11, but instead

$$(12)\quad \delta=\frac{(W_G-W_L)}{W_L}.$$

To see what Equation 11 implies for estimates of Equation 12, we need to carry out another simulation. Consider the ratio of Equations 12 and 11 and rearrange to obtain:

$$(13)\quad \delta=\frac{\Pr(W_G|A)\times W_G+\Pr(W_L|A)\times W_L+\Pr(W_N|A)\times W_N}{W_L}\times 0.63.$$

It follows that the simulated return on a highest secondary versus a restricted higher track certificate is 0.63 times the ratio of the expected wage (which is a weighted average of the wages corresponding to the three types of schooling) and the wage with a restricted higher track certificate. Because the sum of the weights equals one (see Equation 8), and because, $W_G > W_L > W_N$, we obtain the following extreme scenarios: For $\Pr(W_G|A) = 1$, we obtain $\delta = \frac{W_G}{W_L} \times 0.63$ and for $\Pr(W_N|A) = 1$, we obtain $\delta = \frac{W_N}{W_L} \times 0.63$.

So in the one extreme, $\delta > 0.63$, which is way beyond realism (see also the regression-adjusted estimates in Section IIID). In the other extreme, we have to provide a lower bound for W_N/W_L in order to obtain a lower bound for δ. The regression-adjusted estimates in Section IIID are around 1.25 for W_L/W_N (the coefficients in the log wage regressions are about 0.25), which implies W_N/W_L around 0.8. Even if we reduce this number to 0.5, the lower bound for δ would be 0.32, which is three times as large as the Section IIID estimates of 0.08 and 0.11 for men and women, respectively.

Hence, these simulations imply that entering schooling a year late is unlikely to pay off financially in terms of lifetime earnings.

Appendix 2

Remarks on the OLS Estimates

As Table A1 shows, from the fifth to the tenth grade (the grey-shaded areas), all estimates, without exception, are negative and statistically significant.[25] Hence, the correlation between school-entry age and attending a higher track school is unambiguously negative in the middle of secondary school. In addition, a representative estimate indicates that those students who enter school at age seven have a probability of attending the higher track that is 11 percentage points lower than that of students entering school at age six. Moreover, including gender, regional, and country of origin controls into the regression leads to only small changes in the estimates (not shown), with a tendency for the point estimate to become smaller in absolute value. This decrease in the absolute value of the OLS estimate is indicative of a correlation between the actual school-entry age and the socioeconomic characteristics that lead to a downward bias in the OLS coefficients.

Interestingly, the point estimates drop in absolute value after the tenth year of schooling (with point estimates at −5 to −4 percentage points in the twelfth year for example).[26] The drop in the absolute value of the point estimates occurs when upward mobility into the higher track becomes important (see Table 4). Hence it

25. For the 1998 school-entry cohort in 2002/03 (supposed to enter the fifth grade), the estimate is comparatively small in absolute value because some students—who either repeated a grade or entered school through a special preschool (Vorklassen)—are still in primary school.

26. The coefficients turn significantly negative again 12 and especially 13 years after school entry, possibly because some higher track schools providing restricted university access finish after twelfth grade. Since assigning *all* simulated observations to the lower track may be problematic, we deemphasize the results for Grade 13 throughout.

seems that late entrants, likely to be a selected group of students with less innate ability, are more likely to enter the higher track at this stage than early entrants. The decline in the correlation between school-entry age and track level at eleventh grade suggests that track upgrading after tenth grade provides higher track education to less talented students, an argument often made by conservative political circles who want to preserve rigorous tracking. In contrast, the political left, which favors institutional flexibility, argues that track upgrading helps students with innate ability but disadvantaged backgrounds. The results of our paper give support to both arguments: the OLS estimates are consistent with the less proficient students making use of the opportunity to upgrade to the higher track, whereas the two-stage least squares results show that disadvantaged students seize the opportunity given by a second chance concerning choice of educational path.

Table A1
OLS Results for Attendance of the Higher Track—Population of Students Born in June or July

		2002/03	2003/04	2004/05	2005/06	2006/07
Cohort 1	Coefficient	−0.02**	−0.09**	−0.11**	−0.12**	−0.12**
(1998)	(standard error)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
	Observations	11,077	10,780	10,842	10,824	10,624
Cohort 2	Coefficient	−0.11**	−0.12**	−0.12**	−0.13**	−0.12**
(1997)	(standard error)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
	Observations	10,318	10,412	10,476	10,512	10,192
Cohort 3	Coefficient	−0.09**	−0.11**	−0.11**	−0.11**	−0.04**
(1996)	(standard error)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
	Observations	10,923	10,934	11,044	10,902	10,902
Cohort 4	Coefficient	−0.11**	−0.11**	−0.11**	−0.05**	−0.05**
(1995)	(standard error)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
	Observations	11,061	11,069	10,787	10,787	10,787
Cohort 5	Coefficient	−0.10**	−0.08**	−0.01*	−0.05**	−0.09**
(1994)	(standard error)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
	Observations	10,744	10,396	10,396	10,396	10,396
Cohort 6	Coefficient	−0.08**	−0.02**	−0.04**	−0.07**	—
(1993)	(standard error)	(0.01)	(0.01)	(0.01)	(0.01)	—
	Observations	10,248	10,248	10,248	102,48	—

Source: Student-level data of the statistics on general and vocational schools for the state of Hessen 2002/03 to 2006/07 provided by the Bureau of Statistics of the State of Hessen (Hessisches Statistisches Landesamt). Authors' own calculations. Data on students who are supposed to be in Grades 11–13 include imputed observations (see Section IIB).
Note: OLS regressions of a binary indicator for attending a higher track school on school-entry age.
* Significant at the 10 percent level. ** Significant at the 5 percent level. Documented coefficients refer to specifications without control variables. Effects are robust if available control variables (gender, region, and nationality) are included.