The enrollment effect of secondary school fees in Post-War Germany

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CEPR - IZA - DIW

August 2003

Abstract

This study utilizes a natural experiment in the fee abolition for West German secondary schools to identify its effect on enrollment and to obtain an estimate of the price elasticity of demand for education. The analysis is based on administrative school enrollment statistics as well as on representative individual-level data from three annual surveys of the German Mikrozensus. Estimates suggest that enrollment in Advanced Schools increased by at least 6 to 8 percent overall, where the effect for females is about twice the size of that for males. A change in fees by about 5 percent of average annual incomes is associated with an overall change in enrollment rates by 3.5 to 5 percent, where again the elasticity of the demand for female education exceeds that for males.

Key Words: school fees, tuition, enrollment, demand for education, natural experiment
JEL Classification: I20, H52, H71, C21

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I thank seminar participants at MPI-Rostock, University of Zurich and Lausanne for helpful comments and Joachim Benatzky for excellent research assistance.

1. Introduction

In today's industrialized countries public secondary education is typically provided free of charge. This is commonly justified by economic arguments such as positive externalities of an educated population as well as by equity and distributive justice arguments. Historically, school fees were the rule at public schools and they are still commonplace for private schools. Even though economic theory suggests that the demand for schooling responds to its price and the price of schooling changed over the course of decades, studies of educational attainment over time often do not account for this development and the price elasticity of secondary schooling has found little research attention.[1]

This research takes advantage of a natural experiment in post-war Germany to provide an estimate of the effect of (the abolition of) school fees on school enrollment and on the price elasticity of education demand. This contributes to several ongoing debates. First, the results can be informative for the discussion on school vouchers in the United States (e.g. Ladd 2002, Neal 2002) where the financial cost of secondary education and its behavioral effect is an important aspect. Second, the debates on the effect of tuition subsidies in the United States or relatedly on the introduction of university fees in Europe generally lack reliable measures of the price elasticity of education demand: For the European case, data on prior experiences with academic fees are often unavailable. In the U.S. the measurement of the effect of public aid on college enrollment is hampered by the potential endogeneity of aid receipt.[2] The evidence presented here is relevant to both of these discussions. Finally, this study is related to a growing literature that

[1] For studies on historical developments in educational attainment see e.g. Dustmann (2001), Ichino and Winter-Ebmer (2002), or Schnabel and Schnabel (2002).

[2] The literature addresses this endogeneity using a variety of natural experiments (e.g. involving the GI Bill, tuition or subsidy changes). For a survey see Dynarski (2002). Key contributions are Kane (1995, 2002), Ichimura and Taber (2002), or Heckman et al. (1998).

investigates instruments to increase school attendance in developing countries[3] as well as in industrialized countries.[4] We focus on the sensitivity of enrollment to the abolition of school fees.

Up until the end of World War II fees had to be paid for advanced secondary education in Germany, typically amounting to about ten percent of an average worker's gross earnings per pupil. After the war, when educational authority was returned to the federal states, fees for advanced secondary education were abolished state by state between 1947 and 1962. The variation in the timing of fee abolition across regions is used here to identify the effect of fees on Advanced School enrollment, and to compare the price responsiveness of demand for the education of male and female youth. In step one of the investigation we analyze the responsiveness of education demand to the existence of a school fee and in step two we evaluate the sensitivity of enrollment to changes in the price of education.

We find sizeable and significant effects of school fee abolition on enrollment. The responsiveness of the demand for female education clearly exceeds that of the demand for male education. Overall fee abolition is associated with an increase in enrollment rates by 6 to 8 percent. A drop in the fee-to-income ratio by 50 percent or five points increases the aggregate enrollment rate by around 3.5 to 5 percent again with larger effects for females than for males.

The paper proceeds as follows: Section 2 surveys the institutional background and outlines our theoretical model and hypotheses. Aggregate and individual-level data as well as the empirical approach for step one of the analysis are described in section 3 before the corresponding results are presented and discussed in section 4. Section 5 discusses the responsiveness of enrollment to changes in fee amounts and section 6 concludes.

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[3] Examples are Vermeersch (2002) on school meals in Kenya, Miguel and Kremer (2001) on deworming pupils in Kenya, Schultz (2000) on cash transfers to Mexican parents, or Kim et al. (1999) on subsidies for girls' education in Pakistan.

[4] See Meghir and Palme (2003) for Swedish experience in the 1950s and 1960s, Aakvik et al. (2003) on Norway, and Dearden et al. (2003) for a current program in the United Kingdom.

2. Institutional Background, Theoretical Model and Hypotheses

2.1 School Fees in a Historical Perspective

Traditionally, the German schooling system has been structured not only by years of schooling, but also by parallel tracks with different requirements. Since the 19th century the standard education has been provided by Basic Schools (*Volksschule* / *Hauptschule*) which used to last 8 years and prepared pupils for apprenticeships or vocational schools. It was possible to advance from Basic Schools after 4 years to either Middle School (*Realschule* / *Mittelschule*) or Advanced School (*Gymnasium* / *Oberschule*),[5] where education continued for an additional 6 or 9 years, respectively (cf. Figure 1). The system hardly changed in post-war Germany, where the Advanced School degree remained the key requirement for university studies.

Through the 19th century there was a fee to be paid for any type of school financing teacher salaries. Starting with Prussia (1888) and ending with Saxony (1919) fees were abolished for Basic Schools (Kahlert 1974). The regulations on school fees for Middle and Advanced Schools varied across regions. The fees per pupil at times exceeded 10 percent of an average labor income. Figure 2 depicts the share of school fees in average income for the case of Prussia. It shows nominally rising earnings during inflation when fees remained unadjusted. Around the time of WWII the German educational system was centralized and underwent major distortions connected to the manpower needs of the military (for an evaluation see Ichino and Winter-Ebmer 2002). Advanced School education was reduced by one year in 1938, and starting 1941 it was at times shortened by an additional 6 months. Also, final examination requirements were reduced and frequently dropped completely to facilitate voluntary and non-voluntary military service, affecting the birth cohorts 1922-1928.

After the war the authority for the administration of the schooling system was returned

[5]Depending on region and period entrance exams were required to enter Middle or Advanced School.

to the German federal states. They increased the duration of Advanced School education back to 9 years and re-regulated the fee system: Starting with the city-state of Bremen (1947) and ending with Rhineland-Palatinate (1962) all states abolished tuition fees for the public secondary schooling system (Benatzky 2001, Berger and Ehmann 2000). However, there was considerable regional variation in the speed and extent of fee abolition, which we use to identify its effects. Figure 3 describes the fee abolition pattern across the 11 federal states. Frequently tuition was abolished stepwise, e.g. annually by one seventh over the course of 7 years as in the case of Hamburg, or in steps from 100, to 50 and 25 percent of the original amount as in the case of Bavaria. Figure 4 describes the reduction of school fees for one pupil by state and over time measured as a share of average earnings for selected states. It clarifies the heterogeneity of the abolition process, with the first abolition depicted for Berlin and the last for Rhineland-Palatinate.

Among the generations of youth growing up in a given state the analysis below distinguishes three cohort groups based on the fee system they faced when entering Advanced School: The first and oldest group would have had to pay school fees upon entering Advanced School (pre group). For a second group it depended on the speed at which they completed primary education whether they would have entered Advanced school prior to the abolition of the school fees (transitional group). The number of "transitional cohorts" may increase due to the distortions in individual education biographies during the war. Finally, the third group consists of those birth cohorts who certainly would not have had to pay school fees, because they entered Advanced School after the fee abolition (post group). Since fees were abolished at different dates for different states, Table 1 indicates the relevant cohort groups for each of the 11 states, Appendix A provides additional explanations.

It is important to note that the abolition of school fees was not the only development in the German educational system during the 1950s and 1960s. Similar to other industrialized countries the educational system expanded vastly beginning in the early 1960s. This was due to

demographic shifts to more sizeable birth cohorts, the increased demand for advanced education, as well as a an intentional broadening of access to education with increasing public investments in the school and academic system. The standing conference of state ministers of education in the 1960s agreed to raise the level of education and to increase Advanced School enrollment. In consequence, education expenditures went up significantly (Fränz and Schulz-Hardt 1998).

2.2 Theoretical Model and Hypotheses

Similar to Card (1999) we model the optimal amount of schooling in a framework that abstracts from dynamic processes and describes the schooling decision as a tradeoff between increases in the present discounted value of the utility derived from future earnings, and the disutility connected to education costs and taste factors. However, we are not interested in the optimal number of years of schooling but in an individual's (latent) propensity to enrol in Advanced School (S*):

$$(1) \qquad S_i^* = Y(S_i , A_i; \mu_i) - H (S_i , A_i, C; \nu_i)$$

Y is the discounted utility of lifetime earnings and H is the discounted disutility connected to Advanced School participation. Both depend on school enrollment (S_i) where we assume an increasing concave function for Y and an increasing convex function for H. Both may also vary with a pupil's ability (A), which may yield higher earnings advantages and lower disutility from additional schooling.[6] C represents the direct cost of Advanced School participation affecting the utility loss due to school participation. μ_i and ν_i are person-specific effects.

A simple specification of the two factors could be:

$$(2) \qquad Y_i = \mu_i + b_1 S_i + b_2 A_i \qquad \text{with } b_1 , b_2 > 0$$

$$(3) \qquad H_i = \nu_i + c_1 S_i + c_2 A_i + C \qquad \text{with } c_1 > 0 \text{ and } c_2 < 0$$

[6] For the more able it may be possible to earn the highest returns given their education, and they may be able learn quicker, incurring lower cost of education, e.g. by earning an income at the side, whereas the less able may need additional time and tutoring to meet requirements.

such that

(4) $S_i^* = (\mu_i - \nu_i) + (b_1 - c_1) S_i + (b_2 - c_2) A_i - C$

Clearly, a reduction in C will increase the probability of Advanced School enrollment. Participation probabilities are higher for the more able students. Also, if e.g. individual effects μ_i or returns to schooling and ability (b_1, b_2) vary systematically across population groups g, such as the two sexes, with $\mu^{g=1} > \mu^{g=0}$, $b_1^{g=1} > b_1^{g=0}$ or $b_2^{g=1} > b_2^{g=0}$, then it follows that

(5) $S_i^*_{|g=1} > S_i^*_{|g=0}$.

Figure 5 depicts a situation, where pupils are sorted by ability on the abscissa. We expect that those for whom the expected lifetime benefit of schooling (Y_i) exceeds the discounted disutility (H_i) will participate in Advanced Schooling. In Figure 5 everybody to the left of point A will enrol in Advanced School, here amounting to the 10 percent most able pupils. If fees are abolished direct costs (C) decline and the share of pupils in Advanced Schools may increase to e.g. the 20 percent most able individuals (see point B in Figure 5).

If we hypothesize further, that for parts of the population such as females the expected benefits at all ability levels are below the average - e.g. due to a smaller value of parameter b_2 - then this group's participation share should be below average, both before and after the abolition of fees. In that case females' Y_i schedule is flatter than males' and females' response to the abolition of school fees in terms of the relative enrollment increase may exceed that of males (for details on the theoretical analysis see Appendix B).

Within this framework we hypothesize, that the abolition of tuition causes a decline in the direct cost of education and yields an overall increase in the participation rate. Given the variation across federal states and time we hypothesize:

H1: Overall Advanced School participation increases after the abolition of school fees.
H2: Advanced School participation in states without fees exceeds that of states with fees.
H3: Advanced School participation for males exceeds that of females.
H4: The increase in Advanced School participation may be more pronounced for females than for males.

The next sections describe the procedure applied to test these hypotheses.

3. Data Description and Empirical Strategy

3.1 Aggregate Evidence

Our first approach at evaluating the enrollment effects of school fee abolition takes advantage of historic administrative Advanced School enrollment data at the state level. Ideally we would measure the size of the annual school entry cohorts, but unfortunately only the total number of pupils per year cumulatively over all 9 grades in Advanced School is available from the state statistical offices. A disadvantage of this aggregate measure is that changes in school entry can only be measured to the extent that they change *total* school enrollment.[7] Because of this imprecision in the data we present average figures across the years before and after the fee abolition. As there were significant changes in birth cohort sizes in this time we generated demography-corrected cohort-specific Advanced School enrollment rates by state.[8]

Not all of the 11 state statistical offices could provide the necessary figures. Therefore we are restricted to evaluate the 6 states described in Table 2. The numbers indicate sizeable increases in aggregate enrollment rates around the time of the fee abolition. On average the cohort share attending Advanced School increased by 22.5 percent between the average of 5 years prior and 5 years after the abolition of school fees. The aggregate year-by-year development is depicted in Figure 6 and confirms the upward trend in Advanced School enrollment across states. This supports hypothesis 1 (H1), school participation increased after the abolition of school fees.

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[7] If, e.g. fees are abolished in Hamburg as of 1957, we would expect higher entry rates (at grade 5) in 1958. However in 1958 we only know the total number of pupils attending Advanced School (grades 5-13).

[8] Enrollment rates are calculated as the ratio of the number of pupils in Advanced School in a given state over the total population aged 10-19 in that same state and year.

This evidence blurs the fee effects by looking at the total number of pupils in Advanced School (grades 5 - 13) and by disregarding the general education expansion over time. For more precise measures and to control for time trends we now turn to individual level data.

3.2 Individual-Level Evidence

3.2.1 Data Source and Sample

The individual-level data are taken from the Mikrozensus, which is an annual survey of a one percent random sample of German households. Public use files of 70 percent of the original data are available for the years 1989, 1991, 1993, 1995, 1996, and 1997. The Mikrozensus uses a rotating scheme in that the inhabitants of a given dwelling are re-interviewed up to four times. Unfortunately households or individuals cannot be identified across survey waves. To avoid a duplication of records we restrict the analysis to the surveys of 1989, 1993, and 1997 where the set of respondents does not overlap.

Our sample considers the birth cohorts of 1930 through 1965 if they are German nationals and living in West German states. We drop observations with missing values on key variables such as age, sex, schooling or state. This yields a total of 540,834 observations, about one third from each of the 3 surveys and about 14'000 per birth cohort. The key advantage of the dataset is its size, which allows to compare state-level differences by birth cohort. The main disadvantage is the lack of social background variables. It would be interesting to control for parental human capital as a determinant of child educational attainment. Given that such measures are not available the findings presented below cannot separate the impact of social background from the measured state and cohort effects. This limitation is addressed in the discussion below.

3.2.2 Descriptives

Figure 7 describes the development of the enrollment rate in Advanced Schools over

subsequent cohorts. As suggested by hypothesis 3 (H3) the enrollment rates differ between the sexes. They were at about 10 percent for men and 5 percent for women up until the birth cohorts of the 1930s for which the rates started to increase. For more recent birth cohorts females reach and even exceed males' educational attainment.

To investigate regional differences in Advanced School participation Figure 8 describes the average enrollment rates for the 11 German states for three groups of cohorts. We find particularly high levels of education in the city states of Bremen, Hamburg, and Berlin. Hypothesis 2 (H2) suggested that enrollment rates in states without fees exceed those in states with fees for any given cohort. Confirmative aggregate evidence is presented in Figure 9, which depicts average enrollment rates for cohorts in states with and without school fees.

To obtain preliminary evidence of the fee effect we calculated state-specific Advanced School participation rates for those cohorts entering Advanced School before and after the abolition of fees. The results in Table 3 yield that on average participation rates increased vastly from 8 percent among the "pre-fee" cohorts to 21 percent for the "post-fee" cohorts. These developments are similar when calculated for males and females separately. Not only *levels* of education attainment vary across states but also the developments over time are heterogeneous. We find particularly large increases in Advanced School participation in Hamburg, Bremen, and Hesse and the smallest increases in Berlin, Saarland, and Rhineland-Palatinate. As these results again do not account for developments over time we proceed to a regression based strategy to identify the effect of the abolition of school fees.

3.2.3 Empirical Strategy

The objective of the analysis is to reliably identify the effect of the abolition of school fees on Advanced School enrollment. Our dependent variable describes whether an individual

obtained an Advanced School degree ("*Abitur*") and we use a simple logit estimator.[9] We apply four flexible approaches to control for state and period-specific general effects.

Based on Table 1 we categorized the residents of every state into three groups depending on their year of birth: The first group would certainly have had to pay fees upon entering Advanced School ("pre" fee abolition cohorts), for a second group of birth cohorts we cannot be certain ("trans"(itional) birth cohorts), and the last group would certainly not have had to pay tuition fees when attending Advanced School ("post" fee abolition cohorts). Our four estimation approaches differ in their flexibility in controlling for time trends and in state-specific effects:

(i) A first approach controls for the cohort groups (pre, trans, post), for state fixed effects, and a linear cohort effect:

$$\Pr(S_i = 1) = \Lambda(\alpha + \beta_1 \text{trans}_i + \beta_2 \text{post}_i + \gamma\, c_i + \delta\, \text{State FE}_i),$$

where S indicates Advanced School attendance, Λ represents the logistic cumulative distribution function, c represents the birth year, trans and post represent cohort group indicators, State FE stands for a vector of state fixed effects, and α, β, γ, and δ are coefficients to be determined.

(ii) A second approach differs from the first by allowing for group-specific linear cohort splines as opposed to one overall linear cohort trend:

$$\Pr(S_i = 1) = \Lambda(\alpha + \beta_1 \text{trans}_i + \beta_2 \text{post}_i + \gamma_1 \text{pre}_i \cdot c_i + \gamma_2 \text{trans}_i \cdot c_i + \gamma_3 \text{post}_i \cdot c_i + \delta\, \text{State FE}_i).$$

(iii) The third approach instead considers state-specific linear cohort trends:

$$\Pr(S_i = 1) = \Lambda(\alpha + \beta_1 \text{trans}_i + \beta_2 \text{post}_i + \gamma^{o}\, \text{State FE}_i \cdot c_i + \delta\, \text{State FE}_i).$$

(iv) The final approach most flexibly controls for the differences in cohort effects by state and by group:

$$\Pr(S_i = 1) = \Lambda(\alpha + \beta_1 \text{trans}_i + \beta_2 \text{post}_i + \gamma_1{}^{o}\, \text{State FE}_i \cdot \text{pre}_i \cdot c_i$$

[9] The models were also run as linear probability models. While the coefficient signs and significances were comparable, predictions differed vastly from those generated based on discrete choice models.

$$+ \gamma_2^{o} \text{ State FE}_i \cdot \text{trans}_i \cdot c_i + \gamma_3^{o} \text{ State FE}_i \cdot \text{post}_i \cdot c_i + \delta \text{ State FE}_i).$$

The coefficients of the post cohort group indicators and simulation results yield whether there are significant differences in Advanced School attendance after the fee abolition and what their magnitudes amount to.

4. Results and Discussion: The Enrollment Effect of Fee Abolition

4.1 Estimation and Simulation Results

The estimation results for the full sample applying the four approaches discussed above are presented in Panel A of Table 4. The coefficient estimates for β_2 are highly significant and positive in all specifications suggesting that the probability of attending Advanced School is higher for individuals who are not subject to school fees compared to those in the "pre" cohorts.[10] The state-specific heterogeneity in Advanced School enrollment rates is reflected in highly significant state fixed effects (δ).[11] In contrast to those in Tables 2 and 3 these results now control for aggregate and state-specific trends reflecting e.g. the educational expansion over time.

Panels B and C of Table 4 present the predicted effects of the abolition of school fees on enrollment probabilities for Advanced Schools: The "fee effect" describes the average increase in Advanced School enrollment probabilities across observations and states. The Panels differ in the underlying simulation experiments: Panel B compares the hypothetical enrollment probability of an individual born in the midst of the transition cohort group if she were to follow the enrollment pattern of the pre-abolition group to the enrollment probability that would result if this person behaved like individuals born in the post-abolition group. This simulation procedure involves out of sample predictions as the cohort effects of the pre and the post groups

[10] In models with interaction terms the main effects (β_1, β_2) of the cohort group indicators can of course not be interpreted independently of interaction terms.

[11] The results regarding β_2 and δ hold identically for the estimations that were performed separately for the two sexes.

are applied to a person born in the trans group. Panel C focuses on an individual that belongs to the first cohort not having to pay a fee and compares enrollment under the transitional regime with that under the post-abolition regime. This more conservative simulation experiment avoids out-of-sample predictions and provides a lower bound for the true fee effect. Figure 10 illustrates the different simulation experiments.[12]

About representative for subsequent specifications model (1) yields that the average enrollment probability increased after the abolition of fees. The predicted average effect is - not surprisingly - larger when based on the simulation experiment in Panel B than in Panel C. For the full sample the conservative simulations yield overall fee effects of 6 to 8 percent higher enrollment probabilities after the abolition of fees compared to effects of up to 16 percent in Panel B. In both simulations the increase in average enrollment rates is more sizeable for females than for males, with about 11 percent for women and 5 percent for men in the conservative simulations.

Adding flexibility to the representation of the time trend, specification 2 allows for different slopes by cohort group: Instead of one time coefficient three splines are estimated. The positive coefficients of the splines agree with the secular increase in Advanced School enrollment over time. With this added flexibility the predicted fee effects overall remain within the range of the predictions based on model (1).

Alternatively one can allow for more state-specific flexibility: In columns (3) and (4) the group - cohort interactions are replaced with state - cohort interaction terms, again yielding statistically significant coefficients. The predicted fee effects in column (3) hardly differ from those presented in the first specification which controlled for only one overall time trend instead of 11 different ones.

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[12]Both panels describe predictions for the full sample based on the presented regression results and for the male and female subsamples based on separate regressions that are not presented to save space.

In the last model we control for a separate set of three time trend splines for each of the eleven states yielding 33 parameters to represent the cohort effects. The added flexibility yields somewhat reduced fee effects particularly in Panel B. However, the predictions here still yield an aggregate enrollment increase at the order of 10 percent. The more conservative simulations in Panel C predict an overall effect of about 6 percent. Particularly in Panel C the simulated fee effect for females (11.4 percent) far exceeds that of males (3.7 percent).

A test of the relatively restrictive specifications in columns (1) and (3) against their more flexible counterparts in columns (2) and (4) yields in both cases that the null hypothesis of the parameter restrictions inherent in specifications (1) and (3) must be rejected at the 1 percent level. The more general models in columns (2) and (4) provide a significantly better fit for the full sample as well as for the sex-specific subsamples.

The individual level data provides robust evidence for a significant increase in the probability of attending Advanced School after the abolition of fees. The simulations suggest that overall enrollment rates increased on average by between 6 and 16 percent with significantly more sizeable effects for females than for men.[13] Depending on the estimated model and the simulation experiment the enrollment effect for females reaches twice the size compared to that for men, thus confirming Hypothesis 4.

4.2 Robustness Tests and Discussion

Next we show that the above results hold in robustness tests, and discuss how various potential limitations of the data might affect the findings before we extend the evidence to indicators of the elasticity of education demand with respect to the amount of fees in section 5.

[13] The statistical significance of the male-female difference has been investigated in models with interaction terms (not presented to save space).

Sample: One objection to the above analysis may concern the selection of the sample, which considers every observation born between 1930 and 1965. This might cause misleading estimates of cohort and cohort group effects, as at times irrelevant cohorts are considered, and in some instances the cohorts available to support the estimates are limited.[14]

To test for the effect of such sampling problems the analysis was redone, this time considering for each state only those 15 cohorts entering Advanced School before and after fee abolition. The results obtained with this sample are presented in Table 5. We find again confirmation for increasing enrollment probabilities over time (see the β_2 coefficient in specification 1 and the γ coefficients in models 1 and 2). The simulation results confirm that the abolition of fees yielded increases in enrollment probabilities which are similar to those obtained with the original sample in Table 4. Again effects are larger in Panel B than in Panel C. Even though some of the simulations differ in size from those obtained in Table 4 the main conclusions are confirmed: We find significant responses to the abolition of fees, conservative estimates of the overall abolition effect vary between 3 and 8 percent again with much larger effects for females than for males.

Income Effects: One may argue that the estimation suffers from omitting controls for the increasing income of the population in post-war Germany. As the speed of economic growth differed across federal states this may be responsible for the heterogeneity in responses to fee abolition which we noticed in Table 3. Inhabitants of poorer states may respond stronger to the price changes of secondary education. To solve this omitted variable problem one would ideally control for state-specific annual incomes. As an approximation we consider real state-specific per capita gross domestic product (GDP). Such figures are available annually for West-German states

[14] If, e.g., fees were abolished in Rhineland-Palatinate in 1962, trends for those born in the 1930s may cause spurious results.

since 1950 and they confirm the heterogeneity in state-specific growth processes: States such as Bavaria and Schleswig-Holstein quadrupled their real per capita GDP between 1950 and 1980 while others such as Bremen or Northrhine-Westphalia merely tripled theirs. The GDP information is not available for years prior to 1950, and for Berlin and Saarland only after 1960. The above estimations were repeated with controls for annual state-level per capita GDP, where a 'missing-value indicator' was added to the specification for observations with missing GDP information.[15]

The estimations with GDP controls yield results that are quite similar to those presented in Tables 4 and 5.[16] Surprisingly, the significant coefficients of the GDP indicators generally have negative signs suggesting that once all the cohort and trend effects were controlled for the enrollment rate was higher in states with lower GDP per capita. Table 6 summarizes the simulation results obtained for both samples when GDP controls were added to the models. The fee effects are within the ranges observed in Tables 4 and 5. Also the difference between the sexes holds up to the additional controls. Therefore the results are robust to income controls.

Enrollment versus Completion: So far we have not paid much attention to the definition of our dependent variable, which does not measure Advanced School enrollment but completion of the Advanced School degree. This could systematically bias the results if the group of individuals starting out in Advanced School and the group completing it successfully differ in a way that is correlated with the effect of school fees. Such a correlation is indeed likely, as the children of better off parents would be less restricted by school fees *and* are more likely to receive extra support in completing their school work than children of poor parents. After the abolition of fees

[15] Since we want to use only one value of state-level GDP per person, we chose the one year when the individual turned 11, which is the typical age of transition to Advanced School.

[16] The estimates are not presented to save space and are available upon request.

more poor kids might have started Advanced School than show up in our data, which describes only those who successfully completed school. Therefore this measurement problem leads to an underestimate of the true enrollment effect of fee abolition, rendering our figures lower bounds.[17]

Regional Mobility: Another issue to address is that we do not know in which state an individual actually lived when attending school since we only observe the state of residence at the time of the survey. As long as individuals moved between states in a random fashion, this would cause an attenuation bias in the effects of state-specific measures, again rendering our measures lower bounds of the true effect.

An upward bias would result only if high internal migration were correlated with large state-specific fee effects, e.g. if individuals with (without) Advanced School degrees move to states where they belong to the post (pre, trans) group. We have no evidence confirming such specific migration patterns. Generalizing a little, an upward bias would be more likely, if high immigration were correlated with large fee abolition effects. To evaluate the degree to which regional mobility is likely to affect our results we look at two external sources of evidence.

First, Table 7 presents the heterogeneity of internal migration in Germany across states. It describes the relevance of internal migration for each state over the last five decades looking at the annual immigration from other German states relative to the state's population. The mean across states and time indicates that yearly immigration amounted to about 2 percent of each state's population. The last two columns do not show clear patterns in the correlation between immigration and effect size. Since states with very low immigration, such as Bavaria or Saarland have above average fee effects, and states with very high immigration can have very small fee effects (see Hamburg) it seems unlikely that *systematic* migration biases our results.

[17] Clearly this underestimation of the true effect is limited by the extent to which children of poor parents are able to balance pecuniary disadvantages by higher motivation.

In addition, the German Socioeconomic Panel (GSOEP) a household panel survey running annually since 1984 provides evidence on the regional mobility of Germans. In the GSOEP every respondent is asked whether he still lives in the town where he was raised. This question is obviously much more narrow than what we need here, as it asks about living in the same town while we are interested in residing in the same state only. Nevertheless, in 1985 58 percent of the respondents of the then representative GSOEP sample still lived in the town where they were raised![18]

As the GSOEP has been running for 18 years now we can also use the panel nature of the data to find out that of the (non-representative) sample of 6,284 individuals who were surveyed both in 1984 and in 2001 only about 5 percent changed their federal state of residence in between. These figures are not indicative of a highly mobile population. Therefore the effect of neglecting residential mobility is not likely to be large in magnitude.

Omitted Parental Characteristics: The data does not provide information on important covariates that may influence school attendance decisions, such as parental human capital. This should cause a systematic bias only if the omitted parental measures are correlated with the cohort group indicators (pre, trans, post). Such a correlation is plausible to the degree that either the distribution of parental characteristics or the role of intergenerational transmission of education changed over time. The existing evidence on the intergenerational transmission of human capital for Germany (see e.g. Blossfeld 1993, Müller and Haun 1993) suggests that inspite of the educational expansion the intergenerational correlation of educational success has not changed over time. In addition there is no reason to expect a large change in the level of parental education for those entering Advanced School before and after the fee abolitions, as the

[18] The question was posed again to a large subsample in 2001 yielding 55 percent of respondents living in the same town where they spent their childhood.

educational expansion took place only for cohorts born much later. Thus the omission of parental controls should not substantially affect the nature of our estimates.

Admission Requirements: Changing admission requirements to Advanced School education over time may cause shifts in enrollment patterns that interfere with our measures of fee abolition effects. Unfortunately, there is no source of information on this aspect. Up to today admission standards vary significantly across federal states, with strict grade requirements in southern Germany and less restrictive systems in other states. Only if these requirements changed exactly at the time of fee abolition would our estimates be biased.[19] However there is no evidence for such developments.

Educational expansion: A final objection to the chosen approach might be that the aggregate expansion of the educational system (see Figure 7) is not explicitly controlled for in the estimations. While a control variable for state-specific education expansion is not available, the cohort effects and in particular the state-specific cohort effects in model 4 of Table 4 should capture such developments. Also, given that fees were abolished for about 90 percent of the population by 1960[20] when the educational system only started its expansion, it is unlikely that our results are biased by the subsequent educational expansion.

5. Estimation of the Enrollment Sensitivity to Fee Changes

After the first part of our analyses was devoted to the question of whether the abolition of fees as such caused behavioral responses in Advanced School enrollment, we now turn to the

[19] In that case we would not be able to distinguish between the effects of fee abolition and of changed admission requirements.

[20] The only state with fees at that time was Rhineland-Palatinate, which has a small share of the total population.

price sensitivity of demand for higher secondary education. The empirical analysis follows the patterns established above: We estimate logit models on individual school enrollment, provide various ways of controlling for cohort effects, and generate predictions on the estimated effect of fee changes on enrollment probabilities.

The key explanatory variable here is the fee amount to be paid for Advanced School participation. Since the full set of relevant state-specific fees is not available (see Figure 3), some of the missing figures were replaced by plausible assumptions.[21] As the fee amount was set nominally and its real value thus changed over time, we deflate the fee measure by calculating the share of fee per pupil in average annual incomes. Average annual incomes are available for all of Germany in the records of the retirement insurance (cf. Figures 2 and 4). In our regressions the income share represents the state-specific ratio in the year when the pupil was 11 years of age.

The analysis is based on both, the original sample of individuals born between 1930 and 1965 as well as the modified sample of individuals born in the 15 year period before and after the cohort first enjoying full fee abolition. The specification of the school attendance model follows the patterns described above, only now considering controls for state- and period-specific income effects (GDP per capita) in all estimations.[22] Since we are no longer focusing on fee abolition the cohort group indicators used above are not relevant for these estimations. The models control instead for linear, quadratic, and cubic cohort effects either as main effects or interacted with state indicators. The estimation results are summarized in Panel A of Table 8.

The estimates yield a clear and generally highly significant, negative correlation of the

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[21] In particular we assumed that fees were nationally identical at 240 Marks per year before 1945 and generally used the nominal amount of 240 Marks as the basis from which later reductions were calculated. For the state of Saarland we only have information that fees were abolished in 1959. In this case we make no assumptions for the developments between 1945 and 1958 and instead disregard observations from this state in the analysis. The available evidence on fee developments is discussed in Benatzky (2001). For the fee data applied see Appendix C.

[22] The simulation results are slightly larger in magnitude in estimations without controls for GDP per capita.

fee-to-income ratio with individual enrollment probabilities. While the estimated coefficients vary across specifications the predicted effect of changes in the fee-to-income ratio on enrollment rates appears to be rather stable. Panels B and C of Table 8 present -for the two samples- simulated effects of a decline in the fee-to-income ratio from 10 to 5 percent, a decline which actually occurred after the war (cf. Figure 4). The simulated effects are higher when only general cohort controls are considered in the estimations (models 1-3) compared to the very flexible state-specific controls (models 4-6). Overall a reduction in the fee-to-income ratio by fifty percent is correlated with enrollment increases at the order of 3.5 to 5 percent for the full sample with somewhat larger effects for the female subsample.[23]

6. Conclusions

Reliable evidence on the price sensitivity of education demand is hard to come by and the effect of school fees or tuition subsidies on educational enrollment is much debated. This study provides evidence on the enrollment effect of school fees by taking advantage of a natural experiment in post-war West Germany where fees for advanced secondary schools were abolished at different points in time between 1947 and 1962 across the eleven federal states.

Based on a variant of Card's (1999) optimal schooling model we derive four hypotheses on the enrollment effect of school fees. Our evidence is consistent with the hypotheses that (1) Advanced School participation increases after the abolition of school fees, (2) Advanced School participation in states without fees exceeds that in states with fees, (3) Advanced School participation for males exceeds that of females, and (4) the increase in Advanced School participation after fee abolition is more pronounced for females than for males.

[23] In estimations with sex interactions the simulated differences where much larger. However this was due to the implicit restriction of identical state and cohort effects for both subsamples. The results presented in Table 8 are based on separate estimations for the two sexes and are preferred since they more flexibly capture the sex-specific trend effects.

Aggregate data suggest sizeable enrollment increases around the period of fee abolition. When we control for overall time trend effects using individual level data we find again clear and significant enrollment responses to the abolition of fees. Conservative estimates yield jumps in Advanced School enrollment at the order of 5 percent for males and 11 percent for females. In additional simulations that rely on out-of-sample predictions we obtain enrollment responses of up to 16 percent for women and 10 percent for men.

In a second step we investigate the sensitivity of enrollment rates to changes in the price for secondary education. The simulation exercises yield that a reduction in the fee-to-income ratio by 50 percent (a change in the ratio from 10 to 5 percent) is associated with an increase in enrollment rates of 3.5 to 5 percent, again with significantly higher elasticities in the demand for girls' than for boys' education.[24]

These results suggest that the existence of school fees for Advanced Schools set an effective barrier to higher education which affected females more than males. To the degree that the mechanisms of the 1950s and 1960s are still at work today the existence of fees for higher secondary schooling affects human capital investments, involving significant lifetime earnings differences at the individual level. In the aggregate, school fees thus appear to be an important limitation to the growth of a society's stock of human capital.

The differential price sensitivity for male and female students may provide part of the answer to the question of why even today there are significant enrollment differences between the sexes: Parental demand for girls' education seems to be significantly more price elastic.

[24] In terms of current incomes the simulated fee change (five percent of annual incomes) would be equivalent to a nominal change in fees by 1400 € per year.

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Table 1 Abolition Phases and Affected Birth Cohorts

	Year of Abolition	Cohorts with fee	Cohorts in Transition	Cohorts without fee
		"Pre"	"Trans"	"Post"
Baden-Württemberg	1957	-1944	1945 - 1948	1949 +
Bavaria	1951	-1937	1938 - 1942	1943 +
Berlin	1948	-1934	1935 - 1939	1940 +
Bremen	1947	-1933	1934 - 1938	1939 +
Hamburg	1957	-1944	1945 - 1948	1949 +
Hesse	1949	-1935	1936 - 1940	1941 +
Lower- Saxony	1959	-1946	1947 - 1950	1951 +
NRW	1959	-1946	1947 - 1950	1951 +
Rhineland-Palatinate	1962	-1949	1950 - 1953	1954 +
Saarland	1959	-1946	1947 - 1950	1951 +
S.-Holstein	1952	-1939	1940 - 1943	1944 +

Source: Own calculations based on abolition dates summarized by Benatzky (2001), see Appendix A.

Table 2 Average Demography-Corrected Advanced School Participation Rates before and after the Abolition of School Fees

	Rhineland-Palatinate	Hamburg	Lower Saxony	Baden Württemberg	NRW	Saarland	All
5 years prior	0.109	0.093	0.094	0.111	0.092	0.088	0.098
5 years after	0.154	0.108	0.102	0.125	0.119	0.112	0.118
Abs. Diff.	0.036	0.015	0.008	0.014	0.026	0.024	0.021
Rel. Diff. (%)	33.2	16.5	8.3	12.2	28.4	26.7	20.9

Note: The figures present average enrollment rates in the 5 years preceding and following the abolition of school fees in each of the states. Since abolition happened at different points in time, different calendar years are covered by each column (for Rhineland-Palatinate cohorts 1958-68, for Hamburg and Baden Württemberg cohorts 1953-63, and for the remaining cohorts 1955-1665). The last column provides an average over the 6 states.
The absolute difference is simply the difference between the two entries, the relative differences calculates the percent increase in enrollment rates for the period after the fee abolition.

Sources:

(i) Pupils in Advanced School by state and year: Federal Statistical Office, *Zeitreihen zur Fachserie 11, Reihe 1*.

(ii) Population aged 10-19 by state and year: State Statistical Offices.

Table 3 Average Advanced School Participation Rates before and after the Abolition of School Fees by State

Cohort	All	S. Hol.	Ham-burg	L. Sax.	Bre-men	NRW	Hesse	R.Pa-latin.	B. Württ.	Bava-ria	Saar-land	Berlin
Fee	0.08	0.08	0.12	0.08	0.07	0.08	0.08	0.08	0.09	0.07	0.07	0.15
No fee	0.21	0.17	0.33	0.19	0.20	0.22	0.23	0.18	0.21	0.17	0.16	0.29
Abs. Diff.	0.12	0.09	0.21	0.11	0.13	0.14	0.15	0.09	0.12	0.10	0.08	0.14
Rel. Diff.	1.51	1.18	1.80	1.50	2.03	1.67	2.01	1.15	1.30	1.49	1.09	0.96

Note: 1. The cohort group "fee" describes the average Advanced School participation of a state's population born between 1930 and the last cohort that had to pay the fee (the "pre" group of Table 1). The cohort group "no fee" describes the average Advanced School participation of a state's population born as the first cohort not having to pay a fee up until 1965 (the "post" group of Table 1).

2. Abs.Diff. describes the percentage point difference between the two averages, Rel.Diff describes the percent increase in average participation rates: (Abs.Diff / Fee) - 1.

Source: Own calculations based on Mikrozensus data 1989, 1993, 1997.

Table 4 Estimation and Simulation Results - Logit on Advanced School Enrollment Original Sample

	1		2		3		4	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
A: Estimation Results								
pre (reference)	-	-	-	-	-	-	-	-
β_1: trans	0.099	0.016**	0.261	0.132**	0.793	0.017**	-0.566	0.438
β_2: post	0.177	0.018**	0.723	0.082**	0.154	0.020**	0.732	0.113**
γ: cohort	0.043	0.001**	-	-	-	-	-	-
γ_1: pre * cohort	-	-	0.054	0.002**	-	-	-	-
γ_2: trans * cohort	-	-	0.049	0.003**	-	-	-	-
γ_3: post * cohort	-	-	0.041	0.001**	-	-	-	-
δ: state FE (10)	yes	**	yes	**	yes	**	yes	**
γ^o: state * cohort (11)	-	-	-	-	yes	**	-	
γ_j^o: state * cohort * (pre/trans/post) (33)	-	-	-	-	-	-	yes	**
α: constant	yes	**	yes	**	yes	**	yes	**
Log Likelihood	-221,305.1		-221,280.0		-221,181.6		-221,132.1	
B: Simulation of Enrollment Change from Pre to Post Cohorts								
Fee effect - Full sample	16.3%		12.4%		14.5%		10.1%	
Fee effect - Females	18.4%		16.3%		16.4%		11.5%	
Fee effect - Males	16.4%		10.8%		15.0%		10.1%	
C: Simulation of Enrollment Change from Trans to Post Cohorts								
Fee effect - Full sample	6.8%		8.2%		6.7%		5.8%	
Fee effect - Females	11.1%		12.2%		10.9%		11.4%	
Fee effect - Males	4.8%		6.6%		4.7%		3.7%	

Notes:

1. **, * indicate statistical significance at the 5 and 1 percent level, respectively.
2. The figures in parentheses in the first column represent the number of coefficients estimated for the particular group of covariates.
3. The full sample fee effect is based on the above represented coefficient estimates. The model was reestimated for the 2 sexes to generate the predictions for males and females.
4. The simulations provide the percent increase in the predicted probability of Advanced School attendance for youth in a state-specific "index" cohort and averaged across states: In Panel B the index cohort was born in the middle of the trans-group, in Panel C the index cohort was born 10 years before the fee abolition, theoretically being the first to choose Advanced School enrollment without fee. For those index cohorts we predicted the hypothetical probability of Advanced School enrollment if they were part of the post, trans or pre group. The fee effect is the average of the following expression over all sample observations (and states):
   Panel B: [Pr (S=1 | index cohort, post =1) / Pr (S=1 | index cohort, pre =1)] - 1
   Panel C: [Pr (S=1 | index cohort, post =1) / Pr (S=1 | index cohort, trans =1)] - 1
5. The estimation on the full sample used 540,834 observations, the regressions for females and males 270,493 and 270,341 observations, respectively.

Source: Own calculations based on Mikrozensus data 1989, 1993, 1997.

Table 5 Estimation and Simulation Results - Logit on Advanced School Enrollment Modified Sample

	1		2		3		4	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
A: Estimation Results								
pre (reference)	-	-	-	-	-	-	-	-
β_1: trans	0.019	0.017	-0.806	0.125**	0.011	0.017	-1.328	0.433**
β_2: post	0.099	0.022**	-0.334	0.072**	0.097	0.022**	-0.080	0.099
γ: cohort	0.045	0.001**	-	-	-	-	-	-
γ_1: pre * cohort	-	-	0.037	0.002**	-	-	-	-
γ_2: trans * cohort	-	-	0.057	0.003**	-	-	-	-
γ_3: post * cohort	-	-	0.047	0.001**	-	-	-	-
δ: state FE (10)	yes	**	yes	**	yes	**	yes	**
γ^o: state * cohort (11)	-	-	-	-	yes	**	-	
γ_j^o: state * cohort * (pre/trans/post) (33)	-	-	-	-	-	-	yes	**
α: constant	yes	**	yes	**	yes	**	yes	**
Log Likelihood	-192,610.0		-192,578.8		-192,498.9		-192,431.4	
B: Simulation of Enrollment Change from Pre to Post Cohorts								
Fee effect - Full sample	8.9%		12.3%		8.9%		15.0%	
Fee effect - Females	11.9%		18.8%		11.7%		17.6%	
Fee effect - Males	8.2%		10.4%		8.3%		15.8%	
C: Simulation of Enrollment Change from Trans to Post Cohorts								
Fee effect - Full sample	7.1%		2.7%		7.7%		4.1%	
Fee effect - Females	12.5%		7.0%		13.3%		10.1%	
Fee effect - Males	4.9%		0.5%		5.5%		1.1%	

Notes:

1. **, * indicate statistical significance at the 5 and 1 percent level, respectively.
2. The figures in parentheses in the first column represent the number of coefficients estimated for the particular group of covariates.
3. The full sample fee effect is based on the above represented coefficient estimates. The model was reestimated for the 2 sexes to generate the predictions for males and females.
4. The simulations provide the percent increase in the predicted probability of Advanced School attendance for youth in a state-specific "index" cohort and averaged across states: In Panel B the index cohort was born in the middle of the trans-group, in Panel C the index cohort was born 10 years before the fee abolition, theoretically being the first to choose Advanced School enrollment without fee. For those index cohorts we predicted the hypothetical probability of Advanced School enrollment if they were part of the post, trans or pre group. The fee effect is the average of the following expression over all sample observations (and states):
   Panel B: [Pr (S=1 | index cohort, post =1) / Pr (S=1 | index cohort, pre =1)] - 1
   Panel C: [Pr (S=1 | index cohort, post =1) / Pr (S=1 | index cohort, trans =1)] - 1
5. The estimation on the full sample used 493,118 observations, the regressions for females and males 248,659 and 244,459 observations, respectively.

Source: Own calculations based on Mikrozensus data 1989, 1993, 1997.

Table 6 Simulation Results based on in Estimations with Income Controls
Predicted Fee Effect in Percent

Specification:	1	2	3	4
Original Sample (N = 540,834)				
Simulation of Enrollment Change from Pre to Post Cohorts				
Full sample	13.8%	12.8%	9.3%	9.9%
Females	18.0%	16.3%	14.0%	11.8%
Males	12.2%	11.3%	7.7%	9.3%
Simulation of Enrollment Change from Trans to Post Cohorts				
Full sample	7.5%	8.1%	7.1%	5.6%
Females	11.3%	12.4%	11.0%	11.3%
Males	5.9%	6.2%	5.6%	3.3%
Modified Sample (N = 493,118)				
Simulation of Enrollment Change from Pre to Post Cohorts				
Full sample	8.6%	13.3%	6.5%	12.7%
Females	13.5%	19.8%	10.5%	16.7%
Males	7.0%	11.9%	5.3%	12.3%
Simulation of Enrollment Change from Trans to Post Cohorts				
Full sample	8.3%	3.2%	9.3%	4.4%
Females	12.8%	7.4%	13.9%	10.3%
Males	6.9%	1.0%	8.2%	1.6%

Notes: See Table 4.

Source: Own calculations based on Mikrozensus data 1989, 1993, 1997.

Table 7 State-Specific Annual Immigration per 1000 Population from within Germany and Predicted Fee Effects

	50	55	60	65	70	75	80	85	90	95	Mean	Effect
Bad.-W.	28.2	20.5	19.1	19.6	17.5	11.7	12.7	10.5	13.8	11.3	16.5	0.066
Bavaria	6.3	10.3	13.6	14.0	14.2	9.9	10.3	8.2	10.0	10.7	10.8	0.070
Berlin	-	-	-	26.8	31.1	15.0	16.0	21.2	9.8	10.2	18.6	0.063
Bremen	44.6	42.3	42.6	37.6	36.0	32.9	33.4	23.7	28.9	30.3	35.2	0.070
Hamburg	40.8	32.4	30.8	30.0	30.7	28.4	25.4	22.8	27.5	29.0	29.8	0.061
Hessen	17.7	19.8	22.4	24.9	23.9	16.9	16.9	11.5	15.6	15.8	18.5	0.069
L.- Saxony	10.2	14.8	18.9	19.8	20.6	16.4	16.5	11.3	13.6	16.3	15.8	0.067
NRW	17.2	17.4	11.9	11.9	11.9	8.3	7.7	6.2	9.3	8.2	11.0	0.066
R-Palatinate	43.3	20.5	23.4	24.9	24.1	18.4	19.9	14.3	19.2	19.3	22.7	0.067
Saarland	-	-	17.4	16.0	15.6	12.8	13.5	8.8	12.0	10.5	13.3	0.069
S.-Holstein	12.1	18.4	29.4	32.2	31.7	24.8	23.9	20.0	20.3	22.8	23.6	0.069
Germany	17.4	16.4	16.9	18.5	18.3	13.2	13.3	10.5	10.5	12.8	19.6	0.067

Note: 1. The immigration figures describe the total number of individuals newly taking residence in a given state and coming from another German state, relative to the state's population for any given calendar year. Figures are not available for the early years for the states Berlin and Saarland.

2. The column "Mean" presents the average immigration rates by state for years described in prior columns.

3. The column "Effect" describes the state-specific predicted fee effect, based on model 3 in Table 4.

Source: Immigration data: Federal Statistical Office.
Fee Effect: Own calculations based on Mikrozensus data 1989, 1993, 1997.

Table 8 Estimation and Simulation Results - Logit on Advanced School Enrollment

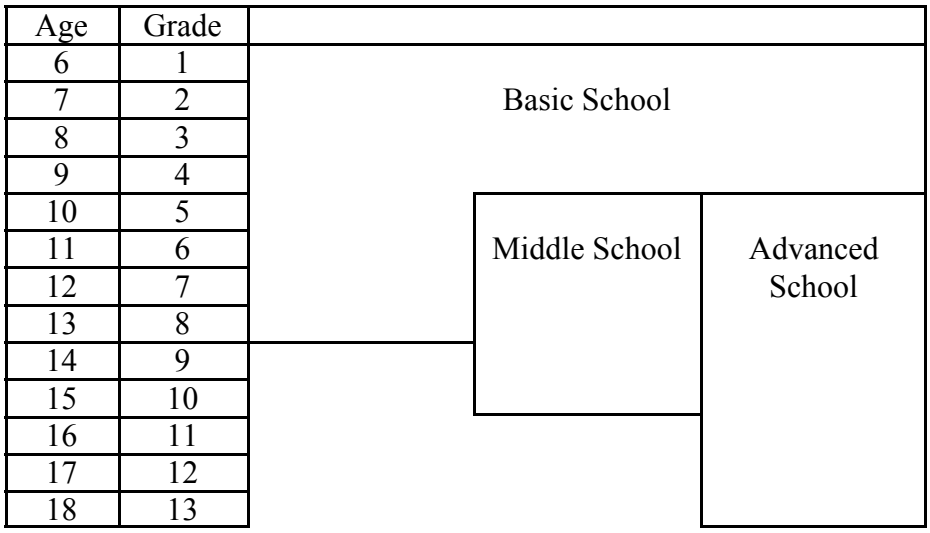
	1		2		3		4		5		6	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
A: Estimation Results (Original Sample)												
income ratio	-1.63	0.293**	-1.08	0.201**	-1.16	0.201**	-0.81	0.194**	-0.51	0.22*	-0.71	0.243**
state gdp p.c.	yes	**	yes		yes	*	yes	**	yes	**	yes	**
cohort	yes	**	yes	**	yes	**	-		-		-	
cohort^2	-		yes	**	yes	**	-		-		-	
cohort^3	-		-		yes	**	-		-		-	
state FE * cohort (10)	-		-		-		yes	**	yes	**	yes	**
state FE * cohort^2 (10)	-		-		-		-		yes	**	yes	**
state FE * cohort^3 (10)	-		-		-		-		-		yes	**
state FE (9)	yes	**	yes	**	yes	**	yes	**	yes	**	yes	**
α: constant	yes	**	yes	**	yes	*	yes	**	yes	**	yes	
Log Likelihood	-217890.6		-217887.9		-217870.5		-217751.62		-217736.7		-217695. 5	
B: Simulation of change in income ratio from 10 to 5 percent (Original Sample)												
Fee effect - Full sample	5.4%		4.5%		4.8%		3.4%		2.1%		3.0%	
Fee effect - Females	6.9%		4.7%		5.4%		4.9%		2.1%		2.9%	
Fee effect - Males	4.8%		4.1%		4.3%		2.8%		2.0%		3.0%	
C: Simulation of change in income ratio from 10 to 5 percent (Modified Sample)												
Fee effect - Full sample	0.6%		5.3%		4.7%		-0.1%		4.5%		3.6%	
Fee effect - Females	1.4%		6.6%		5.7%		0.4%		4.9%		3.6%	
Fee effect - Males	-0.1%		4.7%		4.0%		-0.7%		4.6%		3.6%	

Notes:
1. **, * indicate statistical significance at the 5 and 1 percent level, respectively.
2. The figures in parentheses in the first column represent the number of coefficients estimated for the particular group of covariates.

3. The estimation on the original full sample used 530,986 observations, the regressions for females and males 265,535 and 265,451 observations, respectively. In the modified sample there are 483,733 observations in total of which 243,924 are female and 239,809 are male.
4. Each fee effect is estimated using sample-specific coefficient estimates.
5. The simulations provide the percent increase in the predicted probability of Advanced School attendance for youth comparing a scenario where 10 and 5 percent of incomes are to be paid for school fees. The predicted individual enrollment rates in both scenarios are averaged over the sample yielding in both panels: [Pr (S=1 | income ratio = 0.05) / Pr (S=1 | income ration = 0.01)] - 1

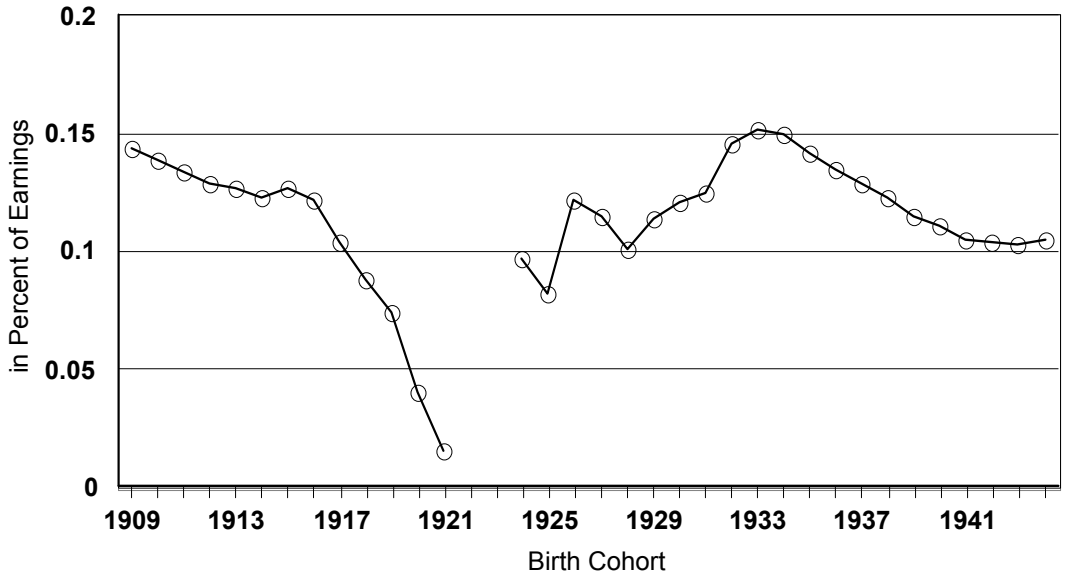
Source: Own calculations based on Mikrozensus data 1989, 1993, 1997.

Figure 1 Sketch of the traditional German schooling system



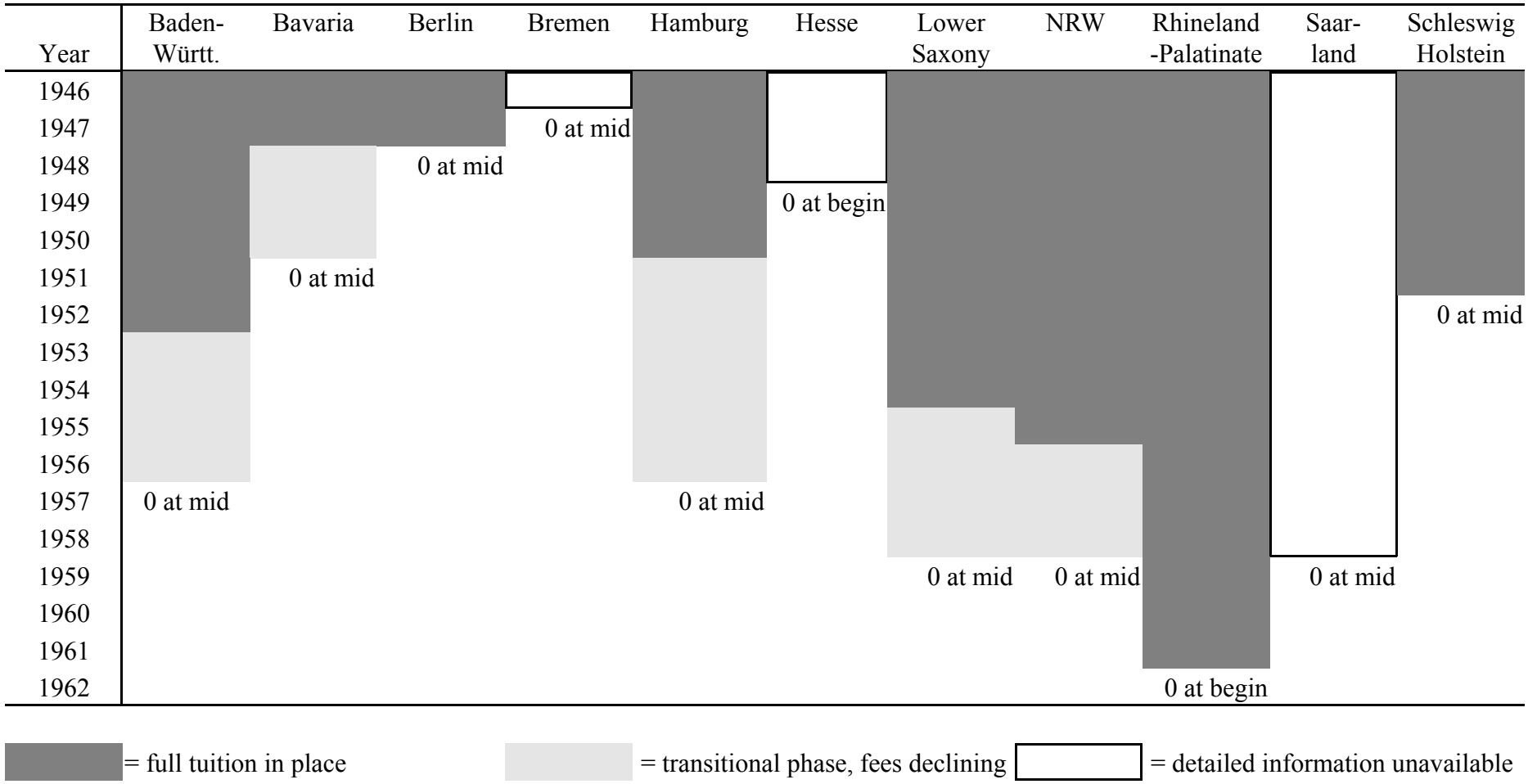
Source: Own presentation

Figure 2 Prussian School Fees for Advanced Schools as Share of Average Earnings



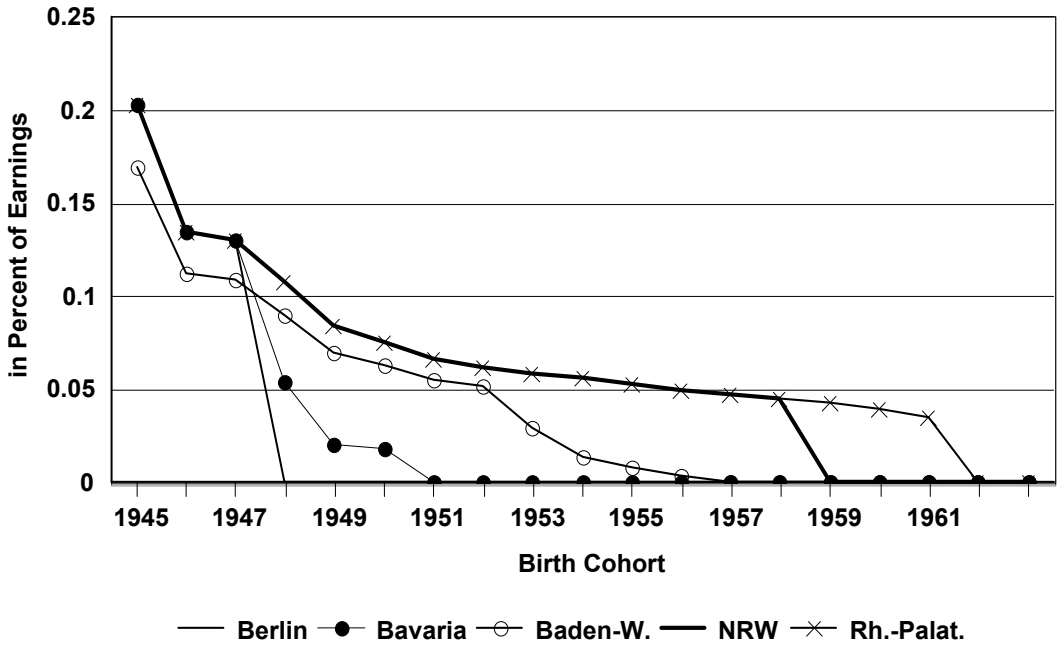
Source: (i) Earnings data from retirement insurance statistics (annual average gross earnings: www.bfa.de 2001).
(ii) Tuition fees from various sources (Benatzky 2001).

Figure 3 State-Specific Patterns of Tuition Abolition



Source: Own graphical representation of fee information in Benatzky (2001).

Figure 4 School Fees for Advanced School as Share of Average Earnings (Selected States)



Source: Earnings data from retirement insurance statistics
Tuition fees from various sources (Benatzky, 2001).

Figure 5 Representation of Fee Effects

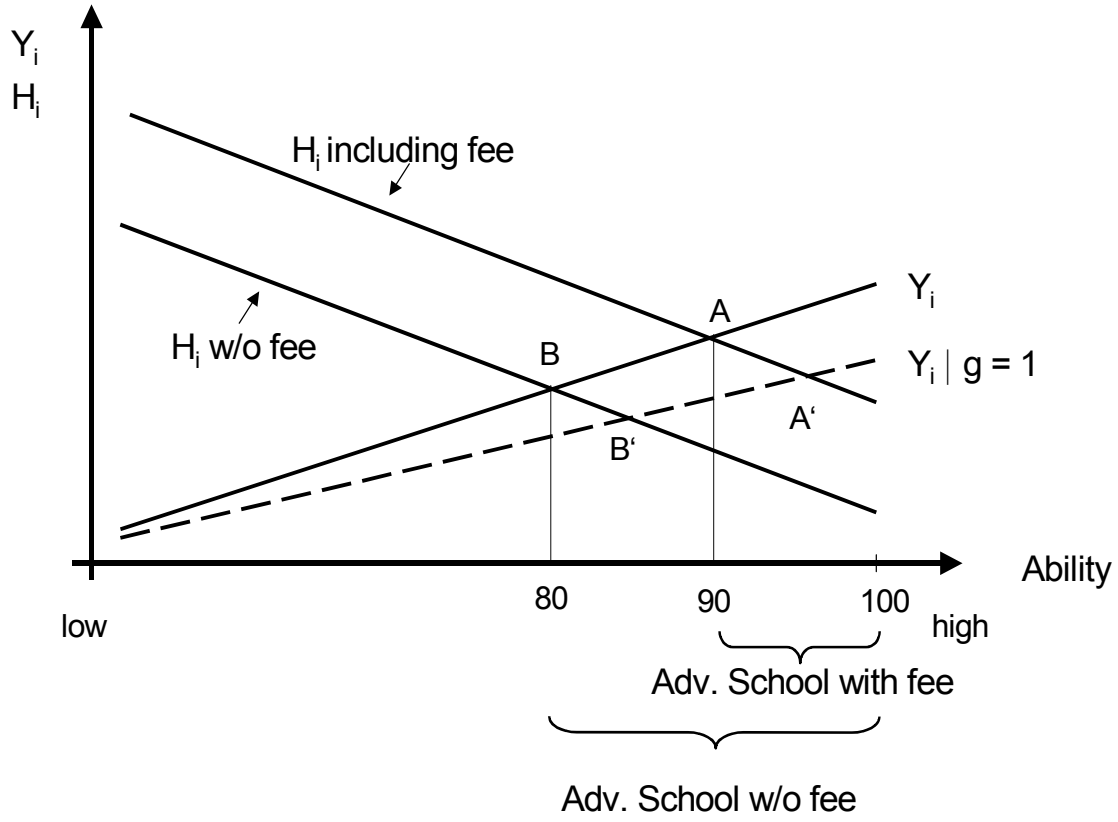
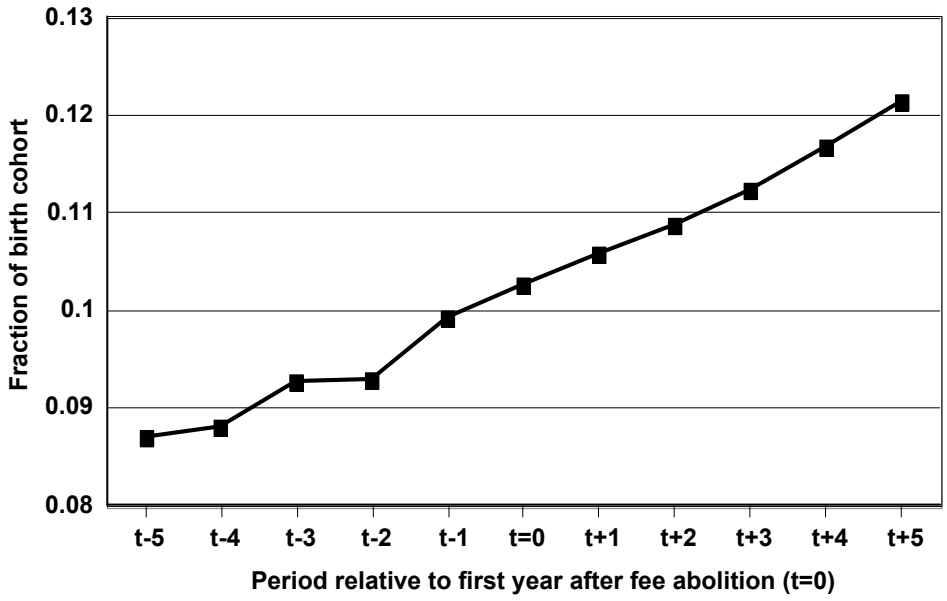


Figure 6 Aggregate Demography-Corrected Enrollment Development Around the Abolition of School Fees



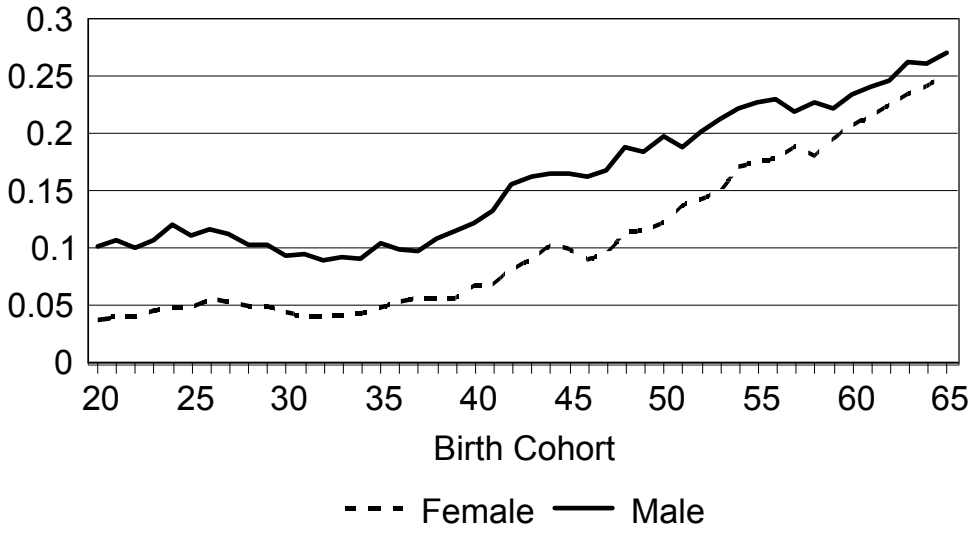
Note: The line represents the average development for the six states described in Table 2. For every state the index "t=0" was set to the first year after the abolition of school fees.

Source:

(i) Pupils in Advanced School by state and year: Federal Statistical Office, *Zeitreihen zur Fachserie 11, Reihe 1*

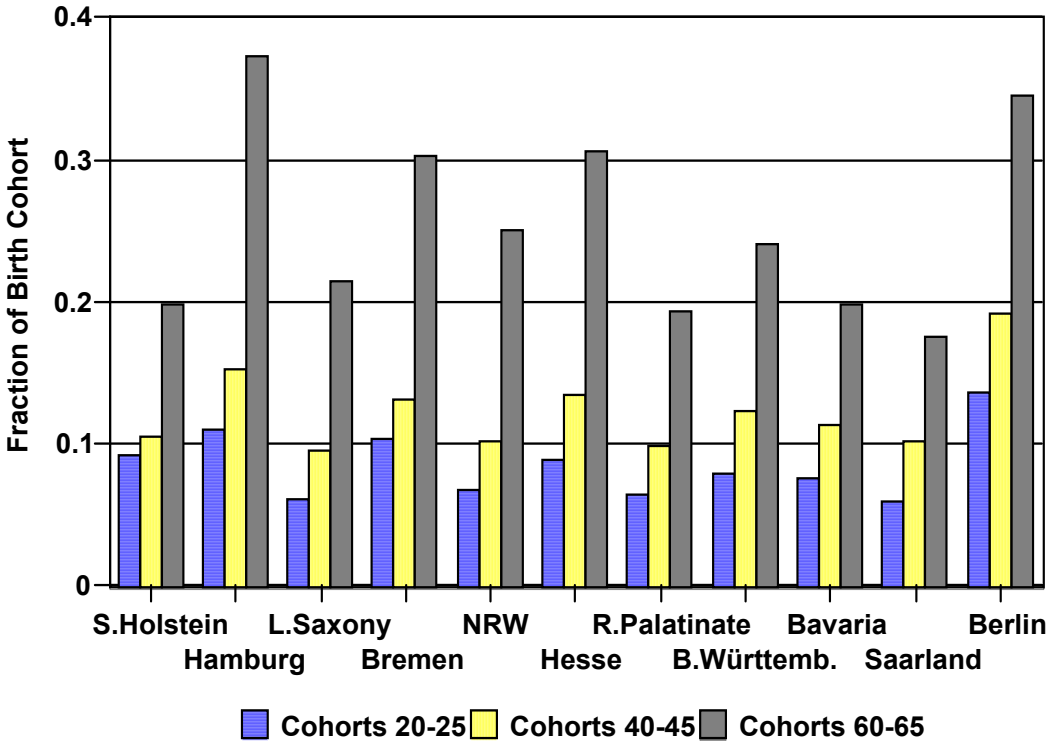
(ii) Population aged 10-19 by state and year: State Statistical Offices.

Figure 7 Population Shares with Advanced School Degree by Birth Cohort



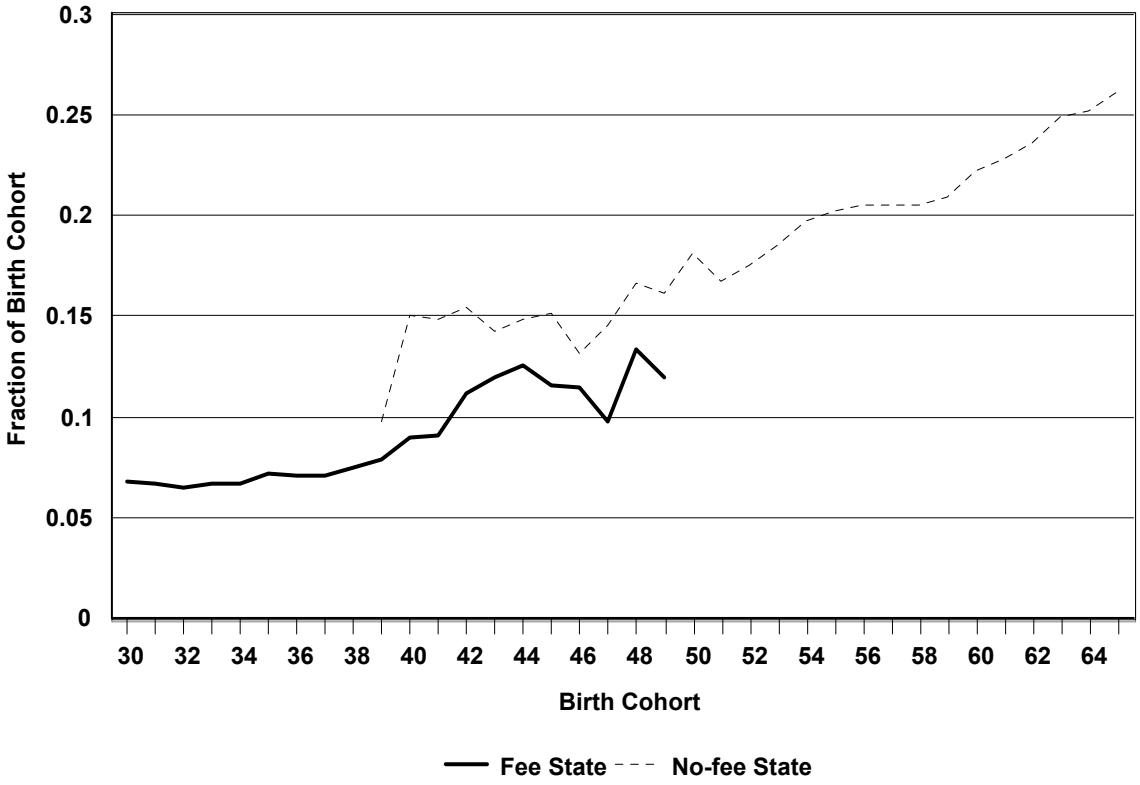
Source: Own calculations based on Mikrozensus data 1989, 1993, 1997.

Figure 8 State-specific Advanced School Participation by Birth Cohort



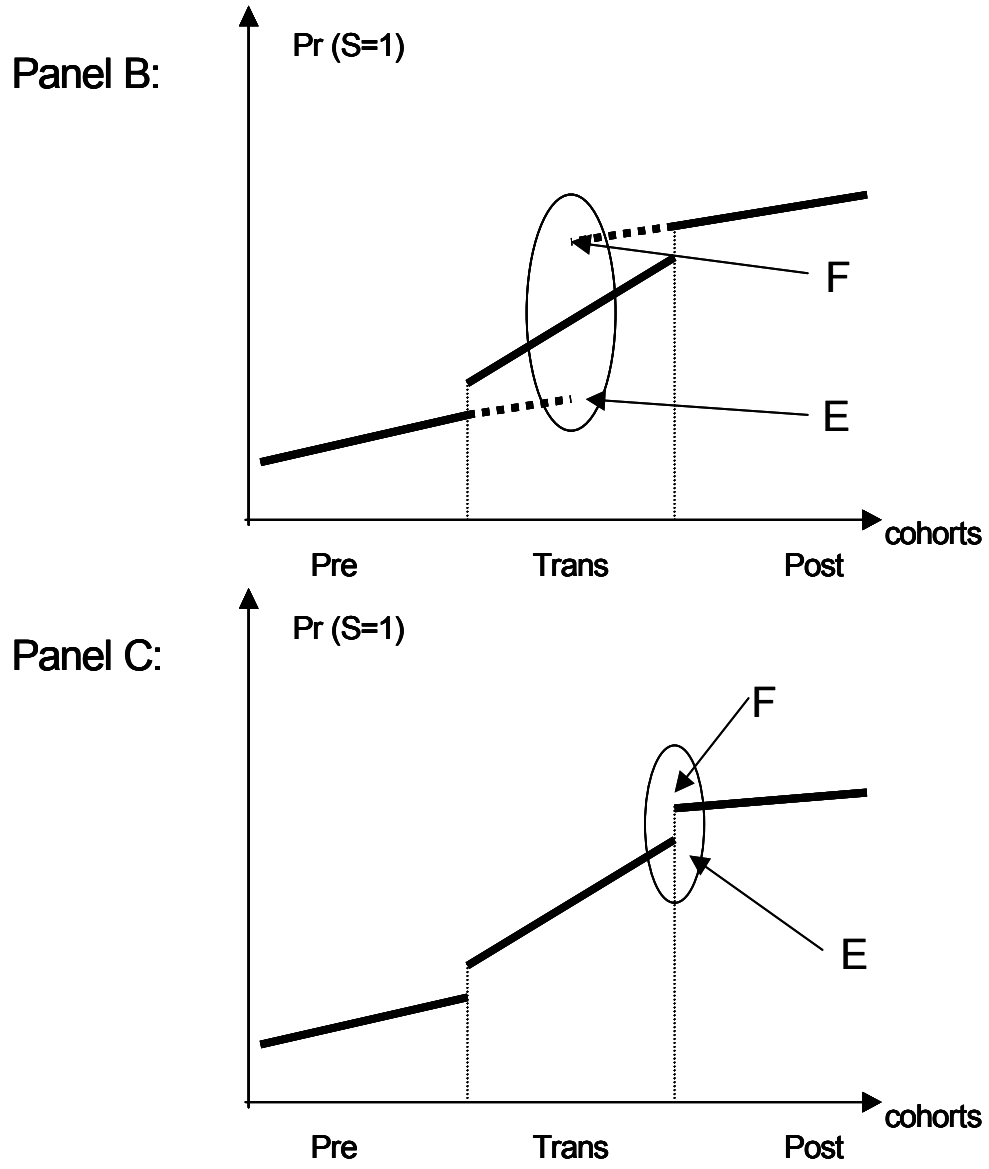
Source: Own calculations based on Mikrozensus data 1989, 1993, 1997.

Figure 9 Advanced School Participation by Fee Status of State
(Reflects enrollment of pre and post cohort groups)



Source: Own calculations based on Mikrozensus data 1989, 1993, 1997.

Figure 10 Illustration of Simulation Experiments



Note: 1. The simulation experiments calculate the predicted enrollment differences between points E and F.

2. The depicted cohort group splines directly represent the specification of the second estimation approach (model 2). In model 4 the three cohort-group splines are estimated separately by state.

Appendix A: Assignment of Cohorts to Historic Groups

(1) Based on the state fee development we distinguish three groups of cohorts based on whether they had to pay fees at the point of entry to Advanced School (fifth grade):
- Cohorts, which certainly did not pay a fee ("pre" group)
- Cohorts, for which we cannot be sure ("trans" group)
- Cohorts, which certainly had to pay a fee ("post" group)

(2) Example: Baden Württemberg, fee abolished in 1957.

Entry age to Basic School: Earliest 5, regular 6, late 7.
Transfer to Advanced School: Earliest 9, regular 10, late 12 (e.g. with one repeat year).

Cohorts 1949 and later certainly did not have to pay a fee ("post").
Cohorts 1944 and prior certainly had to pay fee ("pre").
Cohorts 1945 - 1948 are in a transition period ("trans").

(3) Same procedure for each state.

(4) Exceptions are granted for four states, which abolished fees early (Bavaria 1951, Berlin 1948, Bremen 1947, and Hesse 1949). The educational biographies were at times strongly affected by the war (e.g. no schools operating, refugees transferred between available school types, additional repeat classes due to general stress). Since the war may have delayed entry to the Gymnasium for some cohorts we shift one additional cohort from "with fee" to "transition" for these states. The last cohort certainly paying a fee is calculated based on the assumption that entry to Advanced School took place by the latest at age 12.

Appendix B: Simple Theoretical Framework

Here we derive the effect of changes in C (the direct cost of schooling) as well as of different returns to education and ability that may exist for the two sexes on the propensity to attend Advanced School (S*) as well as on the critical ability level (A*) beyond which school enrollment appears preferable (see Figure 5).

Given

(1) $S_i^* = Y(S_i , A_i; \mu_i) - H (S_i , A_i, C; \nu_i)$

with Y the discounted utility of lifetime earnings and H the discounted disutility connected to Advanced School participation. Let both depend on school enrollment (S_i) where we assume an increasing concave function for Y and an increasing convex function for H. Both may also vary with a pupil's ability (A), which may yield higher earnings advantages and lower disutility from additional schooling. C represents the cost of Advanced School participation which is positively correlated with the utility loss due to school participation. μ_i and ν_i are person-specific effects.

If we chose the simplest linear specification:

(2) $Y_i = \mu_i + b_1 S_i + b_2 A_i$ with $b_1 , b_2 > 0$

(3) $H_i = \nu_i + c_1 S_i + c_2 A_i + C$ with $c_1 > 0$ and $c_2 < 0$

we obtain

(4) $S_i^* = (\mu_i - \nu_i) + (b_1 - c_1) S_i + (b_2 - c_2) A_i - C$

$$+ \quad + \quad - \quad +$$

and it follows immediately $S^* = S^* (b_1 , b_2 , C, \mu)$.

Also it follows that in this model higher ability individuals obtain more schooling. To evaluate the determinants of the 'critical ability level' (A*) beyond which school enrollment appears preferable, we solve (2) and (3) for :

(5) $A^* = b_1 / (c_2 b_1 - c_1 b_2) [H_i - \nu_i - (c_1 / b_1) Y_i + (c_1 / b_1) \mu_i - C]$.

$$? \quad - \quad + \quad -$$

Now we can derive $A^* = A^* (b_1 , b_2 , C, \mu)$.

(where $\partial A^* / \partial b_1 < 0$ if $b_1 > 1$, which we do not know).

These results support the hypothesis that higher returns to ability and possibly to schooling are correlated with a higher propensity to attend Advanced School and a lower critical ability level. Also, individuals with high 'person-specific earnings effects' have a higher propensity to attend Advanced School and a lower critical ability level. The gender wage gap might be an example of differences in average person-specific earnings effects.

Appendix C: Data for the Analysis of Fee Change Effects

	-45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62+
Bad.-W.	240	200	200	200	200	200	200	200	120	60	40	20	0	0	0	0	0	0
Bavaria	240	*240*	*240*	120	60	60	0	0	0	0	0	0	0	0	0	0	0	0
Berlin	240	160	80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bremen	240	*120*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hamburg	240	240	240	240	240	240	205.7	171.4	137.1	102.9	68.57	34.29	0	0	0	0	0	0
Hessen	240	*120*	*60*	*30*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
L.- Saxony	240	*240*	*240*	*240*	*240*	*240*	*240*	180	180	180	144	108	72	36	0	0	0	0
NRW	240	240	240	240	240	240	240	240	240	240	240	240	240	240	0	0	0	0
R-Palatinate	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	0
Saarland	240	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	0	0
S.-Holstein	240	*240*	*240*	*240*	*240*	*240*	*240*	0	0	0	0	0	0	0	0	0	0	0

Source: Based on Benatzky (2001).

Notes: 1. The figures for Baden-Württemberg represent the situation in the region of *Südbaden*.
2. Figures in italics are added based on plausibility assumptions.
3. Observations for Saarland are dropped from the analysis.