The Transition to Tertiary Education and Parental Background over Time

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Using SOEP data (1984-2006) we analyze the role of parental background for transitions to tertiary education in Germany and answer three questions: (a) does the relevance of parental background shift from short-term (contemporary income) to long factors (ability, parental education) at higher levels of education? (b) Did the impact of parental background on participation in tertiary education change over time? (c) Are there different patterns by sex and region? We consider panel estimators with and without selectivity corrections and numerous robustness tests. Parental income significantly affects transitions to tertiary education. Its impact seems to have lost magnitude over time. We find no clear differences by sex, and larger parental income effects in West than in East Germany.

Key Words: intergenerational transmission, human capital investment, tertiary education, education expansion, college entry

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1. Introduction

Aggregate demand for highly qualified workers as well as the provision of tertiary education increase internationally. At the individual level, tertiary education is a key determinant of wage differentials. This study investigates the role of parental background for individual transitions to tertiary education with a special interest (a) in the relative importance of family ability vs. available financial resources, (b) in changes in the correlation of parental background with college entry over time, and (c) in systematic differences in the relevance of parental background across population groups.

The determinants of entry to tertiary education are of immediate policy relevance for several reasons. First, the large expected demand for a qualified labor force directs political attention to the issue of broadening access to tertiary education (OECD 2007). Second, in societies aiming at equal education opportunities for all children and independent of parental background it is important to learn about the relative impact of various constraints for the transition to higher education. Third, research on college entry is informative with respect to policy instruments supporting college entry, be it tuition remissions or other financial transfers: Cameron and Heckman (2001) suggest that such programs do not work because short-term financial and liquidity constraints are not central in keeping individuals from investing in tertiary education.[1] Instead, they find the long-run factors that are reflected e.g. in parental educational background and child ability to be key determinants of continued schooling. If our results confirm this conclusion educational policy may have to face up to the ineffectiveness of major policy tools.

This analysis ties in with the literature on intergenerational educational mobility which found for the United Kingdom (Machin and Vignoles 2004, Galindo-Rueda and Vignoles 2005) as well as for Germany (Heineck and Riphahn 2009) that the expansion of higher *secondary* education mostly benefited the children of well educated and high income

[1] This result is disputed by Belley and Lochner (2007) but supported by Mayer (2008).

parents. Extending these analyses we focus on the transition to tertiary education. The recent literature on college entry in the United States predominantly investigated the development of racial differences over time (e.g. Cameron and Heckman 2001, Black and Sufi 2002, Kane 1994) and the sensitivity of education demand to changes in tuition fees (e.g. Cameron and Taber 2004, Dynarski 2003, Hilmer 1998). Relevant European studies on college entry are Lauer (2003) who compares the selection into higher education for Germany and France, Rice (1987) and Leslie and Drinkwater (1999) who investigate the transition to tertiary education in the United Kingdom, and Checci et al. (2008) who study the Italian case.

Among numerous sociological contributions on the role of parental background for child tertiary education in Germany, Blossfeld (1993) described educational outcomes for the birth cohorts 1916-1960. With respect to the transition to tertiary education he finds positive effects of paternal education and occupational prestige which are, however, weaker than for secondary education outcomes. There is no clear trend across birth cohorts. The author makes no attempt to control for sample selection at higher educational outcomes.[2] Lauer (2002) investigates the determinants of enrolment in tertiary education in Germany testing a broader set of hypotheses. She finds a significant effect of the student financial assistance scheme. This is not confirmed by Baumgartner and Steiner (2005, 2006) who take advantage of two reforms of the student financial assistance scheme to identify its effects. However, Steiner and Wrohlich (2008) do find significant effects of student assistance and of parental income on college enrolment in Germany. Most of these papers consider only graduates of the German advanced secondary schools (*Gymnasium*) but omit sample selection controls.

Our study contributes to the existing literature on the intergenerational transmission of education in several ways: it provides evidence on the relative impact of short-run and long-run determinants of tertiary education in a large European country, it describes the

[2] This methodological shortcoming also characterizes more recent sociological analyses of education transmission in Germany, e.g. Mayer et al. (2007), Maaz (2006).

developments over more than two decades separately for males and females, and it contrasts the developments in East and West Germany using the rich and representative data of the German Socioeconomic Panel (1984-2006). In contrast to corresponding U.S. studies our analysis is set in a secondary school system which is organized based on ability-based tracks. This makes it particularly important to allow for endogenous selection into subsequent educational stages. In addition, we aim at controlling for individual ability and test whether the potential endogeneity of parental income affects our findings.

Our key results are that both long-run and short-run factors appear to affect the transition to tertiary education in Germany as long as selection into high secondary schooling is not accounted for. When controlling for the selectivity inherent in attaining university access only parental income remains a significant determinant of college entry while parental education loses its statistical significance. There is a slight indication that the impact of parental income on transitions to tertiary education declined over time. We find no clear differences in the patterns behind college entry by sex, and larger parental income effects in West than in East Germany.

2. Institutional Background

The German secondary school system is organized in three tracks (see Figure 1). Typically at the age of 10 and after four grades in elementary school, pupils are sorted in three secondary school tracks: a basic school which prepares for blue collar vocational apprenticeships, a middle school with higher requirements preparing for white collar vocational training, and an advanced school (*Gymnasium*) which prepares for academic studies.[3] The final degree of the *Gymnasium*, the *Abitur,* is the entrance requirement for

[3] In addition, there are comprehensive schools where pupils can obtain either level of education. However, only a share of about four percent of every cohort attends these.

tertiary education. Besides classic universities the German tertiary education system entails polytechnical universities (*Fachhochschulen*).

While traditionally less than 20 percent of a birth cohort completed advanced school and attained academic entrance requirements, recent decades witnessed a massive expansion of the educational system: Figure 2 depicts the development of the population shares attaining *Abitur* by birth cohort, Table 1 describes more recent cohort shares with *Abitur* separately for males and females based on administrative data. The development over time (see columns 1 and 2) suggests that the education expansion benefited particularly females. While one might suspect that part of this development is due to unification and different gender roles in former East Germany, we find massive educational improvements also for females in West Germany alone (see column 6).

We focus on pupils who graduate from *Gymnasium*. Our data allow us to follow them for the first five years after the *Abitur* and to observe whether they take up tertiary education. Figure 3 provides aggregate data on the distribution of delays in college entry by gender over time. The figures suggest that only small cohort shares take up academic education later than three years after obtaining the *Abitur*. As we observe individuals up until five years after *Abitur* our data should cover the vast majority of individuals ever taking up tertiary education after meeting the entrance requirements.

Figure 3 suggests noticeable gender differences in the timing of university entry which are most likely due to the military service requirements for males.[4] Whereas around 40 percent of all females take up tertiary education in the very year they leave *Gymnasium*, this immediate transition rate recently amounts to less than 20 percent for men. In their majority

[4] The requirements for male military or substitute civil service have been shortened in recent years. The duration of military service was shortened from 15 months (1984-1990), to 12 months (1990-1996), 10 months (1996-2002), and nine months since 2002. Alternative civilian service obligations were as high as 20 months (1984-1990), then 15 months (1990-1996), reaching 10 months between 2002 and 2004, and nine months since.

they enter academics one year later. The share of *Gymnasium* graduates that never commences tertiary education is larger among females than among males.

In view of the rising cohort shares with *Gymnasium* degrees (see Figure 2, Table 1), it is of interest to examine the development of cohort shares taking up tertiary education over time. Figure 4 depicts the annual absolute number of entering students since 1975, which has more than doubled since. Table 2 presents entry rates by gender across all institutions of tertiary education. Clearly, both the cohort share of males and females entering tertiary education increased strongly over the last decades and females caught up with males.[5] Aggregate data suggest that also the cohort shares with completed tertiary degrees have been going up (for recent evidence by sex see Table 3).

Tertiary education has been subject to institutional reforms over time (for a description see e.g. Mayer et al. 2007). As documented e.g. by Heineck and Riphahn (2009) the entire education system in Germany experienced an expansion over the last decades. Table 4 summarizes key budgetary developments regarding the tertiary education system: the total number of students and nominal expenditures increased, while the expenditures as share of GDP and professor-student ratios declined.

In addition, a number of reforms affected the investment decision of the individual high school graduate. For the time of our data there were basically no tuition fees in German public tertiary education except for administrative fees of around 100 Euro per semester. For students in financial need, i.e. when parental income is below a fixed cutoff level, a support system has been available for decades to cover students' costs of living (it pays a maximum of about 584 Euro per month as of 2009). This support system has undergone a number of reforms: until 1974 it was a full grant, later an increasing share was provided as a loan. Since

[5] It is not useful to compare the rates in Table 2 to those in Table 1 or Figure 1, as Table 2 combines all individuals entering tertiary education in a given calendar year, independent of their age, while Table 1 and Figure 1 condition on the year of leaving school. As cohort sizes vary substantially over time the difference in conditioning affects the cohort shares.

1983 the support was granted as a full loan to be repaid with interest. In 1990 a reform reinstated that half of the support was provided as an unconditional transfer and half as an interest-free loan. In 2001 the benefit amount was increased and the fixed cutoff level of parental income rose by 20 percent.

3. Literature and Hypotheses

Prior literature has paid attention to both, the intergenerational transmission of income and of educational attainment between parent and child. Among the central mechanisms explaining this transmission are the genetic inheritability of ability, parenting quality, parental income, and other environmental factors. Parental income and wealth find particular attention in the debate about equal access to education. Since parental income is potentially correlated with unobserved determinants of child educational outcomes numerous studies focus on identifying its true causal effect. Some use social experiments that affect family income (e.g. Clark-Kauffman et al. 2003), others apply various instrumental variables (e.g. Blanden and Gregg 2004), and others again control for fixed family- or individual-specific unobservables, e.g. by comparing the outcomes for siblings and twins (see Tamm 2007) or for adopted and non-adopted children (Plug and Vijverberg 2003).

Besides the literature which studies the correlation of income and child educational attainment at a given point in time, other analyses investigate trends in intergenerational transmission. In an important contribution Cameron and Heckman (1998) evaluate the development for American males born between 1907 and 1964. They distinguish the effects of family income at the time when the schooling decisions were to be taken (short-run effects) from the effects of parent and child ability endowments (long-run effects). The authors stress the phenomenon of dynamic selection bias: the selective educational progress of those with the best unobservable characteristics can lead to biased estimates of the impact of family background. After the first educational selection stage individual unobservables are

no longer statistically independent of observable background characteristics. In their 1998 study Cameron and Heckman find that short-run income effects hardly matter for the transition to tertiary education. This is confirmed by Cameron and Heckman (2001), but disputed by Belley and Lochner (2007) who consider data on younger birth cohorts in the United States. Similar results are obtained by Blanden and Machin (2004) who look at British data. However, the two latter studies do not control for dynamic selection bias.

We follow the Cameron and Heckman-set up and compare the relevance of short- and long-run effects over subsequent birth cohorts in order to identify the impact of short-run parental income after controlling for the long-run ability characteristics of the family. It is this conditional short-term income effect which is of foremost political interest as it is the only determinant of educational outcomes which transfer programs may be able to affect directly. The identification strategy typically applied to measure short-run income effects consists of controlling both for general family ability (measured e.g. via parental education) as well as for unobservable ability of the individual using e.g. intelligence test scores. Only if family income affects educational choices after conditioning on these factors can we expect policies to be successful which attempt to affect the enrolment of the smart poor by providing relief to short-term liquidity restrictions.

Some analyses of the determinants of educational outcomes at the tertiary level discuss cost-benefit considerations (e.g. Black and Sufi (2002), Kane (1994) and for a recent survey Kane (2006)) and use empirical specifications which approximate the cost (e.g. the level of tuition) and benefits (expected returns to tertiary education) of tertiary education. In the German case it is difficult to come up with indicators of either measure. First, for the time of our data there were no university fees. Therefore the only relevant cost would be the opportunity cost of studying which hardly differs across high school graduates. Even more uncertainty governs the benefits of education. Most of the heterogeneity in expected benefits derives from the field of study which we do not observe and which is endogenous. Therefore

we model the transition to tertiary education without explicitly controlling for cost and benefit indicators. We specify the transition to tertiary education as follows:

$$P(\text{tert. education}) = f(\alpha + \beta_1 \text{ parental education} + \beta_2 \text{ child ability} + \gamma \text{ parental income} + \delta_1 \text{ sex} + \delta_2 \text{ federal state FE} + \delta_3 \text{ calendar year FE}),$$

where α, β, γ, and δ indicate parameter vectors to be estimated. A key disadvantage of our data is that it does not provide a general indicator of individual ability, such as an IQ test score or average grade at school for all observations. We consider the indicator individual age at *Abitur* as a proxy for individual ability and expect that those individuals who finish secondary school faster than their peers are on average of higher ability. Taking a year longer e.g. after repeating a grade or after entering school late, might indicate difficulties in reaching age-specific learning objectives at some point in the individual's past. As the SOEP provides grade information (for mathematics, German, and a foreign language) in its more recent surveys we apply these indicators in robustness tests.[6] Our specification controls for a measure of parental income, youth sex as well as region and calendar year fixed effects. The regional controls are important as German educational policy is determined at the state level.

4. Data Description

We use annual data of the German Socio-Economic Panel (SOEP, 1984-2006). The SOEP is a representative household panel survey which gathers information on a variety of topics, some annually, others only in certain survey years (SOEP Group 2001). The SOEP is the only German dataset which provides information on parental background and allows one to follow high school graduates and their human capital investments over time.

[6] We used the small samples with available grade information to compare individual grades by age at *Abitur*. In two out of the three subjects (German and foreign language) those individuals who completed the *Abitur* early, i.e. at age 17 or 18, indeed had better grades than those who graduated at older age. In addition, the most recent data on a sample of high school graduates eligible to enter tertiary education ("Studienberechtigte 2008") yield a significant positive correlation between a young age at *Abitur* and high scholastic attainment.

As we are interested in the transition of *Gymnasium* graduates to tertiary education, our main sample consists of individuals who are observed to graduate from *Gymnasium*.[7] The most common age at which pupils attain this degree is 19 or 20. We restrict our main sample to those individuals who were not older than 25 when they graduated and – to allow for reliable measures of parental background and income when the youth was age 19 – we consider only those individuals who were SOEP respondents already prior to age 20. In our estimation we also control for selection into the group of *Gymnasium* graduates. With a broader first stage sample, we model the schooling outcome of all individuals aged 17-25 in our data.

The SOEP asks every person annually about the highest degree attained. As we are interested in the timing of secondary school graduation and college entry, we have to account for the timing of SOEP interviews, which can take place in any month during the year (most are administered in the first quarter). Since secondary school graduation typically takes place in June or July, we assume that individuals who newly indicated a high school degree in an interview prior to June graduated in the year before. If, e.g., an individual did not have an advanced school degree in the interview of April 2003 and indicated an advanced school degree in January 2004, we assume that the degree was attained in June or July of 2003. If, however, the 2004 interview took place in July we assume that the degree was attained in 2004. Overall, the data allow a precise and unambiguous timing of the *Abitur* event in 96.5 percent of all cases.

In total and over the course of 23 survey years we observe 1170 individuals graduating from *Gymnasium*.[8] Figure 5 describes the distribution of the observed events over time. It confirms the rising cohort share of female graduates which we also encountered in the

[7] Individuals who did not indicate to attend school in the year before they first claimed a high school degree are not considered in the group of new high school graduates.

[8] Individuals attaining a "*Fachabitur*" degree are not part of our sample because they are not eligible for university education.

aggregate data (cf. Table 1). In our sample 555 male and 615 female *Gymnasium* graduates are at risk of entering tertiary education, where we consider transitions to universities and polytechnicals (*Fachhochschulen*) jointly because the data do not allow us to separate the two institutions. Our dependent variable indicates whether an individual commenced tertiary education in a given year. The distribution of our SOEP secondary school graduates by age is presented in Figure 6, which shows that at least 75 percent of the graduates are either age 19 or 20.[9]

In order to correctly time the entry to tertiary education further adjustments are required. Academic degree programs typically start in the fall term, i.e. in October. Therefore we coded individuals who were interviewed prior to October of year *t* and indicated for the first time to be students to have started their academic education in year *t-1*. Individuals who were interviewed in November of year *t* and indicated for the first time to be students were considered to be students since October of year *t*. We observe a total of 754 entries to tertiary education, 377 men and 377 women. Our aggregate transition rate to tertiary education – by year five after high school graduation – thus reaches 64 percent, i.e. 68 and 61 percent among men and women, respectively. This is below aggregate figures: the Federal Statistical Office (StBA, 2006, p.144) finds that between 83 and 73 percent of those graduating from Advanced School between 1985 and 2000 at some point took up tertiary education.[10] Figure 7 depicts the share of *Gymnasium* graduates by year of graduation, who, over the course of our observation period were observed to start a tertiary education. Despite the small number of observations we find an about constant cohort share between 60 and 70 percent with only the most recent cohorts dropping off, because they had not completed their education.

[9] In the regression we adjust the age at Abitur variable for individuals who graduated in states with shorter *Gymnasium* schooling requirements: in Thuringia and Saxony-Anhalt the Abitur can be attained after 12 instead of 13 years of schooling, which were required everywhere else during the time of our observations.

[10] A panel survey of Advanced School graduates yielded that between 18 and 29 percent of males and 29 and 39 percent of females did not plan to take up tertiary education half a year after leaving Advanced School (Heine et al. 2006). The remaining difference in transition rates with our data is partly due to transitions to tertiary education outside of our observation window (i.e. after year five after the *Abitur*) and partly to panel attrition of young individuals in the German Socioeconomic Panel.

We follow individuals for up to 5 years after their high school diploma to code college entry. As in the aggregate data females are much more likely to immediately take up an academic education than males. Table 5 presents the unweighted distribution of the time until take-up of tertiary education in our sample for those graduates who were observed for the entire first five years after high school graduation. A larger share of males than females is observed to enter university or polytechnical schools. Two years after secondary school graduation more than half of the graduation class has entered tertiary education for both sexes.

Our first research question focuses on the long-run and short-run determinants of transitions to tertiary education. Following Cameron and Heckman (2001), we consider parental income at age 19 as a short-run factor that might influence individuals' decision to take up an academic education. In our baseline model we consider household net equivalence income, coded as the percentile rank in the annual distribution of household equivalence incomes. We use the rank position to generate income measures that are comparable over time. Since the amount of parental income that is disposable for investments in child education varies with household size, we use equivalent income defined as net income over the square root of household members.[11]

Long-run factors are those which influence individuals since the early ages of childhood and individuals' unobserved ability. We consider parental educational background as indicative of such long-run characteristics, as more able parents tend to be better educated and to have more able children on average.[12] Parental educational background is coded in four categories: missing information or other schooling, no degree or only basic school, middle school, and *Gymnasium* with or without tertiary education. The indicator reflects the

[11] Ideally, one might want to control for the number of siblings supported by parents, however this information is not available for all observations in our sample. In a robustness test (discussed below), we determine whether the equivalence correction affects our results.

[12] The psychological literature clearly indicates the inheritability of ability, see e.g. Plomin et al. (2001).

higher of paternal and maternal education. While parental education can be considered as an indirect indicator of (inheritable) child ability, we consider the age at which the child graduated from *Gymnasium* as a direct indicator.

As a first description of the relevance of parental income, Table 6 depicts transition rates to tertiary education conditional on *Abitur* by parental education. The first row shows that the propensity to enter advanced education, conditional on attaining the *Abitur* increases with parental education. A comparison of the entries in columns (2) and (4) implies a disadvantage in college entry rates of about 14 percentage points for children of parents with at most basic school education (60 percent) compared to children of parents with academic degrees (74 percent). The next row indicates the respective probabilities after holding household income constant at the level observed among parents with high education. Income appears to eliminate three percentage points out of the 14 point gap between columns (2) and (4) and three points of the 13 point gap between columns (3) and (4). Thus, adjusting for income explains only a small share of the observed differences in probabilities.

Figures 8a and 8b depict the probability of attaining the *Abitur* degree as well as the probability of starting tertiary education after *Abitur* as a function of parental education by income group. The probability of attaining the *Abitur* varies much more strongly with parental education than with parental income. The evidence for the transition to tertiary education is not as clear. We find high transition rates among those with missing income information. It is surprising to see higher transition rates for children of parents with no or only low educational degrees than for children of parents with middle degrees in three of the four income quartiles. However, the number of observations in the missing (N=27) and low education category is small (N=207). Conditioning on parental education we see a positive income effect in all groups. A comparison across the two figures suggests that parental ability loses significance when focusing on tertiary instead of secondary education.

5. Empirical Approach

While most authors (e.g. Blossfeld 1993 or Belley and Lochner 2007) estimate the correlates of educational outcomes in a cross-sectional regression, Cameron and Heckman (1998, 2001) stress that this may lead to biased results. If both, observable and neglected unobservable characteristics determine educational success at any given stage, and thus affect the eligibility for a transition to the next stage then coefficient estimates obtained based on separate estimations for each stage of the educational career are likely to be biased. Cameron and Heckman (1998, Appendix A) derive the coefficient bias if general log cumulative distribution functions for discrete dependent variables (including e.g. logit and probit models) are estimated omitting unobserved characteristics: while the bias cannot be signed in general it is different from zero.

Additionally, the distribution of unobservables can shift to the right over subsequent steps of the education process. In particular, unobservables may be increasingly negatively correlated with individual background: if typically the children of parents with high socioeconomic status progress successfully through the educational system, then those children of parents with low socioeconomic status, who are able to keep up, must have an (increasingly) positive set of unobservable characteristics.

Therefore the bias in coefficient estimates derives both from the omission of relevant variables and from neglecting the potential correlation of observables with the distribution of unobservables. Cameron and Heckman (1998) show that it is necessary to account for unobservables and for selection mechanisms to determine the unbiased effect of socioeconomic variables on educational attainment.

We offer estimates with and without a correction for this selection process. To control for selection, we apply a full information maximum likelihood bivariate probit estimator. As

a first stage we model whether or not an individual attains the *Abitur* degree.[13] The error term is allowed to be correlated with the error term of the second stage probit regression, which models the transition to tertiary education conditional on attaining the *Abitur*. Three issues are to be discussed for this standard framework: a first complication derives from the panel nature of our data. In our main equation of interest we model the discrete time hazard of a transition to tertiary education, conditional on attaining the *Abitur* within the last 5 years and conditional on not having entered tertiary education before.[14] We use the following setup:

Stage 1:	$Abitur^*_{i,ta}$	$= x_{i,ta}\,\beta + u_{1,i,ta}$	$ta = 17, \ldots, T_a$
	$Abitur_{i,ta}$	$= (Abitur^*_{i,ta} > 0)$	
where	T_a	= min(first year of study, year of Abitur + 5)	if Abitur = 1
	T_a	= min(age 25, censored)	if Abitur = 0
Stage 2:	$Study^*_{i,ts}$	$= z_{i,ts}\,\gamma + u_{2,i,ts}$	$ts = T_{Abi}, \ldots, T_E$
	$Study_{i,ts}$	$= (Study^*_{i,ts} > 0)$	if $Abitur_{i,ts} = 1$
		= unobserved	if $Abitur_{i,ts} = 0$
where	T_{Abi}	= first year of Abitur	
	T_E	= min(T_{Abi} + 5, censored)	if $Study_{i,ts} = 0$ & $Abitur_{i,ts} = 1$
	T_E	= first year of study	if $Study_{i,ts} = 1$ & $Abitur_{i,ts} = 1$

where $Abitur^*_{i,ta}$ and $Study^*_{i,ts}$ are latent, unobserved variables which reflect the propensity to graduate from *Gymnasium* (in year *ta* or earlier) and to enter tertiary education (in *ts*), respectively, x and z represent the vectors of explanatory variables considered in the two probit models. β and γ are vectors of coefficients, and u_1 and u_2 are residuals of the latent variable models. We assume $u_1 \sim N(0,1)$, $u_2 \sim N(0,1)$, u_1 and u_2 are assumed to be jointly normal with $corr(u_1, u_2) = \rho$. The error term correlation could both be positive or negative and will be identified based on only those individuals who attained the *Abitur* degree. A positive correlation suggests that those who succeed against the odds at stage one continue to do so at

[13] In principle one might want to separately model entry to the *Gymnasium* and successful completion in greater detail. Since our data does not provide information on individual secondary school careers we combine these events in our first stage outcome.

[14] This longitudinal modeling strategy goes beyond the classic bivariate probit application as it requires panel data also for the first stage selection equation.

stage two, i.e. they start studying. A negative correlation suggests that those who make it against their odds to the Abitur ceteris paribus have a less than average chance of progressing to tertiary education. We consider the latter to be the more likely scenario.

As a second issue we need to account for observing every individual repeatedly until either entering tertiary education or being censored. We use clustered standard errors at the individual level in order to increase the efficiency of our estimation and to account for any within-person correlation of unobservables.

The third issue concerns identification and the specification of our models. Though the model is identified by functional form we apply several exclusion restrictions to strengthen identification. Based on aggregate school data we coded the share of a given state's pupils attending *Gymnasium* prior to an individual's entry at *Gymnasium*. This time-varying indicator is expected to reflect the state-level education supply conditions when a pupil was assigned to a secondary school track at about age ten. It should affect the individual propensity to attain the *Abitur* degree without affecting the individual probability of taking up tertiary education. The indicator would not present a valid instrument if the supply of Gymnasium education in a given state were correlated with that state's university supply. We examined the correlation both, of levels and of changes in the two indicators of education supply and did not find systematic patterns.

A second indicator describes the rigor with which states select pupils allowed to enter *Gymnasium*. Some states use objective grade restrictions while others permit parental school choice independent of prior child educational attainments. This indicator of parental influence may affect the probability to attain the *Abitur* degree but should not affect entry to tertiary education. In addition, we consider the age of father and mother at birth of the child and indicators of whether these measures are missing in the data. High parental age is known to increase secondary school attainment (e.g. Booth and Kee 2009 or Eschelbach 2009) but – as

confirmed by Mare and Tzeng (1989) – should not affect subsequent transitions to tertiary education.[15]

In sum, the *Abitur* outcome is regressed on indicators of parental education and income, vectors of federal state and calendar year fixed effects, individual age and sex, and - as instruments - the time-varying state-specific share of pupils attending *Gymnasium*, the state specific rigor of *Gymnasium* admission, and the age of both parents. The regression for college entry controls for parental education and income, individual sex, immigrant status, years since graduating from *Gymnasium* and age at attaining the *Abitur*, as well as vectors of state and year of *Abitur* fixed effects. In modeling annual transition probabilities we additionally control for the baseline hazard of transitions to tertiary education using a vector of indicators for "years since *Abitur*". Descriptive statistics of the explanatory variables for the two regression equations are presented in Table 7.

6. Results

In order to evaluate the relative impact of long-term and short-term determinants of college entry we estimate their marginal effects in three different empirical specifications. Cameron and Heckman (1998) find that the effect of family income greatly weakens after controls for long-term factors are added to the model. In Table 8 we present the marginal effects obtained in probit estimations of the outcome "transition to tertiary education" for three specifications. Specification (a) considers controls for parental education, specification (b) additionally controls for household equivalent income, and specification (c) omits the controls for parental education and considers the household equivalent income, only. Panel A presents the marginal effects based on estimations for the sample holding the *Abitur* degree, Panel B shows the marginal effects after correcting for the potential sample selection bias when conditioning on those who hold the *Abitur* degree.

[15] Our estimation results are robust to omitting the instruments measuring parental age.

In Panel A of Table 8 parental education yields the expected effects: the probability of a transition to tertiary education is highest for those with highly educated parents with an advantage of close to ten percentage points over children of parents with only basic school education. The parental education effects are jointly highly statistically significant. Also, the controls for age at *Abitur* are jointly significant. However, they indicate the highest probability of a transition to tertiary education for those who attained the *Abitur* at the (regular) age of 19 or 20 years. This finding does not match our original interpretation of the age at *Abitur* variable as indicator of student ability. If early *Abitur* is correlated with high ability this does not seem to translate to a higher probability of a transition to university.[16] The parental income indicators considered in specifications (b) and (c) are also jointly highly significant: parental income is positively correlated with the probability of a transition to tertiary education. The baseline hazard indicators of years since *Abitur* are highly significant and indicate the highest transition probability in year 1 after the *Abitur* (marginal effects not presented to save space).

It is of particular interest to compare the effects of parental education and parental income. In Panel A both covariate groups show significant marginal effects of comparable size. Compared to either specification (a) or (c), the marginal effects of education and income decline slightly when both indicator groups are considered jointly in specification (b), but they remain statistically significant.

The results differ somewhat in Panel B, where the effect of non-random selection into the *Abitur* is controlled for. The estimates in Panel B were obtained jointly with those of the first stage regression as presented in Panel C. For selected marginal effects of the first stage covariates see Panel D. The instruments in the first stage regression and the error term correlations between u_1 and u_2 are significantly different from zero (see bottom rows of

[16] We expect that our sample is too small to reflect the generally found pattern of scholastic attainment by age at *Abitur*.

Tables 8B and 8C).[17] The negative correlation of stage one and stage two unobservables suggests that individuals with positive residuals in the *Abitur*-equation tend to have negative residuals in the study-equation (and, in theory, vice versa), i.e. those who attain the *Abitur* against the odds of their characteristics have a lower probability to move on to tertiary education than those who were expected to attain the *Abitur* degree. A possible interpretation is that parents may be able to push their children to high school graduation despite their poor odds, but their influence does not extend to the tertiary level.

The main difference when comparing Panels A and B is that the marginal effects of parental education lose statistical and economic significance. In Panel B they are small and imprecisely measured whereas the effects of parental income hardly change compared to those in Panel A. This suggests that the significant correlation between parental education and the propensity to take up academic education conditional on Abitur in Panel A is due to omitted controls for sample selection[18]. However, the central result is that – in contrast to some results obtained for the United States – even after sample selection correction parental income is significant for the transition to tertiary education. Parental income in the top quartile increases the transition probability to tertiary education by almost ten percentage points relative to parental income in the bottom quartile.

Our second research question addresses the relevance of parental background over time. We split the observation period in West Germany in three subperiods and re-estimated the probit and selection models separately for each of the three periods using the same

[17] The hypothesis that the coefficients of the instruments are jointly equal to zero was rejected at the one percent significance level in all cases. In addition to testing the joint significance of our instruments in the *Abitur*-equation we performed an overidentification test as described in Bratti (2007): since the estimator is identified by functional form we omitted the instruments from the first-stage (*Abitur*) equation and added them to the second-stage equation. Here they were neither individually nor jointly statistically significant (p-value of joint test: 0.5929).

[18] For results of the first stage regression see Table 8 Panel C. Interestingly, the marginal effects of parental education are substantially stronger and those of parental income are smaller for the first stage outcomes in Panel D. This confirms the broad sociological evidence on changing parental background effects at increasingly higher educational stages as discussed by Cameron and Heckman (1998).

specification as in Table 8. The number of observations at the second stage equation is now strongly reduced. The results are depicted in Table 9: now, the parental education effects no longer indicate the positive and significant effects on transitions to tertiary education. The marginal effect is highest for those attaining the *Abitur* in the middle period and it reverses in sign in the last period, both in Panel A and in Panel B. The marginal effects of parental income are jointly statistically significant only for the first group of graduates. In later years the marginal effects of parental income decline in magnitude or turn negative. These results suggest a slight reduction in the relevance of both parental income and education over time. The large estimate for the error term correlation rho and the unexpected effects of parental education in the last period might be due to the insignificance of the instruments in the accompanying first stage regression.

As a robustness check we re-estimated specification (b) of Table 8 for the full model adding interactions of a linear time trend with parental background effects. While interaction terms in nonlinear models are to be handled with care (Ai and Norton 2003) the resulting coefficients confirm our conclusions based on the more flexible specifications used in Table 9: all parental education interactions with the time trend are statistically insignificant. They yield small positive interaction terms for parental education. The interactions with parental income are small and positive without selection correction and negative when selection corrections are considered. Thus we find no clear or substantial development and possibly a slight decline in the relevance of parental income over time.

Finally, we investigate the heterogeneity of parental background effects across population groups. Table 10 presents the marginal effects of the two probit estimations separately for males and females in West German states.[19] In both cases we obtain (statistically insignificant) positive effects of parental education for males. As in the full

[19] The number of observations in East Germany (824) appears to be too small to split this sample.

sample (cf. Table 8) the positive effect of parental education for females disappears once selection corrections are considered. The parental income effect yields the expected sign for both groups in both panels. It is more precisely estimated and slightly larger for males. The results confirm that the effects of parental income dominate the education effects.

Table 11 compares the impact of parental background for East and West Germans. As before, we find positive marginal effects of parental education in Panel A, only. These effects are of comparable size for the two subsamples. The effect of parental income for the West German sample is generally positive but not precisely measured. The patterns are less clear in the case of the East German sample where children of parents with missing income information have by far the largest probability to start tertiary education. The income information is missing for about 8 percent of the East German sample, i.e. 24 of 311 East German *Abitur* holders. When we dropped these observations, the magnitude of the other income effects hardly changed and the unexpected negative correlation of high income and the transition to tertiary education remained. This suggests that the positive marginal effect of parental income is limited to the West German part of our sample.[20]

We applied various robustness tests to evaluate the reliability of our results. While our main estimation approach uses the panel character of our data to describe the transition to tertiary education, this outcome can also be reflected in a cross-sectional setting: here a first stage regression models whether an individual attains the *Abitur* between ages 17 and 25, and a second stage models whether a transition to tertiary education is observed within the first five years after *Abitur*. While controls for the baseline hazard and for calendar year fixed effects are not possible in the cross-sectional framework, we obtained the same pattern of

[20] In the overall income distribution East German households are positioned at lower percentile ranks than their West German counterparts (average rank East: 58th, average rank West: 69th percentile among those attaining the *Abitur* degree). However, since separate models are estimated this difference should not affect our results.

highly significant effects of parental income for the transition to tertiary education, both in models with and without selection controls (see Table A1 in the Appendix).[21]

As another robustness test of the panel estimation results, we applied an alternative income measure and used the rank in the household net income distribution without equivalence scale adjustments. Our results remained unchanged. Next, we considered the possibility that income was closely affected by parental education. To test whether and how this influences our results we replaced our income measure by an indicator that was orthogonal to parental education: in a first step we regressed income on maternal and paternal education indicators. Then we calculated the residuals from this auxiliary regression and used it as an income indicator. This correction should focus the income measure on its transitory component. However, it did not affect our results (see Table A2).[22] Alternatively, we evaluated a more permanent income component: we replaced the time-varying income indicator by the average of all annually available net equivalence income indicators for a given youth as observed between ages 17 and 20. This yielded on average 3.1 repeated observations per person. However, the income effect in the estimation did not differ in its nature from that presented above (not presented to save space).

As a fourth robustness test, we applied a linear probability model for the second stage of our sample selection model. The nature of the results for long and short-term effects, over time and across subsamples was robust to this alternative estimation approach.

In a fifth approach, we tested whether our treatment of missing values for the parental education and parental income variables affected the estimation outcomes. Regressions on samples where all incomplete observations had been omitted corroborated our key results,

[21] In contrast to the results based on panel data, parental educational background indicators remain statistically significant in Panel B of Table A1 and the error term correlation is at times positive and insignificant. We expect that our instrumental variables, which mainly identify the selection into *Abitur* based on state-specific developments over time, provide insufficient variation in the first stage of the selection model which as before controls for federal state fixed effects.

[22] After taking these ability related determinants of income out of the income indicator the estimated marginal effect may be interpreted as the 'nurture' effect of income, as opposed to genetic or 'nature' effects.

even though the statistical significance of the income effect was not upheld when about one third of the observations was omitted.

Finally, we replaced our indicator of student ability by a more potent measure. In the survey years after 2000 the German Socioeconomic Panel asked every pupil about grades in mathematics, German and a foreign language. We expect that grades are closely correlated to scholastic abilities. We reestimated the three specifications in Table 8 for the subsample interviewed after 2000 now adding controls for grades. The results for this subsample with and without grade controls are presented in Table A3 in the Appendix. We assume that it is the much reduced sample size which causes the overall loss in statistical significance of the estimation results. When comparing the marginal effects in the specifications with and without controls for grades we find hardly any difference at all. While the vector of grade indicators is jointly statistically significant, controlling for grades thus does not change the marginal effects of parental education or income. This suggests that our results presented on the full sample above are not biased due to insufficient controls for abilities.

7. Conclusions

This study extends the economic analysis of intergenerational education mobility in Germany, which is typically analyzed exclusively with respect to attainment in the track-based secondary education system. In contrast, we apply rich panel data to carefully describe graduation from secondary school and subsequent college entry over a period of more than 20 years. In this period the German educational system continued to expand and it is important to ask who benefited from this expansion. The literature on educational mobility with respect to German secondary school attainment suggests that intergenerational educational mobility did not increase in the wake of education expansion.

However, Cameron and Heckman (1998, 2001) point out that the mechanisms determining educational attainment are not constant across subsequent educational outcomes.

Therefore different results are possible for educational mobility at the secondary and at the tertiary education level. These authors find for the U.S. birth cohorts through 1965 that the impact of parental income declines at advanced educational levels and that only the impact of parental ability remains important. However, Belley and Lochner (2007) extend the analysis to consider the birth cohorts through 1985 and conclude that the impact of parental income on college attendance increased "dramatically."

In contrast to the U.S. educational system Germany requires potential college freshmen to pass through a tracked secondary school system before being able to take a decision on tertiary educational enrollment. In this institutional framework we find that parental income is clearly positively correlated with the probability of a transition to tertiary education. This result is robust to controls for the non-random selection into the group attaining the *Abitur* degree in secondary school and to controlling for child ability and parent educational background. In contrast, parental education significantly affects child educational outcomes only as long as selection into the group attaining the *Abitur* degree is not accounted for. With selectivity control these long run factors lose their statistical significance. Our analysis of developments over time is limited by small sample sizes, but indicates that the relevance of parental income declined over the considered period.

The differences in the parental background effects across population groups are estimated here in very flexible settings which allow all determinants of the transition to tertiary education to vary across population groups. In this framework we do not find clear and unambiguous patterns except that parental income plays a somewhat larger role for West German males than for females and that parental income may matter less for transitions to tertiary education among East than West Germans.

Overall, we cannot reject the hypothesis that parental income affects young individuals' decision to move on to tertiary education. In consequence, public programs balancing differences in parental financial background may affect college entry decisions.

Therefore the recent introduction of tuition fees in several German states should affect the composition of the student population, posing an intriguing question for future research.

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Table 1 Share of School Leavers Meeting Entry Requirements of Tertiary Education (in percent of the entire birth cohort at age 18-21)

Year of School Exit	Access to Any Tertiary Education		Access to University			
	Male	Female	Male	Male-West	Female	Female-West
	(1)	(2)	(3)	(4)	(5)	(6)
1980	23.6	20.8	17.3	17.3	16.5	16.5
1985	28.4	27.3	21.2	21.2	21.9	21.9
1990	33.0	29.8	22.6	22.6	23.2	23.2
1995	34.7	38.1	25.2	24.8	30.5	27.6
2000	33.8	40.9	24.2	24.7	31.2	29.9
2005	39.4	45.6	24.9	25.2	32.8	32.3

Notes: (a) Starting 1995 the overall figures represent united Germany. (b) Natives and foreigners are jointly depicted. (c) Columns 1 and 2 provide the cohort share of those meeting requirements for any tertiary education, including e.g. only to polytechnical universities. Columns 3-6 provide the cohort share of those leaving school with *Abitur*, and who have access to university study.

Source: Federal Statistical Office, 2007, FS 11 Reihe 4.3.1 (1980–2005), pp.108-116.

Table 2 Cohort Share of Entrants to Institutions of Tertiary Education

Year of Entry	All	Male	Female
1980	20.4	23.9	16.7
1985	19.9	23.3	16.2
1990	27.3	31.8	22.6
1995	26.8	26.6	27.0
2000	33.5	33.4	33.6
2005	37.0	37.1	36.9

Notes: (a) The overall figures represent united Germany starting 1995. (b) The entries are calculated as share of each birth cohort in the year of entry to tertiary education. (c) Natives and foreigners are jointly represented. (d) The figures combine the university entry in the summer and the subsequent winter term. (e) The figures combine entrance to university with that to other institutions of tertiary education, e.g. polytechnical universities.

Source: Federal Statistical Office, 2007, FS 11 Reihe 4.3.1 (1980 – 2005), p.124.

Table 3 Cohort Share of Graduates with Tertiary Education Degrees

Year of Degree	All	Male	Female
1985	14.2	17.4	10.8
1992	12.6	-	-
1995	14.7	-	-
1998	16.4	17.7	15.0
2000	16.9	17.5	16.2
2005	21.1	20.5	21.6

Notes: (a) The overall figures represent united Germany starting 1995. (b) The entries are calculated as share of each birth cohort in the year of exiting tertiary education. (c) Natives and foreigners are jointly represented. (d) The figures combine degrees from all institutions of tertiary education.

Source: for 2000 and 2005: Federal Statistical Office, 2007, FS 11 Reihe 4.3.1 (1980 – 2005), p.130, for 1998: Statistical Office, 2004, FS 11 Reihe 4.3.1 (1980 – 2002), p.36, for 1992 and 1995: KMK 2005, p. 36*, for 1985: Köhler 1990, p.121

Table 4 Indicators of Tertiary education system

Year	Number of Students (winter term, Univ. only)	Students / Professors (Univ. only)	Expenditures on Tert. Educ. (in Mio. Euro)	Non-Investment Expenditures / Student (in Euro)	Exp. as share of GDP	Exp. per inhabitant (in Euro)
	(1)	(2)	(3)	(4)	(5)	(6)
1975	691,289	39.5	-	-	1.1	91
1980	836,502	41.2	-	-	1.0	116
1985	1,035,669	48.2	-	-	0.9	140
1990	1,208,018	56.2	-	-	0.9	167
1995	1,409,345	56.5	24,996	7520	0.9	199
2000	1,341,149	55.9	27,509	8140	0.9	210
2005	1,418,377	60.4	30,974	8220	-	-

Source: 1: Wissenschaftsrat, 2008, p. 106; 2: Wissenschaftsrat, 2008, p. 107;
3: Federal Statistical Office, 2007, FS 11 Reihe 4.5, p. 17.
4: Federal Statistical Office, 2007, FS 11 Reihe 4.3.2 2005, p. 37.
5,6: Federal Statistical Office, 2006, Bildung im Zahlenspiegel 2006, p. 121,169.

Table 5 Delay in Transition to Tertiary Education for those Meeting Entry Requirements (*Abitur* 1984-2001)

	Number of Observations 1984-2001	Number and Share of High School Graduates starting Tertiary Education						
		same year	after 1 year	after 2 years	after 3 years	after 4 years	after 5 years	censored
Female	521	216	55	33	18	4	1	194
	100%	41.5%	10.6%	6.3%	3.5%	0.8%	0.2%	37.2%
Male	480	86	166	48	20	14	5	141
	100%	17.9%	34.6%	10.0%	4.2%	2.9%	1.0%	29.4%

Source: German Socioeconomic Panel (1984-2006), own calculations.

Table 6 Probability of Transition to Tertiary Education by Parental Education conditional on *Abitur* 1984-2001

Parental Education:	**Missing / Other (1)**	**None / Basic School (2)**	**Middle School (3)**	***Gymnasium* or Tertiary Degree (4)**
Observed average propensity to enter university:	54 %	60 %	61 %	74 %
Predicted propensity to enter university given the income of parents in highest education group:	59 %	63 %	64 %	74 %
Difference:	4.2 %	2.8 %	2.5 %	-0.2 %

Note: Predicted propensities are based on probit regressions performed separately by parental education group and controlling only for a constant and the percentile of household net equivalent income in the relevant annual income distribution.

Source: German Socioeconomic Panel (1984-2006), own calculations.

Table 7 Descriptive Statistics – Full Panel Sample

	Sample Abitur		Sample Study	
	Mean	**Std. Dev.**	**Mean**	**Std. Dev.**
Dependent Variable				
Abitur (0/1)	0.080	0.271	--	--
Study (0/1)	--	--	0.257	0.437
Independent Variables				
Highest Parental Educ. Missing (0/1)	0.102	0.302	0.055	0.228
Highest Parental Educ. Low (0/1)	0.459	0.498	0.205	0.404
Highest Parental Educ. Medium (0/1)	0.282	0.450	0.363	0.481
Highest Parental Educ. High (0/1)	0.157	0.364	0.377	0.485
Age 17/18 (0/1)	0.320	0.466	--	--
Age 19/20 (0/1)	0.293	0.455	--	--
Age 21-25 (0/1)	0.387	0.487	--	--
Age at Abitur 17/18 (0/1)	--	--	0.066	0.248
Age at Abitur 19/20 (0/1)	--	--	0.807	0.395
Age at Abitur 21-25 (0/1)	--	--	0.127	0.333
Rank of household equivalent income at age 19:				
First quartile (0/1)	0.235	0.424	0.153	0.360
Second quartile (0/1)	0.217	0.413	0.196	0.397
Third quartile (0/1)	0.218	0.413	0.260	0.438
Fourth quartile (0/1)	0.223	0.416	0.330	0.470
Income information missing (0/1)	0.107	0.309	0.062	0.241
Male (0/1)	0.511	0.500	0.491	0.500
Immigrant (0/1)	0.187	0.390	0.061	0.239
Immigrant Information Missing (0/1)	0.030	0.169	0.015	0.123
Year of Abitur (0/1)	--	--	0.399	0.490
Year 1 after Abitur (0/1)	--	--	0.249	0.433
Year 2 after Abitur (0/1)	--	--	0.142	0.349
Year 3 after Abitur (0/1)	--	--	0.094	0.292
Year 4 after Abitur (0/1)	--	--	0.067	0.250
Year 5 after Abitur (0/1)	--	--	0.049	0.216
State of Residence at time of Abitur:				
City state (0/1)	0.053	0.225	0.073	0.261
Schleswig-Holstein/Lower Saxony (0/1)	0.114	0.318	0.123	0.328
Rhineland-Palatinate/Hesse (0/1)	0.126	0.332	0.097	0.296
Baden-Württemberg (0/1)	0.158	0.365	0.133	0.339
Bavaria (0/1)	0.137	0.344	0.080	0.271
Mecklenburg-Western Pomerania/Brandenburg (0/1)	0.061	0.240	0.076	0.266
Saxony-Anhalt/Thuringia (0/1)	0.076	0.266	0.112	0.315
Saxony (0/1)	0.057	0.232	0.074	0.262
State share of pupils attending Gymnasium when starting Gymnasium	0.226	0.028	--	--
State with strict Gymnasium admission rules (0/1)	0.437	0.496	--	--
Age of father when child was born	29.372	5.951	--	--
Age father missing (0/1)	0.042	0.201	--	--
Age of mother when child was born	26.276	5.514	--	--
Age mother missing (0/1)	0.022	0.148	--	--
Number of observations	36,739		2,936	

Note: Calendar year fixed effects as well as year of *Abitur* indicators not presented to save space. Northrhine-Westfalia is the reference group for the states of residence. All person-year observations in the "sample study" refer to individuals who obtained the *Abitur* degree.

Source: German Socioeconomic Panel (1984-2006), own calculations.

Table 8 Estimation Results: Probit Marginal Effects of Transition to Tertiary Education with and without Sample Selection Correction and First Stage Probit Selection Equation in 3 Specifications

	Spec. (a)			Spec. (b)			Spec. (c)		
	M.E.		Joint	M.E.		Joint	M.E.		Joint
1	2	3	4	5	6	7	8	9	10
Panel A - Tertiary Education - Without Selection Correction									
Parental educ. missing	-0.018		**	-0.020		**	–		
Parental educ. low (ref.)	–			–			–		
Parental educ. middle	0.024			0.013			–		
Parental educ. high	0.096	**		0.072	**		–		
Age at Abitur 17-18	-0.075	**	*	-0.081	**	*	-0.071	*	*
Age at Abitur 19-20 (ref.)	–			–			–		
Age at Abitur 21-25	-0.015			-0.005			-0.007		
Parental inc. missing	–			0.153	**	**	0.171	**	**
Parental inc. first quartile (ref.)	–			–			–		
Parental inc. second quartile	–			0.019			0.020		
Parental inc. third quartile	–			0.047			0.057	o	
Parental inc. fourth quartile	–			0.091	**		0.114	**	
Male	yes			yes			yes		
Immigrant status (2)	yes		**	yes		**	yes		*
Years since Abitur (5)	yes		**	yes		**	yes		**
Federal state (8)	yes		*	yes			yes		o
Calendar year of Abitur (21)	yes		o	yes			yes		
Log Likelihood	-1554.07			-1545.06			-1551.73		
Panel B - Tertiary Education - With Selection Correction									
Parental educ. missing	-0.045			-0.042			–		
Parental educ. low (ref.)	–			–			–		
Parental educ. middle	-0.014			-0.021			–		
Parental educ. high	0.037			0.019			–		
Age at Abitur 17-18	-0.065			-0.075	*		-0.062		
Age at Abitur 19-20 (ref.)	–			–			–		
Age at Abitur 21-25	-0.019			-0.007			-0.009		
Parental inc. missing	–			0.136	**	**	0.165	**	**
Parental inc. first quartile (ref.)	–			–			–		
Parental inc. second quartile	–			0.013			0.006		
Parental inc. third quartile	–			0.038			0.031		
Parental inc. fourth quartile	–			0.033	*		0.091	*	
Male	yes	o		yes			yes		
Immigrant Status (2)	yes		**	yes		**	yes		**
Years since Abitur (5)	yes		**	yes		**	yes		**
Federal state (8)	yes		*	yes		o	yes		*
Calendar year of Abitur (21)	yes		*	yes			yes		
First Stage: Instruments (6)	yes		**	yes		**	yes		**
Chi squared	56.62			56.64			58.70		
p-value	0.000			0.000			0.000		
Error term correlation rho	-0.236	o		-0.214	o		-0.276	**	
Log Likelihood	-9843.96			-9835.46			-9836.88		

	Spec. (a)			Spec. (b)			Spec. (c)		
	Coeff.		Joint	Coeff.		Joint	Coeff.		Joint
1	2	3	4	5	6	7	8	9	10
Panel C - First Stage Selection Equation for Panel B									
Parental educ. missing	0.292	**	**	0.292	**	**	0.288	**	**
Parental educ. low (reference)	–			–			–		
Parental educ. middle	0.571	**		0.572	**		0.569	**	
Parental educ. high	1.037	**		1.039	**		1.039	**	
Age 17-18	-1.423	**	**	-1.423	**	**	-1.423	**	**
Age 19-20 (reference)	–			–			–		
Age 21-25	-0.031			-0.032			-0.031		
Parental inc. missing	0.312	**	**	0.030	**	**	0.299	**	**
Parental inc. first quartile (ref.)	–			–			–		
Parental inc. second quartile	0.189	**		0.017	**		0.186	**	
Parental inc. third quartile	0.283	**		0.027	**		0.282	**	
Parental inc. fourth quartile	0.252	**		0.023	**		0.245	**	
Male	yes	o		yes	**		yes	o	
Immigrant status (2)	yes	**		yes	**		yes	**	
Federal state (7)	yes	**		yes	**		yes	**	
Calendar year of Abitur (21)	yes	**		yes	**		yes	**	
Father age at birth	0.013	**	**	0.013	**	**	0.013	**	**
Father age at birth missing	-0.429	**		-0.430	**		-0.426	**	
Mother age at birth	0.009	*		0.009	**		0.009	*	
Mother age at birth missing	0.119			0.120			0.118		
State year share at Gymnasium	2.991	**		2.997	**		2.974	**	
State restrictive Gym. access	0.081			0.081			0.080		
Constant	-3.151	**		-3.150	**		-3.141	**	

Panel D - First Stage Selection Equation for Panel B - Selected Marginal Effects

	M.E.			M.E.			M.E.		
Parental educ. missing	0.041	**		0.041	*		0.04	**	
Parental educ. low (reference)	-			-			-		
Parental educ. middle	0.079	**		0.079	**		0.079	**	
Parental educ. high	0.184	**		0.184	**		0.184	**	
Parental inc. missing	0.044	**		0.042	**		0.042	**	
Parental inc. first quartile (ref.)	-			-			-		
Parental inc. second quartile	0.024	*		0.024	**		0.024	*	
Parental inc. third quartile	0.038	**		0.038	**		0.038	**	
Parental inc. fourth quartile	0.033	**		0.032	**		0.032	**	

Note: The results in Panel A are based on 2,936 observations, those in Panel B on 36,739 observations, of which only 2,936 are used in the second stage regression. **, * and o indicate statistical significance at the 1, 5 and 10 percent level. The figures in parentheses in column 1 indicate the number of coefficients estimated for the respective covariate vectors. Columns 2, 5 and 8 contain the marginal effects, columns 3, 6 and 9 indicate their individual statistical significance of the marginal effects and columns 4, 7 and 10 describe the joint statistical significance of the considered groups of covariates. The standard errors for the marginal effects presented in Panel D are bootstrapped using 100 replications.

Source: German Socioeconomic Panel (1984-2006), own calculations.

Table 9 Estimation Results: Probit Marginal Effects of "Transition to Tertiary Education" with and without Sample Selection Correction Separately for three Periods in West Germany

	1984-1990			1991-1999			2000-2005		
	M.E.		Joint	M.E.		Joint	M.E.		Joint
1	2	3	4	5	6	7	8	9	10
Panel A - Without Selection Correction									
Parental educ. missing	-0.052			-0.029	*		-0.028		
Parental educ. low (ref.)	–			–			–		
Parental educ. middle	-0.031			0.058			-0.103		
Parental educ. high	0.042			0.134	**		-0.023		
Parental inc. missing	0.235	**	**	0.050			0.167		
Parental inc. first quartile (ref.)	–			–			–		
Parental inc. second quartile	0.037			0.024			0.243		
Parental inc. third quartile	0.085			0.034			0.144		
Parental inc. fourth quartile	0.282	**		-0.008			0.220	*	
Log Likelihood	-349.30			-396.27			-369.30		
Panel B - With Selection Correction									
Parental educ. missing	-0.050			-0.019			-0.085		*
Parental educ. low (ref.)	–			–			–		
Parental educ. middle	-0.039			0.071			-0.179	**	
Parental educ. high	0.022			0.162	**		-0.201	**	
Parental inc. missing	0.227	*	**	0.057			0.056		
Parental inc. first quartile (ref.)	–			–			–		
Parental inc. second quartile	0.034			0.023			0.109		
Parental inc. third quartile	0.082			0.034			0.021		
Parental inc. fourth quartile	0.281	**		-0.002			0.089		
First Stage: Instruments (6)	yes		**	yes		**	yes		
Chi squared	23.67			28.45			5.16		
p-value	0.0006			0.0001			0.5238		
Error term correlation rho	-0.072			-0.099			-0.818	*	
Log Likelihood	-2198.16			-2509.73			-2128.78		

Note: See notes below Table 8. The empirical specifications are as in Table 8. Panel A is estimated on 707, 781, and 618 West German observations for the respective time periods. The estimations in Panel B use 9125, 10861, and 9137 observations for the three periods, respectively.

Source: German Socioeconomic Panel (1984-2006), own calculations.

Table 10 Estimation Results: Probit Marginal Effects of "Transition to Tertiary Education" with and without Sample Selection Correction Separately for Men and Women in West Germany (1984-2005)

	Women			Men		
	M.E.		Joint	M.E.		Joint
1	2	3	4	5	6	7
Panel A - Without Selection Correction						
Parental educ. missing	-0.099	o	*	0.139		
Parental educ. low (ref.)	–			–		
Parental educ. middle	0.030			-0.021		
Parental educ. high	0.084	*		0.050		
Parental inc. missing	0.167	*	o	0.225	**	*
Parental inc. first quartile (ref.)	–			–		
Parental inc. second quartile	0.087			0.083		
Parental inc. third quartile	0.091			0.151	*	
Parental inc. fourth quartile	0.142	**		0.175	**	
Log Likelihood	-507.80			-563.81		
Panel B - With Selection Correction						
Parental educ. missing	0.217	**	*	0.155		
Parental educ. low (ref.)	–			–		
Parental educ. middle	-0.091			0.005		
Parental educ. high	-0.120			0.068		
Parental inc. missing	0.091			0.182	**	o
Parental inc. first quartile (ref.)	–			–		
Parental inc. second quartile	0.076			0.050		
Parental inc. third quartile	0.063			0.090		
Parental inc. fourth quartile	0.109			0.126	o	
First Stage: Instruments (6)	yes		**	yes		**
Chi squared	20.30			20.64		
p-value	0.0011			0.0009		
Error term correlation rho	-0.677	*		0.030		
Log Likelihood	-3403.23			-3634.41		

Note: See notes below Table 8. The empirical specifications are as in Table 8. Panel A is estimated on 1,084 and 1,028 male and female West German observations. The estimations in Panel B use 14,875 and 14,248 observations for males and females, respectively.

Source: German Socioeconomic Panel (1984-2006), own calculations.

Table 11 Estimation Results: Probit Marginal Effects of "Transition to Tertiary Education" with and without Sample Selection Correction Separately for East and West Germany (1991-2005)

	West 1991-2005			East 1991-2005		
	M.E.		Joint	M.E.		Joint
1	2	3	4	5	6	7
Panel A - Without Selection Correction						
Parental educ. missing	0.003		*	0.019		
Parental educ. low (ref.)	–			–		
Parental educ. middle	0.019			0.028		
Parental educ. high	0.090			0.113		
Parental inc. missing	0.080			0.271	*	*
Parental inc. first quartile (ref.)	–			–		
Parental inc. second quartile	0.075			-0.055		
Parental inc. third quartile	0.060			-0.027		
Parental inc. fourth quartile	0.067			0.022		
Log Likelihood	-774.88			-389.09		
Panel B - With Selection Correction						
Parental educ. missing	-0.076			-0.071		
Parental educ. low (ref.)	–			–		
Parental educ. middle	-0.158	*		-0.069		
Parental educ. high	-0.161	o		-0.072		
Parental inc. missing	0.104			0.301	**	**
Parental inc. first quartile (ref.)	–			–		
Parental inc. second quartile	0.204			-0.129		
Parental inc. third quartile	0.083			-0.140	o	
Parental inc. fourth quartile	0.170			-0.064		
First Stage: Instruments (6)	yes		**	yes		*
Chi squared	78.02			9.16		
p-value	0.0000			0.1029		
Error term correlation rho	-0.469	o		-0.670	**	
Log Likelihood	-2285.43			-2587.36		

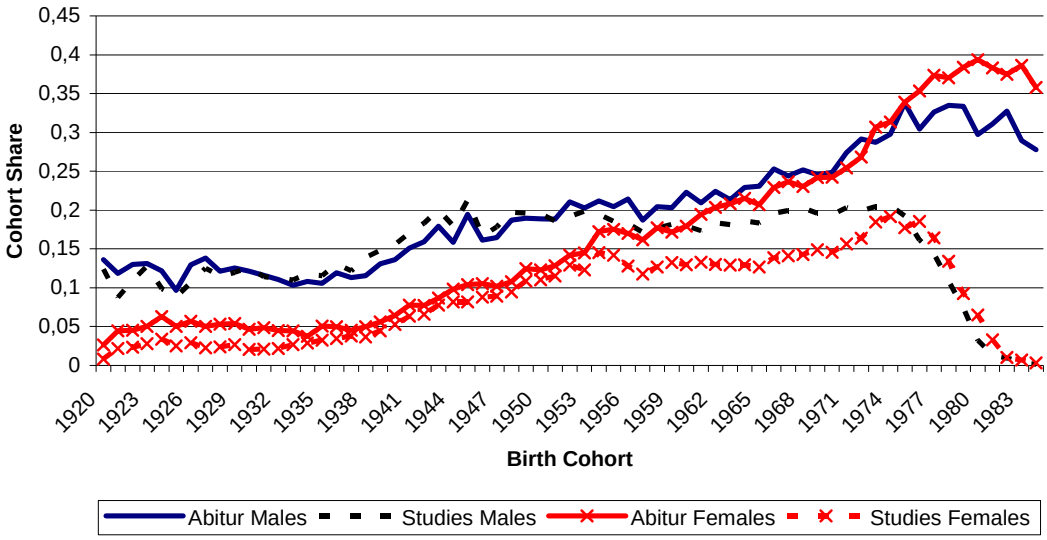
Note: See notes below Table 8. The empirical specifications are as in Table 8. Panel A is estimated on 1405 and 824 West and East German observations for the period between 1991 and 2005. The estimations in Panel B use 27,935 and 7616 observations for West and East Germany, respectively.

Source: German Socioeconomic Panel (1984-2006), own calculations.

Figure 1 Sketch of the German Secondary School System

<table>
<tr><th>Age</th><th>Grade</th><th colspan="3"></th></tr>
<tr><td>6</td><td>1</td><td colspan="3" rowspan="4">Primary School</td></tr>
<tr><td>7</td><td>2</td></tr>
<tr><td>8</td><td>3</td></tr>
<tr><td>9</td><td>4</td></tr>
<tr><td>10</td><td>5</td><td rowspan="5">Basic School</td><td rowspan="5">Middle School</td><td rowspan="8">Advanced School (Gymnasium)</td></tr>
<tr><td>11</td><td>6</td></tr>
<tr><td>12</td><td>7</td></tr>
<tr><td>13</td><td>8</td></tr>
<tr><td>14</td><td>9</td></tr>
<tr><td>15</td><td>10</td><td rowspan="4" colspan="2"></td></tr>
<tr><td>16</td><td>11</td></tr>
<tr><td>17</td><td>12</td></tr>
<tr><td>18</td><td>13</td></tr>
</table>

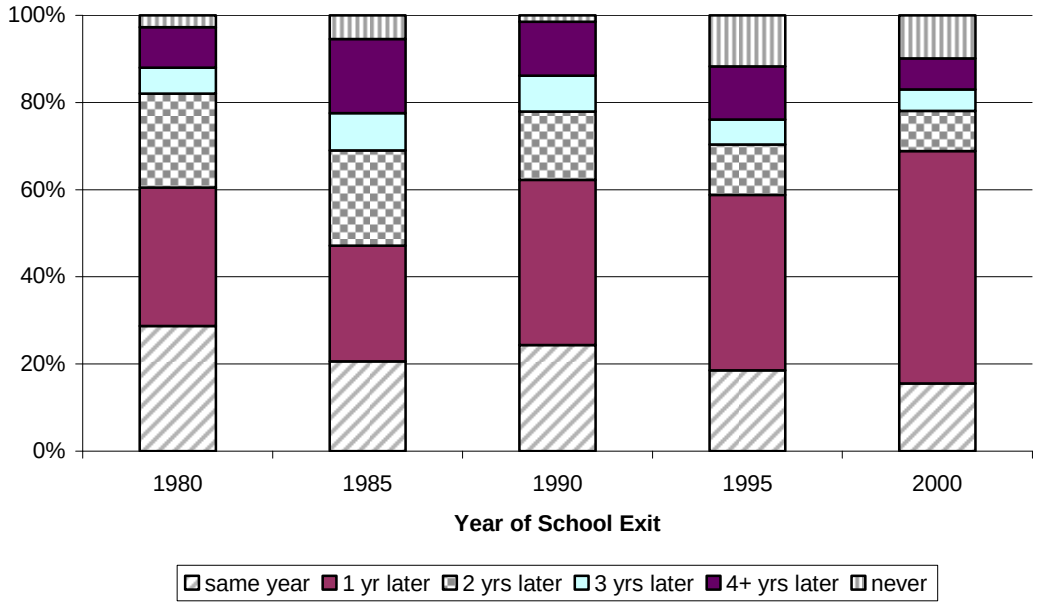
Figure 2 Population Share with Academic Entry Qualification (*Abitur*) and Completed Academic Degree (Univ. or Polytechnical Univ.) by Sex and Birth Cohort Group



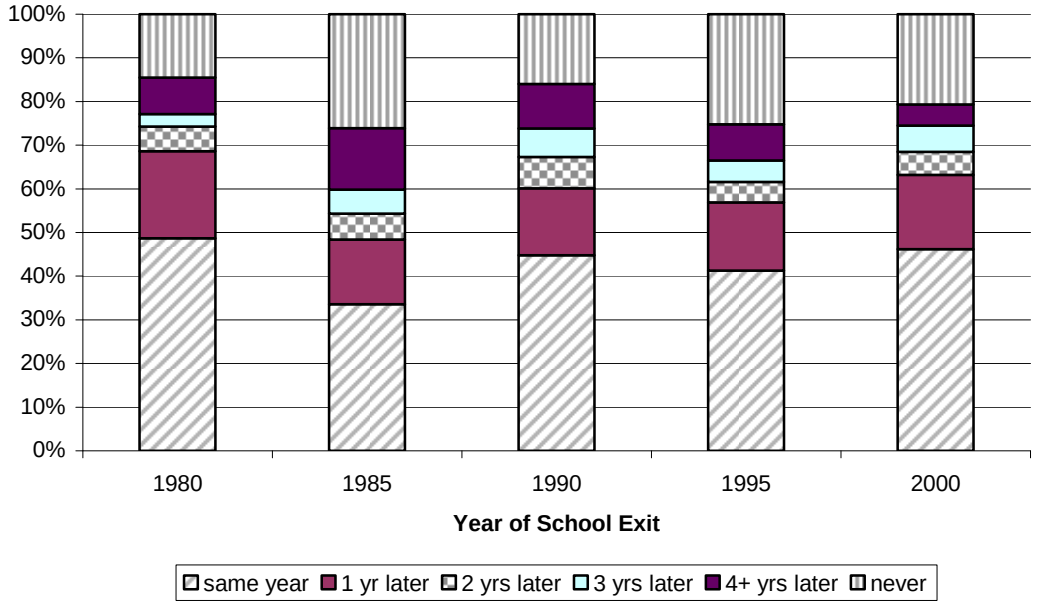
Note: Only considering individuals who indicate to be born in Germany.
Source: Mikrozensus of 2005, weighted data.

Figure 3 Entry into Tertiary Education by Year of Attaining University Entrance Requirement

(a) Males



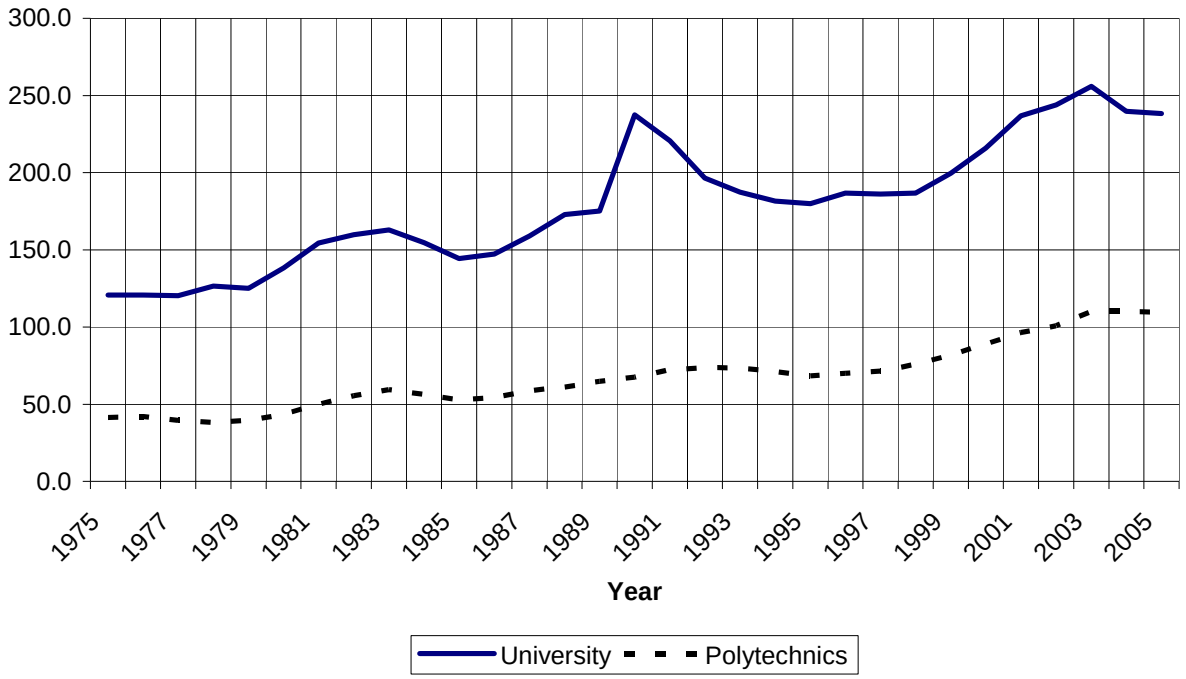
(b) Females



Note: (a) Only individuals meeting general university entry requirements and their entry to universities are considered (i.e. entry to polytechnicals is not described). (b) The data for 1995 and 2000 cover united Germany. (c) The data represent natives and foreigners.

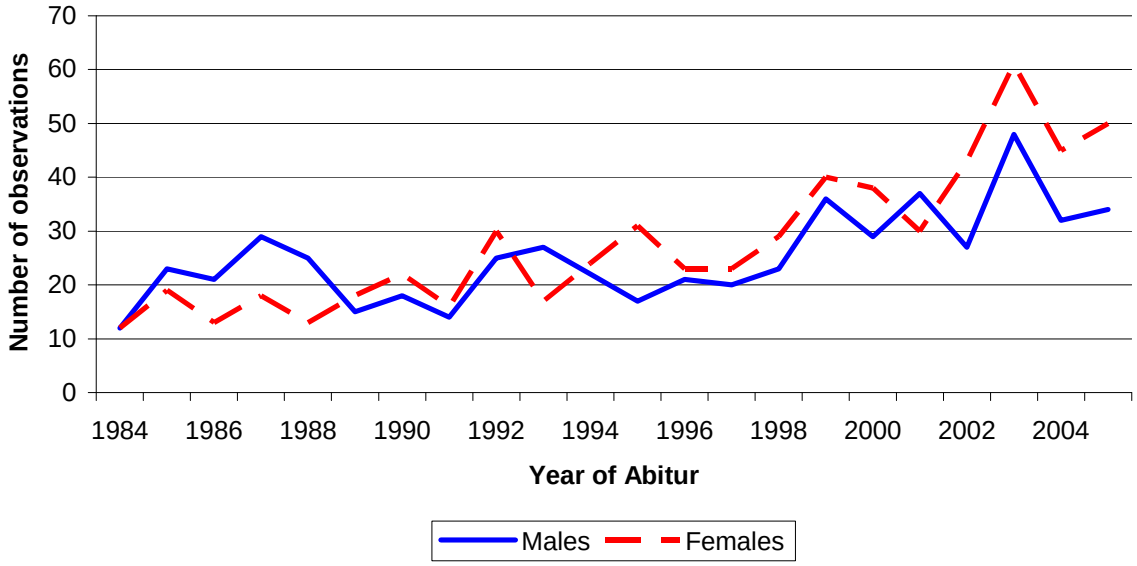
Source: Federal Statistical Office, 2007, Fachserie 11 – Reihe 4.3.1 (1980 – 2005), pp.170-171.

Figure 4 Annual Number of Entrants to Tertiary Education



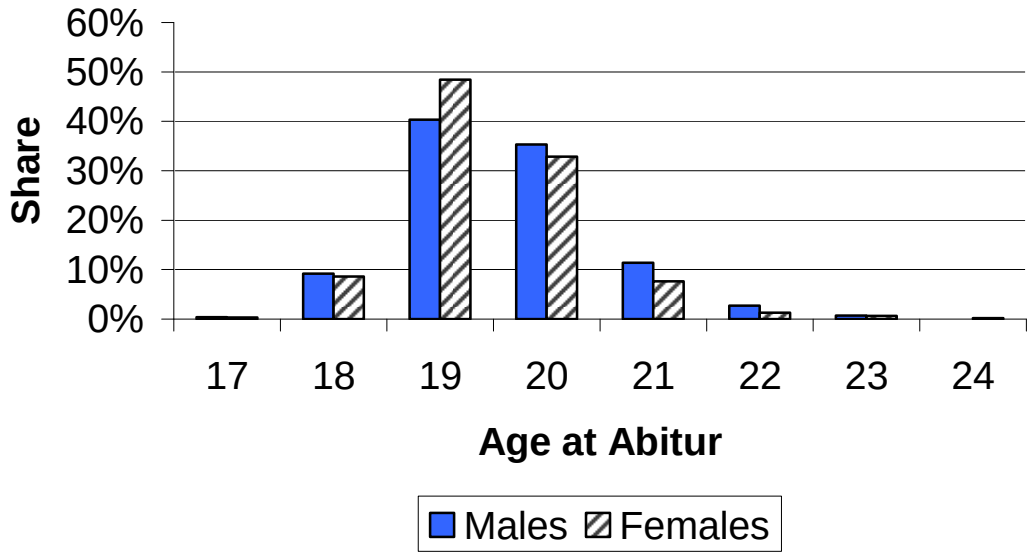
Source: Wissenschaftsrat, 2008, p.106

Figure 5 Observed High School Degrees by Graduation Year and Sex



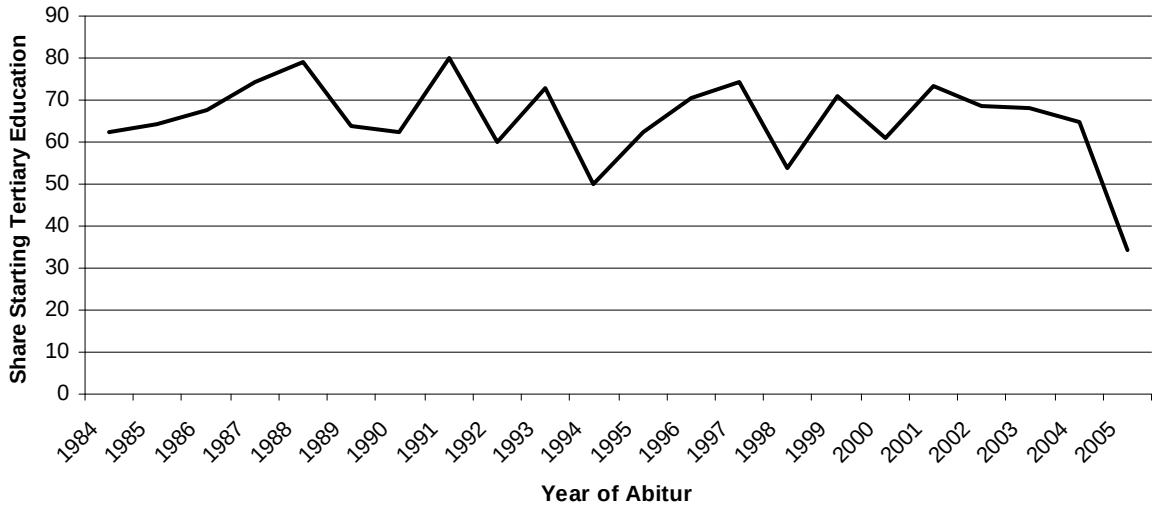
Note: The data is unweighted and does not account for shifts in the raw SOEP sample size over time.
Source: German Socioeconomic Panel (1984-2006), own calculations.

Figure 6 Age at *Abitur* by Sex



Source: German Socioeconomic Panel (1984-2006), own calculations.

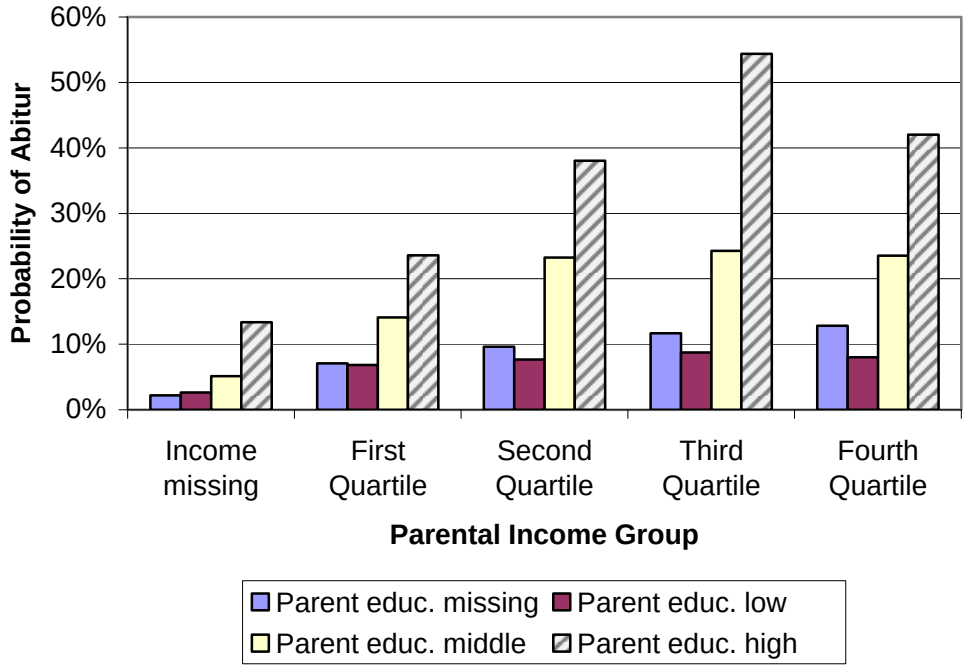
Figure 7 Share of *Gymnasium* Graduates Commencing Tertiary Education by Year of *Abitur*



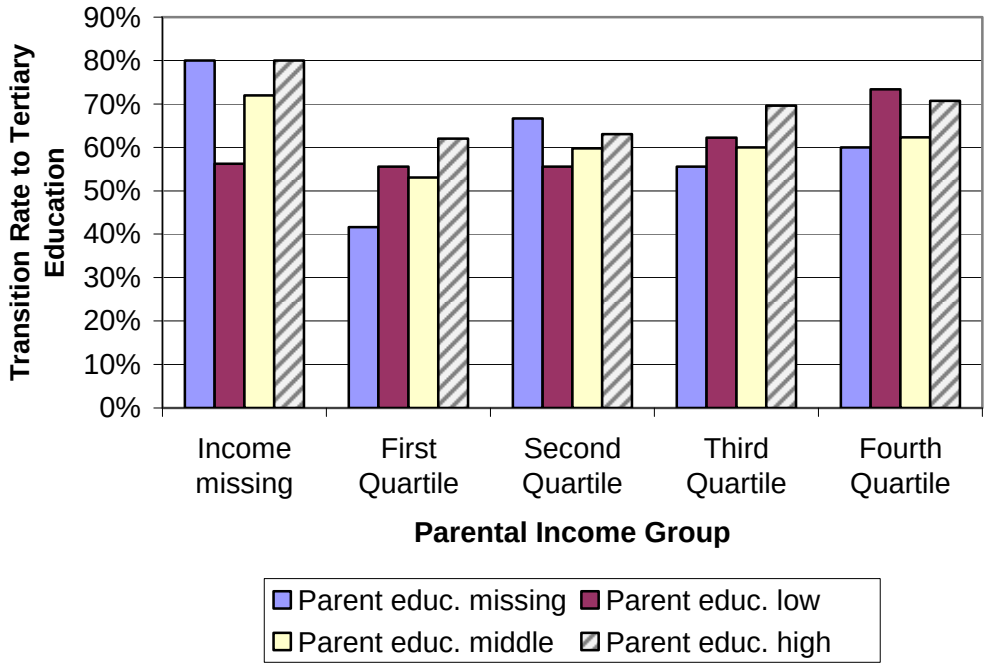
Source: German Socioeconomic Panel (1984-2006), own calculations.

Figure 8 Probability of Educational Outcomes by Parental Income and Education

(a) Probability of a Attaining the *Abitur* Degree



(b) Probability of Transition to Tertiary Education, Conditional on Attaining the *Abitur* Degree



Note: The income percentiles reflect the rank of household equivalent income when the youth was age 19. The data consider all *Abitur* events and transitions to tertiary education observed between 1984 and 2006.
Source: German Socioeconomic Panel (1984-2006), own calculations.

Appendix

Table A1: Reestimation of Table 8 Using Cross-section Data

	Spec. (a)			Spec. (b)			Spec. (c)		
	M.E.		Joint	M.E.		Joint	M.E.		Joint
1	2	3	4	5	6	7	8	9	10
Panel A - Without Selection Correction									
Parental educ. missing	-0.037		**	-0.044		**	-		
Parental educ. low (ref.)	-			-			-		
Parental educ. middle	0.049			0.036			-		
Parental educ. high	0.154	**		0.125	**		-		
Age at Abitur 17-18	-0.137	*	o	-0.154	*	o	-0.133	o	
Age at Abitur 19-20 (ref.)	-			-			-		
Age at Abitur 21-25	-0.050			-0.037			-0.043		
Parental inc. missing	-			0.153	*	o	0.170	**	**
Parental inc. first quartile (ref.)	-			-			-		
Parental inc. second quartile	-			0.040			0.037		
Parental inc. third quartile	-			0.076			0.089	o	
Parental inc. fourth quartile	-			0.126	*		0.159	**	
Male	0.058	*		0.055	o		0.056	o	
Immigrant status (2)	yes		o	yes		o	yes		
Federal state (7)	yes		*	yes		o	yes		o
Calendar Year of Abitur (21)	yes		**	yes		**	yes		**
Log Likelihood	-710.19			-705.48			-711.58		
No. Obs.	1170			1170			1170		
Panel B - With Selection Correction									
Parental educ. missing	-0.017		**	0.003		**	-		
Parental educ. low (ref.)	-			-			-		
Parental educ. middle	0.066	o		0.060	**		-		
Parental educ. high	0.173	**		0.132	**		-		
Age at Abitur 17-18	-0.112	*	o	-0.057			-0.127	*	o
Age at Abitur 19-20 (ref.)	-			-			-		
Age at Abitur 21-25	-0.038			-0.010			-0.042		
Parental inc. missing	-			0.025		**	0.211	**	**
Parental inc. first quartile (ref.)	-			-			-		
Parental inc. second quartile	-			0.033			0.014		
Parental inc. third quartile	-			0.059	*		0.039		
Parental inc. fourth quartile	-			0.083	*		0.089		
Male	0.044			0.012			0.063		*
Immigrant status (2)	yes		o	yes		*	yes		o
Federal state (7)	yes		o	yes			yes		*
Calendar Year of Abitur (21)	yes		**	yes		**	yes		**
First Stage: Instruments (6)	yes		**	yes		**	yes		**
Chi squared	49.59			48.62			44.33		
p-value	0.0000			0.0000			0.0000		
Error term correlation rho	0.161			0.636	o		-0.328	*	
Log Likelihood	-3385.11			-3379.41			-3383.76		
Number of obs	7541			7541			7541		
Censored obs	6371			6371			6371		
Uncensored obs	1170			1170			1170		

Note: **, *, and ^{o} indicate statistical significance at the 1, 5, and 10 percent level.
Source: German Socioeconomic Panel (1984-2006), own calculations.

Table A2: Reestimation of Table 8 with Income Residuals

	Spec. (a)			Spec. (b)			Spec. (c)		
	M.E.		Joint	M.E.		Joint	M.E.		Joint
1	2	3	4	5	6	7	8	9	10
Panel A - Without Selection Correction									
Parental educ. missing	-0.018		**	-0.022		**	–		
Parental educ. low (ref.)	–			–			–		
Parental educ. middle	0.024			0.020			–		
Parental educ. high	0.096	**		0.099	**		–		
Age at Abitur 17-18	-0.075	**	*	-0.082	**	*	-0.068	*	o
Age at Abitur 19-20 (ref.)	–			–			–		
Age at Abitur 21-25	-0.015			-0.008			-0.015		
Parental inc. missing	–			0.154	**	**	0.160	**	**
Parental inc. first quartile (ref.)	–			–			–		
Parental inc. second quartile	–			0.044			0.047		
Parental inc. third quartile	–			0.053	o		0.064	*	
Parental inc. fourth quartile	–			0.104	**		0.091	**	
Male	yes			yes			yes		
Immigrant status (2)	yes		**	yes		**	yes		o
Years since Abitur (5)	yes		**	yes		**	yes		**
Federal state (8)	yes		*	yes			yes		o
Calendar year of Abitur (21)	yes		o	yes			yes		o
Log Likelihood	-1554.07			-1544.74			-1556.91		
Panel B - With Selection Correction									
Parental educ. missing	-0.042			-0.047			–		
Parental educ. low (ref.)	–			–			–		
Parental educ. middle	-0.011			-0.016			–		
Parental educ. high	0.042			0.045			–		
Age at Abitur 17-18	-0.068	o		-0.077	o		-0.052		
Age at Abitur 19-20 (ref.)	–			–			–		
Age at Abitur 21-25	-0.019			-0.010			-0.015		
Parental inc. missing	–			0.168	**	**	0.160	**	**
Parental inc. first quartile (ref.)	–			–			–		
Parental inc. second quartile	–			0.036			0.026		
Parental inc. third quartile	–			0.046			0.037		
Parental inc. fourth quartile	–			0.112	**		0.096	*	
Male	yes			yes			yes		
Immigrant Status (2)	yes		**	yes		**	yes		**
Years since Abitur (5)	yes		**	yes		**	yes		**
Federal state (8)	yes		*	yes		o	yes		*
Calendar year of Abitur (21)	yes		*	yes			yes		
First Stage: Instruments (6)	yes		**	yes		**	yes		**
Chi squared	48.11			48.18			49.57		
p-value	0.0000			0.0000			0.0000		
Error term correlation rho	-0.219	o		-0.231	*		-0.345	**	
Log Likelihood	-9841.32			-9832.00			-9834.65		

Note: **, *, and ^{o} indicate statistical significance at the 1, 5, and 10 percent level. The empirical model is identical to that used in Table 8.

Source: German Socioeconomic Panel (1984-2006), own calculations.

Table A3: Results of Subsample with Grades: With and Without Grade control

	Spec. (a)				Spec. (b)				Spec. (c)			
	W/o Grades M.E.		With Grades M.E.		W/o Grades M.E.		With Grades M.E.		W/o Grades M.E.		With Grades M.E.	
1	2	3	4	5	6	7	8	9	10	11	12	13
Panel A - Without Selection Correction												
P. educ. missing	0.018		-0.009		-0.001		-0.027		–		–	
P. educ. low (ref.)	–		–		–		–		–		–	
P. educ. middle	-0.028		-0.043		-0.046		-0.059		–		–	
P. educ. high	0.042		0.046		0.005		0.009		–		–	
P. inc. missing	–		–		0.014		0.019		0.030		0.041	
P. inc. first quartile (ref.)	–		–		–		–		–		–	
P. inc. second quartile	–		–		-0.017		-0.013		-0.015		-0.013	
P. inc. third quartile	–		–		0.014		0.028		0.022		0.039	
P. inc. fourth quartile	–		–		0.082		0.095		0.097		0.114	
Grades (4)	–		yes	**	–		yes	**	–		yes	**
Log Likelihood	-544.42		-537.61		-541.88		-534.74		-542.91		-536.54	
Panel B - With Selection Correction												
P. educ. missing	-0.037		-0.065		-0.063		-0.089		–		–	
P. educ. low (ref.)	–		–		–		–		–		–	
P. educ. middle	-0.103		-0.121		-0.125	o	-0.141	o	–		–	
P. educ. high	-0.113		-0.110		-0.154	*	-0.147	o	–		–	
P. inc. missing	–		–		0.007		0.010		0.016		0.025	
P. inc. first quartile (ref.)	–		–		–		–		–		–	
P. inc. second quartile	–		–		-0.046		-0.044		-0.037		-0.035	
P. inc. third quartile	–		–		-0.062		-0.050		-0.026		-0.013	
P. inc. fourth quartile	–		–		0.017		0.031		0.041		0.055	
Grades (4)	–		yes	**	–		yes	*	–		yes	**
First Stage: Instruments (6)	yes	*	yes	*	yes	*	yes	*	yes	**	yes	**
Chi squared	15.01		14.83		14.72		14.61		15.92		15.80	
p-value	0.0103		0.0111		0.0116		0.0122		0.0071		0.0074	
Error term correlation rho	-0.537	**	-0.534	**	-0.565	**	-0.540	**	-0.342	*	-0.364	**
Log Likelihood	-3210.45		-3203.74		-3208.37		-3201.67		-3210.38		-3203.68	

Note: In the odd numbered columns **, *, and ^{o} indicate joint statistical significance at the 1, 5, and 10 percent level. All models were specified as the base case in Table 8. As indicators of pupil ability all models control for grades in mathematics, German, a foreign language and an indicator if grade information is missing. The Probit estimations in Panel A use 918 observations, the estimations with selection controls in Panel B are based on 1957 observations.

Source: German Socioeconomic Panel (1984-2006), own calculations.