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Assessing the cumulative impact of primary and secondary effects on the way from elementary to tertiary education. A simulation study for Germany

Schindler, S.

Equalsoc Working Paper
2010 / 2

Assessing the cumulative impact of primary and secondary effects on the way from elementary to tertiary education

A simulation study for Germany

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Abstract:
The distinction of primary and secondary effects of social background on educational attainment, which has been introduced by Boudon (1974), has received a lot of attention recently. Primary effects are influences of social background on school performance and secondary effects are influences of social background on educational decisions even if performance is held constant. Erikson et al. (2005) have provided a method to empirically evaluate the impact of primary and secondary effects at educational transitions. In this paper I draw on this method and extend it to a sequential consideration of transitions from elementary school to higher education enrolment in Germany. Furthermore, I provide an example of how different data sources can be combined for this purpose when biographical data on educational careers is absent. Following the primary and secondary effects framework I simulate the cumulative impact of interventions at different branching points of the education system and evaluate the counterfactual outcomes against the factual situation. The results reveal that interventions at early branching points are more effective than late interventions. They suggest further that measures that are targeted at reducing primary effects are effective in retaining performance levels but only moderately effective in increasing educational participation rates. Measures that are targeting at a reduction of secondary effects are effective in increasing participation rates but lead to a devaluation of performance levels.

Introduction

Visitors of conferences on educational inequality or readers of journals in the field of sociology of education might have noticed (and even been wondering about) an increasing, almost inflationary number of papers that are dealing with so called ‘primary and secondary effects’ of social origin recently (cf. e.g. Contini et al. 2008; Erikson 2007; Erikson and Rudolphi 2010; Jackson et al. 2007; Kloosterman et al. 2009; Schindler and Reimer 2008; Stocké 2007). In most of these cases the concept of primary and secondary effects is being traced back to the influential publication “Education, Opportunity, and Social Inequality” by French sociologist Raymond Boudon (1974). In this book, he makes the distinction between social background effects that stem from differences in cultural resources (primary effects) and social background effects that emanate from differences in educational aspirations. Both types of effects are considered to contribute to socially selective participation patterns at different stages of the educational career. Primary effects are related to different kinds of cultural resources in the family that support their offspring in meeting the requirements of school. Since students from lower status families can rely on less cultural resources than their classmates from higher status families, their school achievement will on average be lower than that of their peers. At the same time, even if we were to compare students with the same achievement levels, we could observe additional (secondary) social background effects in that students from higher status families would aspire to higher levels of education more often than their lower status counterparts. Social differences in educational aspirations are seen as the outcome of cost-benefit considerations, while both the costs and benefits attached to continuing education differ between social backgrounds. Following Boudon, the benefit of continuing education should be much higher for students from higher status families, since it reduces the risk of social demotion, whereas status reproduction can be achieved for lower status offspring at lower levels of education already. As regards the costs, Boudon considers both monetary and social costs as influential parameters which stimulate high status students to continue education and lower status students to leave the education system at earlier levels. Hence, secondary effects can be seen as cost-benefit considerations that must be understood relative to social background.

Boudon’s contribution can be seen in spelling out (in an internationally received publication) an analytical framework which integrates two approaches that have regarded educational inequality from different angles thitherto, namely “cultural theory” (primary effects) and "value/social position theory" (secondary effects).[1] However, he was not the first to make the analytical distinction between the two types of effects. Ichou and Vallet (forthcoming) cite a French article by Girard and Bastide (1963) that already distinguishes between "la première cause" and "la seconde cause de non-démocratisation". Furthermore, according to Erikson and Rudolphi (2010), the distinction between performance and educational choices net of performance also appears in earlier works of Swedish researchers Gunnar Boalt (1947) and Kjell Härnqvist (1958).

Apparently, the concept of primary and secondary effects has been there already for quite a long time. So how come that we experience such a mushrooming of publications on the topic nowadays? First, an important trigger could be the increasing availability of empirical data that – apart from measures of social background and school decisions – include some kind of indicator of school performance or aptitude. Second, analytical methods have become available that claim to be able to separate primary from secondary effects in empirical data. The most seminal contribution in this respect is the working paper by Erikson and colleagues (2005) or the subsequent journal article by Jackson et al. (2007). The idea behind the method described in these papers is to determine the relative importance of primary and secondary effects for any given educational transition.

In this paper, I also draw on the rationale of this method. However, my purpose is not to calculate the relative impact of primary and secondary effects for single transition points in the German education system. I admit that this would be an interesting venture as well, but it has been done already (Neugebauer 2010; Relikowski et al. 2009; Schindler and Reimer 2010). Rather, my interest is directed to the impact that primary and secondary effects have for the whole educational career. I will address this by means of a simulation procedure that also seeks to find viable solutions to the rather severe problem of shortcomings in the German data landscape. How I am going to master this ambitious endeavour will be spelled out in more detail in the remainder of this paper.

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[1] Odd enough, in the scientific debate on educational inequality Boudon is often cited as proponent of the rational choice framework, which in most cases is regarded as a competing theory to culturalist approaches, most prominently represented by the work of Pierre Bourdieu. Following the debates that are being repeated over and over again at conferences and in publications one might get the impression that there are two ideological camps – people either subscribe to Boudon *or* Bourdieu. However, in my reading of Boudon's 1974 book, I clearly see an attempt of integrating both approaches (cf. Boudon 1974: 31).

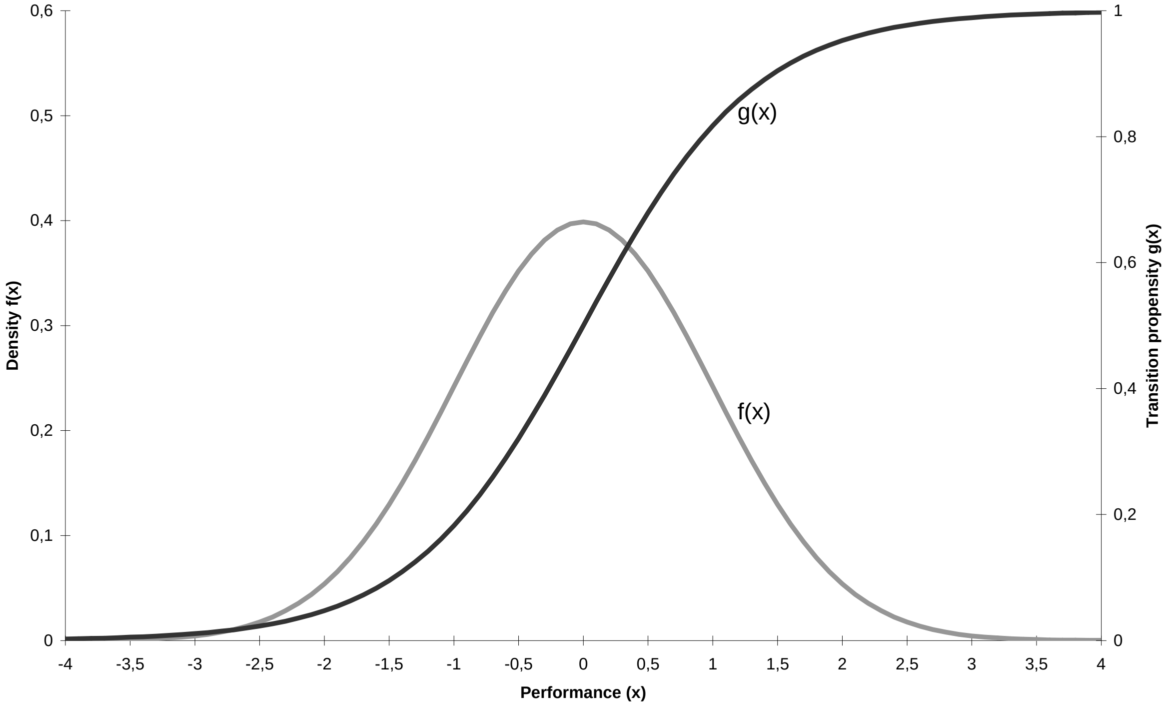
The methodological separation of primary and secondary effects

The method proposed by Erikson and colleagues (2005) starts from an assertion made by Erikson and Jonsson (1996), according to which the proportion *P* of a given class *j* that is making the transition to the next educational level, can be expressed by the function

$$P_{jj} = \int f_j(x)\, g_j(x) dx \qquad \text{(1a)}$$

where $f_j(x)$ describes the distribution of a given performance measure *x* and $g_j(x)$ denotes the conditional transition probability at any specific performance level *x* (cf. Figure 1). Erikson and Jonsson (1996) model the integral by assuming a normal distribution for the performance measure and a logistic function for the transition probabilities. However, according to Buis (2010), the assumption of normally distributed performance values can be relaxed and be replaced by the empirical distribution instead.

Figure 1: Hypothetical performance distribution and transition function



The division into the two components of performance distribution and conditional transition propensity mirrors the distinction of primary and secondary effects and it opens the way for counterfactual considerations. It is now possible to substitute either the performance distribution or the transition function of class *j* with the respective function of any other class *k*:

$$P_{jk} = \int f_j(x)\, g_k(x) dx \qquad \text{(1b)}$$

$$P_{kj} = \int f_k(x)\, g_j(x)dx \qquad (1c)$$

where the first subscript of P indicates the class whose performance distribution is underlying the prediction and the second subscript indicates the class whose transition function is applied, respectively.

Following the method proposed by Erikson et al. (2005), the relative impact of primary and secondary effects can be determined by utilizing the counterfactuals from (1b) and (1c) to explain the gap between class *j* and class *k* in the proportions that are making the transition.

This is done as follows:

The odds ratio *(OR)* of the transition proportions *P* between class *j* and class *k* can be written as

$$OR_{jj.kk} = \frac{P_{jj}/(1-P_{jj})}{P_{kk}/(1-P_{kk})} \qquad (2a)$$

Now, the transition propensity of one class is being manipulated by substituting it through one of the counterfactuals:

$$OR_{jj.kj} = \frac{P_{jj}/(1-P_{jj})}{P_{kj}/(1-P_{kj})} \qquad (2b)$$

In this case, the conditional transition behaviour of class *k* is being replaced by that of class *j*. Consequently, the remaining differences in the odds between the two classes are exclusively due to differences in the performance distributions, or in other words, the odds ratio now describes pure primary effects.

If we want to insulate secondary effects, respectively, class *k*'s performance distribution has to be replaced:

$$OR_{jj.jk} = \frac{P_{jj}/(1-P_{jj})}{P_{jk}/(1-P_{jk})} \qquad (2c)$$

The relative importance of primary or secondary effects is then calculated by determining the ratio between the logarithms *L* of the counterfactual odds ratios and the real overall odds-ratios in the transition propensities between the classes.

Thus, the relative impact of secondary effects can be calculated as

$$\frac{L_{jj.jk}}{L_{jj.kk}} = \frac{log(OR_{jj.jk})}{log(OR_{jj.kk})} \qquad (3a)$$

or

$$\frac{L_{kj.kk}}{L_{jj.kk}} = \frac{log(OR_{kj.kk})}{log(OR_{jj.kk})} \qquad (3b)$$

However, formulas 3a and 3b lead to slightly deviating results. Therefore, Jackson et al. (2007) propose to take the averages of both values.

It is debatable whether this method is able to really separate primary from secondary effects in a strict sense. It very much depends on how one defines, and moreover, operationalizes the primary effects component. Further, the method assumes that any effects that are not by definition "primary" are necessarily "secondary effects", that is to say, based on choice (according to Boudon's distinction). This might be problematic for some education systems that impose institutionalized constraints on educational transitions. One example would be the transition from primary to secondary education in Germany, where some federal states implemented binding teacher recommendations for subsequent school tracks, which limit the choice component for parents (and hence, the scope for secondary effects) but rather introduce a new actor (teacher) to the educational placement process. Another problem, which has already been acknowledged by the authors of the method, is a potential correlation of primary and secondary effects. Jackson et al. (2007) discuss the bias which can be introduced by anticipatory educational decisions, that can result in an overestimation of primary effects. They argue that, when lower class students already know long in advance to the next educational transition that they do not want to proceed with the next educational level, it might be the case that they start to care less about their school performance and become less ambitious to get good grades. In this case, secondary effects (not wanting to proceed in education) would have a precedent effect on primary effects (school performance). Thus, any measure of performance at the time of the next transition would necessarily include some secondary effects element. On the other hand, one could also assume that primary effects are influenced by secondary effects. High educational aspirations might lead to enhanced efforts to do well at school. To sum up, the empirical separation of primary and secondary effects might be sensitive to unobserved factors that bias their measured impact (cf. the critical discussion of exogenous factors in Morgan et al. forthcoming). Notwithstanding these and potential other limitations of the method, I regard it as an informative tool that can by and large provide valuable insights into the major mechanisms that are operating at educational branching points and which result in social selectivities that might be subject to political interventions.

The decomposition method has been applied in different countries for various educational transitions.[2] All of the applications have in common that they describe the relation of primary

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[2] It is not the aim of this paper to summarize or discuss the findings in an internationally comparative perspective. For those who are interested in the results anyway, I would like to provide at least the references. For the UK, the study of Jackson et al. (2007) is dedicated to the transition to A-level-courses; for Sweden, the papers by Erikson (2007) and Erikson and Rudolphi (2010) deal with the transition to upper secondary education; for the Netherlands, Kloosterman et al. (2009) investigate trends in the transition to higher upper secondary education; for Germany, Neugebauer (2010) decomposes primary and secondary effects for the transition from primary school to the upper secondary school track, and the paper by Schindler and Reimer (2010) is dedicated to the transition from upper secondary to tertiary education. In addition to the single country

and secondary effects for at least one educational transition in a given country. But regarding single transitions – as informative as it can be – is always a partial description of the education system. And the further one proceeds in the educational career the more likely it is that the population which is at risk to make another transition is a selected population. For example, the transition from upper secondary to tertiary education in Germany comprises only those successful students that managed to reach the upper secondary degree. Investigating on primary and secondary effects in the next transition for this particular group is – no doubt – interesting in itself. But it would be even more interesting if one could take into account all the primary and secondary effects that preceded the selection of this group, so that we were able to draw a more or less complete picture of the role of both effect types in the entire educational career across all transitions. This is the very task for the remainder of this paper. For this purpose I will abandon the idea of describing the impact of primary and secondary as percentages, as we shall see.[3] I think that it is more intuitive to display counterfactual participation rates as in formulas (1b) and (1c).

The cumulative impact of primary and secondary effects

This endeavour is to some degree inspired by a German study, conducted by Rolf Becker (Becker 2009). In his paper, Becker addresses the question how the comparatively low number of students from low educated backgrounds in higher education could be increased. Following the primary and secondary effects framework, he tries to simulate to what extent the selective neutralisation of either primary or secondary effects at a given educational transition point would result in an increase of the number of lower background students that would end up in higher education. He conducts simulations for the transition from primary education to the upper secondary-track (Gymnasium), for dropout from the Gymnasium and for the transition from upper secondary education to higher education enrolment, using different datasets for each transition. He finds that across all transitions a reduction of secondary effects would be more efficient in decreasing social inequalities than a reduction of primary effects. Further, the impact of neutralising primary or secondary effects for raising the number of working class students in higher education is found to be more pronounced the earlier the intervention

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studies, an internationally comparative edited volume is currently in preparation, which will contain chapters on the decomposition of primary and secondary effects in a series of European countries and the US (cf. Jackson forthcoming).

[3] Displaying the relative importance of primary and secondary effects can be misleading if the degree of inequality at any given transition is rather negligible.

is made. Although I consider the idea of investigating the cumulative impact of primary and secondary effects across various transitions very appealing, the study bares several shortcomings (most of which might be due to lacking availability of adequate data). The central critique that I raise is directed to the simulation technique and the way in which the cumulative impact of manipulating single transitions is deducted. For each transition, Becker displays a two-way table for the working classes and one for the middle classes. Each table contains their distribution over two or three categories of a performance measure (primary effects) and for each performance category the conditional transition propensity to the next educational level (secondary effects). Simulating the neutralisation of either primary or secondary effects is done by exchanging either the performance distribution or the conditional transition propensities of one class by that of the other. This equals the conceptual idea of the method by Erikson and colleagues with the exception that Becker uses a limited number of categories instead of continuous performance or transition curves. The cumulative impact of the manipulation of single transitions is deducted by multiplying the factual or counterfactual transition propensities for each of the three transitions, which results in a specific percentage of working class students that end up in tertiary education under the given counterfactual scenario. Since the transition propensities for those transitions that are not substituted with counterfactual transition rates remain unaltered, the method neglects the impact that manipulations at earlier transitions have on the composition of students that constitute the risk-set of any following transition. This shall be clarified with an example. Imagine we can observe strong primary and strong secondary effects in elementary school, e.g. lower class students are underperforming, and even when performance is held constant, they chose to proceed to the next educational level at much lower rates than their upper class counterparts.

Table 1: Consequences of neutralisation of secondary effects for subsequent risk-set (hypothetical data)

		N first level	Transition propensity	N second level	% bad students	Completion rate 2nd level		N graduates		% bad graduates
Upper class	bad	30	0.5	15	21	(0.6)	0.84	(9)	59	15
	good	70	0.8	56		(0.9)		(50)		
Lower class	bad	60	0.2	12	33	(0.4)	0.67	(5)	24	20
	good	40	0.6	24		(0.8)		(19)		
Lower class with upper class transition propensity at first transition										
	bad	60	0.5	30	48	(0.4)	0.61	(12)	38	30
	good	40	0.8	32		(0.8)		(26)		

Table 1 displays an example of neutralising secondary effects with hypothetical data. If we assign the transition propensities of the upper classes to the lower classes, i.e. if we neutralise secondary effects, we can manage to shift more lower class students to the next educational level (here 62 instead of 36). But we do this at the expense of a decrease in their average performance at the next educational level. Whereas one third of lower class students show a bad performance in the factual case, we have increased the share of bad students to 48 percent in the counterfactual case.

The altered composition of lower class students at the second educational level is also consequential for the completion of the second level. In the example we assume that completion rates are different according to performance. Good students are more likely to graduate than bad students. Further, we assume that even within performance groups, upper class students have higher completion rates than lower class students. This takes into account that secondary effects are also prevalent for school completion.

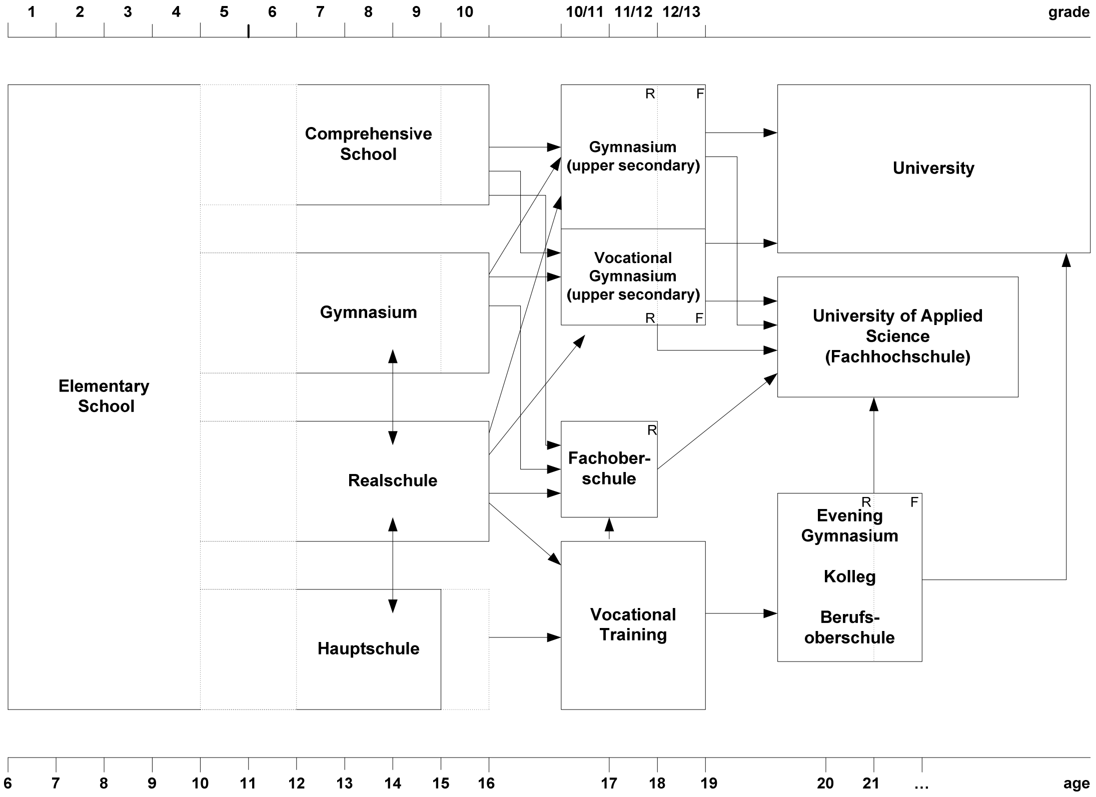
As the counterfactual scenario exemplifies, a higher share of bad students in the risk set of the second level student population eventually leads to a decrease of the second level graduation rate (0.61 instead of 0.67). And in the end, neutralising secondary effects leads to 38 instead of 24 lower class students that graduate from second level education. However, if we had not considered the changes in the performance composition, we would have overestimated the number of graduates. By simply multiplying the counterfactual number of 62 second level students with the graduation rate from the factual scenario (0.67), we would have arrived at a number of 42 students. Hence, neglecting compositional changes in the risk-set of students that are facing educational transitions as imposed by counterfactual manipulations can lead to biased results.

The example that I have just described takes only observable changes (performance distributions) into account. But a more realistic consideration would also have to account for changes that arise from unobserved characteristics. The counterfactual scenario in Table 1 assumes that – although secondary effects have been neutralised in the first transition – the completion rates of second level education remain unaffected. This is a quite unrealistic assumption. Neutralising secondary effects in the first transition might have sustainable consequences. First, since neutralising secondary effects is likely to be connected to enhancing educational aspirations, this should also lead to a weakening of the association between performance and second level school completion. In other words, the conditional completion rates of the lower class students should be much closer to the completion rates of the upper class students. Second – and this applies to manipulations of primary and secondary effects in equal measure – since (at least according to the method by Erikson et al.) transition functions are estimated by logistic regressions on the basis of factual (sub-)populations, any counterfactual composition of these populations includes further unobservable characteristics that would bias the slope of the logit curve. Since unobservable characteristics are even more unobservable in counterfactual situations, it is hard to tell in which direction the bias will go. We will never know how people would behave under counterfactual circumstances. Hence, whenever conducting these kinds of analyses, one should bear in mind that they cannot be considered as *causal* analyses. What can be done instead is to describe different scenarios that might delineate plausible margins of the consequences of ideal typical interventions. In my simulation study I will do so by accounting for compositional changes as long as they are deductable from observables. And whenever possible, I will present ideal typical scenarios that can be regarded as upper or lower bounds of interventions at either primary or secondary effects. But before I proceed with the description of the method, I will briefly outline the German education system with its major branching points.

Transitions in the German education system

My focus is on the educational career from primary to tertiary education. However, the German education system is not just a sequence of subsequent transitions where you either drop out of or continue with education. Neither is it – although often claimed – a system of branching points that lead into irreversible one-way streets. (Un-)fortunately it is much more complicated. Although there is considerable variation in the degree to which specific education institutions are pronounced, the basic structure of the education system is quite similar across the 16 federal states. After elementary school (grade 4 or 6, age 10-12), students are distributed over different school types. The basic idea is to place students at school tracks according to their aptitudes. The *Hauptschule* (which has been abolished in several states recently) is the school type with a practically oriented and the least demanding curriculum; the *Gymnasium* is the academically most demanding school type which is supposed to prepare students for higher education; and the *Realschule* is situated somewhere in between the two other schools and is supposed to prepare students for demanding non-academic training. Besides these three institutions some federal states have introduced comprehensive schools, where students are not separated according to aptitude. Lower secondary education ends after grade 9 or 10 (age 15-16). Students at the Gymnasium continue with upper secondary education and obtain the upper secondary degree (Abitur) after 3 additional years, which is the prerequisite for enrolment in tertiary education. Students from all other institutions graduate after lower secondary education. However, outstanding students from comprehensive schools or from the *Realschule* can also continue their education career in upper secondary education at the Gymnasium. Apart from the Gymnasium, which is designed to teach a general-education curriculum, there exist further upper secondary institutions which are more dedicated to a vocationally oriented curriculum: the *Vocational Gymnasium* and the *Fachoberschule*. Both school types can be attended after the completion of 10th grade at comprehensive schools or the Gymnasium or after graduation from the *Realschule*. However, the two-year *Fachoberschule* only awards restricted upper secondary degrees, which provide access to universities of applied sciences but not to universities.[4] The latter two institutions constitute the German higher education system. Whereas the universities are traditionally academically oriented, the universities of applied sciences are much closer to applied and vocationally oriented education.

Figure 2: The German school system



Note: R=restricted upper secondary degree (access to uni. of appl. science only); F=full upper secondary degree.

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[4] Restricted upper secondary degrees can also be obtained at general and vocational Gymnasiums after 2 instead of the obligatory 3 years.

Apart from the straight pathways described above it is further possible to obtain eligibility for higher education after phases of vocational training or employment at several institutions of further education (*Abendgymnasium*, *Kolleg*, *Berufsoberschule*).

It might have become clear that a simple sequential transition model does not capture the complexity of the German education system. And the various possibilities of post-hoc correction of the educational career and the variety of pathways into tertiary education make it somewhat difficult to apply the conception of primary and secondary effects in a cumulative way. Hence, my simulation exercise can be only partial or ideal typical by definition. Among all the potential pathways I will look at the most significant route to tertiary education, which is the direct path from primary education through the general Gymnasium to the upper secondary degree (*Abitur*) and from there to higher education. More than 60 percent of an upper secondary graduation cohort obtain their eligibility for tertiary education through this road (Statistisches Bundesamt 2008a; Statistisches Bundesamt 2008b). Among those, I will simulate how social inequalities in the access to higher education will change by manipulating primary and secondary effects at the transitions which lie in between.

Setting up the simulation framework and adding data

I consider three branching points for my simulation exercise: first, the transition from elementary school to the Gymnasium track; second, the successful graduation from the Gymnasium; and third, the transition from the Gymnasium to higher education. Ideally, I would approach this endeavour with a cohort study which contains information on individual education biographies. Unfortunately, there is no such longitudinal data for Germany which includes information both on educational transitions and school performance.[5] Hence, I am forced to draw on different data sources for each transition. This is not as big a disadvantage as it might seem at first. The method by Erikson and colleagues that I have outlined above does not require individual level biographical data. We just need a comparable categorisation of social background across all datasets, group specific performance distributions prior to the transitions and the respective transition functions.

For the *transition from elementary school to the Gymnasium*, I will utilize the same dataset that has been used by Becker (2009) in the study described above. The data is connected to a

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[5] Such data is currently collected in the National Educational Panel Study. But it will still take some years until real cohort data will be available (see http://www.uni-bamberg.de/en/neps/).

study entitled ‘The Transfer to Secondary School’ (Fauser data, henceforth) and has been collected in two waves before and after the transition to secondary schools in 1983 (cf. Fauser 1984). For the *transition from the Gymnasium to tertiary education* I draw on upper secondary graduates data for the 1992 graduation cohort, collected by the Higher Education Information System (HIS). Thus, the Gymnasium graduation cohort in the HIS data corresponds exactly to the Gymnasium entrance cohort of 1983. Unfortunately, there is no dataset which covers the *period from Gymnasium enrolment to graduation*. Therefore, it is not possible to apply the concept of primary and secondary effects for this sequence properly. It is however possible to model the group specific performance development at the Gymnasium by comparing the performance distribution of the Gymnasium entrants (Fauser data) with the performance distribution of the Gymnasium graduates (HIS data). If the temporal shifts of the performance distributions are different for social background groups, this would indicate a differential group specific performance development at the Gymnasium and be an approximation to the concept of primary effects. But the performance distribution of the Gymnasium graduates is not only the result of their performance development since enrolment; it is also influenced by selective dropout from Gymnasium. It is plausible to assume that Gymnasium dropouts are to some extent the result of secondary effects, i.e. students from underprivileged backgrounds drop out more often than students from privileged backgrounds; even if performance is held constant (most likely underperforming students would drop out more often among the underprivileged groups). Then, the dropouts would also impact the shapes of the group specific performance distributions of the graduates. Accordingly, the performance development deducted from the comparison of the grade distributions does not only reflect primary effects of the Gymnasium sequence but is also influenced by secondary effects. Furthermore, I still do not have information about social background specific dropout rates. As a solution for the simulation I will draw on figures that have been calculated by Hillmert and Jacob (2010) based on the German life history study.

After having established the data sources, the choice of a comparable categorisation of social background is pretty much straightforward, since it necessarily has to be a common denominator of all datasets that are involved. In this case, the best available indicator is highest parental education. In order to keep the following simulation study in reasonable dimensions, I choose to compare only two groups. I distinguish students with parents that have a lower secondary degree or less from students with parents that have an upper secondary degree or more. As for the performance measure, my hands are tied by the data as well. Both in the

Fauser data and in the HIS data the performance measure is based on average final school grades of the elementary school certificate and the upper secondary certificate, respectively.

The transition from elementary school to the Gymnasium

The Fauser data have been collected in four federal states (Baden-Württemberg, Nordrhein-Westfalen, Niedersachsen and West-Berlin) as a two-wave panel study. I utilize information from the second wave, which took place approximately half a year after the transition from elementary school to secondary education and contains 3085 cases (4252 in the first wave).[6] I exclude those observations from the analysis for which the secondary school track is not identifiable (including comprehensive schools) as well as those observations that have missing values on either parental education or school performance. This results in an analytical sample of 2683 cases.

As performance indicator the dataset contains school grades in mathematics and German for the 4th grade. Both are coded in integer numbers from 1 to 6, which reflects the German grading system: 1 (excellent), 2 (good), 3 (satisfactory), 4 (sufficient), 5 (poor), 6 (insufficient).[7] The final grade of elementary education (and also of the upper secondary exam) is usually calculated as grade point average across all subjects, mostly assigning a special weight to core subjects, such as mathematics and German. The GPA is then expressed as a number with one decimal, which also serves as a landmark for the recommendation of the type of secondary school track. However, having only two elementary school grades at hand, I am not able to construct corresponding decimals. The average grades that can be obtained from maths and German are only half-integral, which translates into 9 empirical categories that range from 1.0 to 5.0. Since the upper secondary grades in the HIS data are available with the full range of decimal places, as we shall see, it would be more desirable to have a similarly detailed grade distribution for the first transition rather than aggregating the HIS data (identical performance scales in both datasets will be a prerequisite for modelling the sequence between Gymnasium enrolment and graduation). My solution is to fit kernel density estimates to the categorical

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[6] In Baden-Württemberg and Nordrhein-Westfalen, the transition took place after fourth grade. In Berlin and Niedersachsen, the transition took place after sixth grade. Hence, in these states the students are already older and would have to be matched to the 1990 upper secondary graduation cohort instead of the 1992 cohort. But to keep things simple I will only use data of the 1992 graduation cohort.

[7] Empirically, the grade 6 (insufficient) does not appear in the data, since it is not possible to proceed to the next level of education with insufficient achievement in one of the core subjects. Note that the German education system includes the possibility of grade repetition (staying down a year).

performance distributions of each class and extract the relative frequencies for each decimal of the performance scale (cf. Figure 3 and Table A2 in the appendix).[8]

Figure 3: Fitting kernel density estimates to categorical performance data (Fauser data)

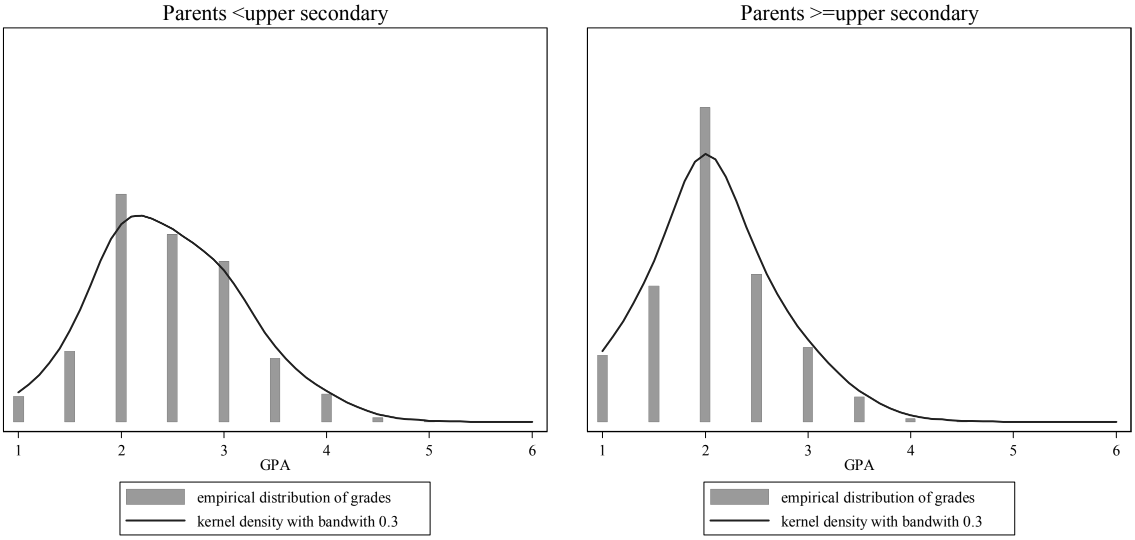

Table 2 displays the observed and predicted performance means and transition rates by parental education. If we take the original performance scores from the dataset, we observe an average GPA of 2.47 for students with low educated parents and an average GPA of 2.08 for students from highly educated parents. Hence, since low values denote the better grades in the German school system, we already detect some primary effects at the end of elementary school. Also, we find drastic differences in the unconditional transition propensity to the Gymnasium track: 82.15 percent of the students with highly educated parents but only 40.09 percent of the students with low educated parents make this transition.[9]

Against these observed figures I now evaluate the predictions that emerge when I use kernel density estimations for the grade distributions and/or logit functions for the transition propensities instead of the empirical values. Substituting the empirical transition rates for each GPA category by a logit function leaves both the average performance values and the unconditional transition propensity unaltered for each class. The predicted probabilities were obtained from logistic regressions of the transition to the Gymnasium on a variable that contained the original (half-integral) GPA values, separately by parental education. Hence, assuming a logistic

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[8] I use Gaussian kernel functions, which result in somewhat smoother but also narrower distributions as compared to e.g. Epanechnikov functions.

[9] These numbers seem quite high and it is very likely that the transition rates of both groups are overestimated by the Fauser data. This will lead to an overestimation of participation rates in the subsequent analyses. But since the bias is consistent across both groups, it won't impact the conclusions of this paper – which are related to between group differences.

function (cf. Erikson et al. 2005) in the relation between elementary school performance and choosing the Gymnasium seems viable.

Table 2: Empirical and predicted GPAs and transition probabilities, by social background (Fauser data)

Performance distribution	Transition function	Parental education < upper secondary GPA	 trans. rate	 >= upper secondary GPA	 trans. rate
empirical	empirical	2.47	40.09	2.08	82.15
empirical	logit prediction	2.47	40.09	2.08	82.15
kernel density (0.20)*	logit prediction	2.49	39.50	2.12	81.00
kernel density (0.25)*	logit prediction	2.49	39.48	2.13	80.64
kernel density (0.30)*	logit prediction	2.50	39.45	2.14	80.20
kernel density (0.35)*	logit prediction	2.50	39.40	2.15	79.69
kernel density (0.40)*	logit prediction	2.51	39.32	2.16	79.10

*numbers in brackets denote bandwidth that was used for kernel density estimation.
Data: Transfer to Secondary School 1983 (ZA No. 1612).

However, replacing the categorical grade distribution by kernel density estimates introduces some bias. Table 2 displays the predictions of average GPAs and transition rates for a set of kernel density estimations with varying bandwidth. In each case the values predict worse average GPA values and lower transition rates than in the actual data. The bias is somewhat stronger in the group of students with highly educated parents. But since the bias is (a) not very severe, and (b) both primary and secondary effects are downsized in the same direction, I see no objection to proceed with the predicted data instead of the empirical data, which will maintain the possibility to fully exploit the detailedness of the HIS data. The choice of the bandwidth in the kernel density estimations is somewhat arbitrary. I decided to apply a bandwidth of 0.3, which I think is a good compromise between being close to the actual data with the predictions of mean GPA and transition rates and a reasonably smooth looking distribution (cf. Figure 3 and Figure A1 in the appendix).

Figure 4 depicts the elementary school GPA distributions of the two social background groups together with their respective transition curves for Gymnasium enrolment. Again, primary effects become visible as the bulk of the performance distribution of students with highly educated parents is located somewhat more to the left than the distribution of students with lower educated parents. Secondary effects become visible as for each performance value the transition curve of students from highly educated families is located above the transition curve of the students with low educated backgrounds.

Figure 4: Performance distributions and transition functions to the Gymnasium, by social background

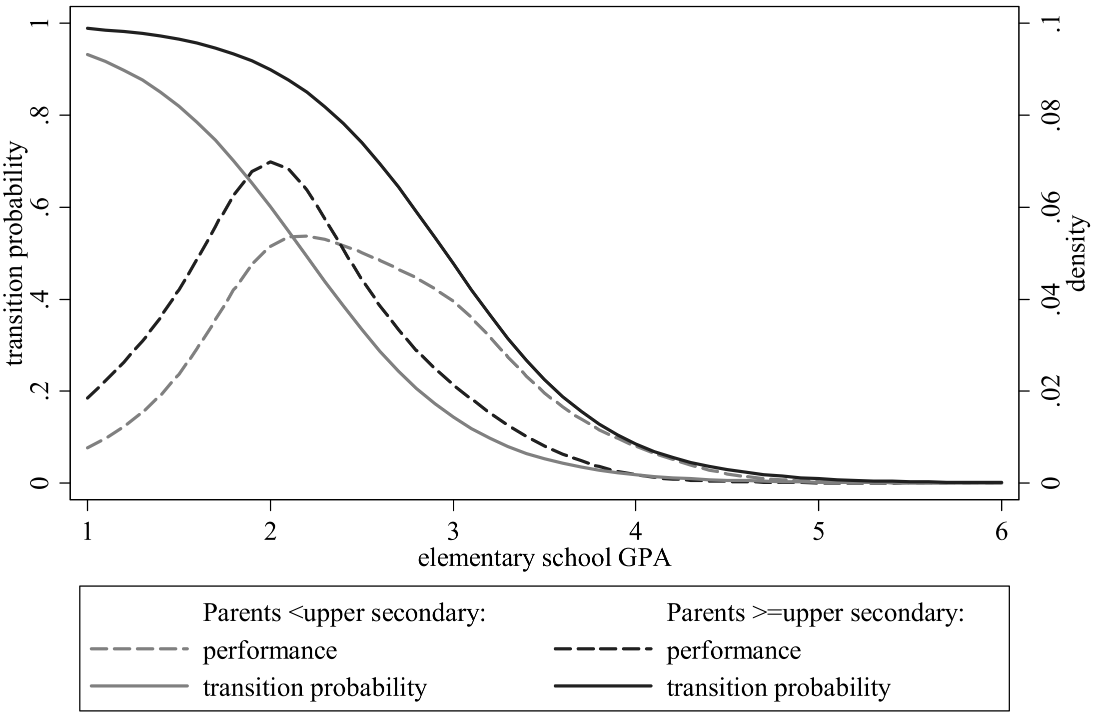
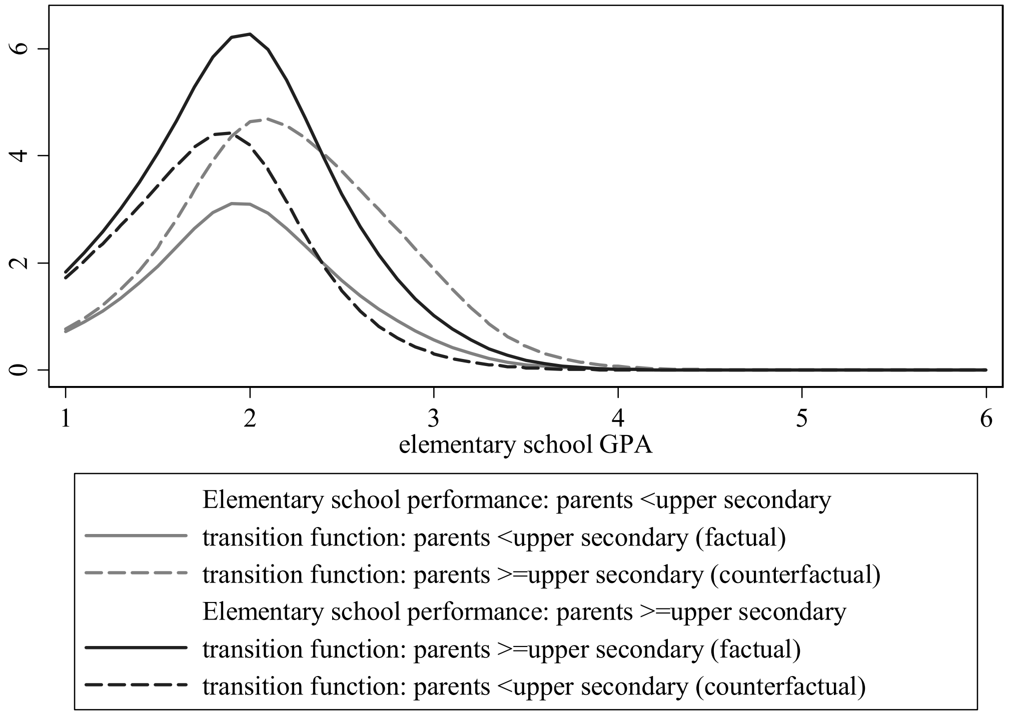


Figure 5: Factual and counterfactual performance distributions, Gymnasium students only



Following Erikson et al. (2005) the overall transition rate of one group can be calculated by the integral of the product of their performance distribution and their transition function (cf. Formula 1a). Since, in our case, the performance distributions are based on semi-parametric functions, it is not possible to calculate an integral. However, this is not even necessary since grades in the real world are only defined by up to one decimal after the comma. Hence, it is sufficient to multiply the cell frequencies for each decimal of the grade scale with its respective transition probability as predicted by the logit curve (which will result in the overall transition rates that have already been shown in Table 2). Moreover, the method proposed by Erikson and colleagues allows for the estimation of counterfactual situations. We can assign the transition function of students from highly educated families to students from low educated families – and vice versa. This will result in counterfactual compositions of the students at the Gymnasium. Figure 5 displays the performance distributions of Gymnasium enrollers (based on elementary school grades) that result from the four possible combinations of elementary school performance and transition propensities. Table 3 lists the average performance scores and transition rates that follow from the different counterfactual combinations.

Table 3: (Counter)factual transition rates to the Gymnasium and mean GPA of Gymnasium students

Elementary school performance distribution	Transition function to Gymnasium	Gymnasium students' average GPA	Transition rate to Gymnasium
< upper secondary	< upper secondary	2.02	39.45
< upper secondary	>= upper secondary	2.21	67.72
>= upper secondary	< upper secondary	1.84	53.05
>= upper secondary	>= upper secondary	1.99	80.20

As we know already, 39 percent of students with low educational background make the transition to the Gymnasium. If we consider only the average GPA of that very group, it would be 2.02. If we replace their transition function by that of the students from highly educated families but leave their performance distribution unchanged, their transition rate would increase to 68 percent. However, since higher shares of poor performing students would slip into the Gymnasium that way (cf. the transition curve in Figure 4), their average GPA would become somewhat worse with a value of 2.21. If we instead exchange their performance distribution and leave the transition rate unchanged, we obtain a transition rate of 53 percent. This is again an increase as compared to the original value, but a much lower gain as compared to exchanging the transition function. Hence, neutralising secondary effects would in this case be more effective in raising participation rates at the Gymnasium.[10] A look at the counterfactual mean GPA of 1.84 reveals that on the other hand, neutralising primary effects would of course lead to a better performance composition of Gymnasium students from low educated families.

The transition from the Gymnasium to tertiary education

The HIS upper secondary graduates panel 1992 is a sample of graduates that obtained any kind of upper secondary degree in this year. They were interviewed half a year after graduation and a sub-sample again in a follow up survey three and a half years after graduation. The first wave dataset contains 10,357 cases. For our purpose, however, I only work with a sub-sample. In order to make the data comparable to the Fauser data, I selected only graduates that obtained a full upper secondary degree at the Gymnasium in one of the corresponding federal states (Baden-Württemberg, Nordrhein-Westfalen, Niedersachsen and Berlin).[11] After list-wise deletion and considering panel attrition I end up with an analytical sample of 1,611 cases. In all analyses I apply sample weights provided by the data producers, which account for selective non-response and panel attrition. As variables, I use again parents' education, school performance and a dichotomous transition measure. Parents' education is coded identical to the coding in the Fauser data. The performance measure is the final GPA of the upper secondary certificate, measured on the German grading scale with one decimal. The empirical range is 1.0 to 3.8 (it is not possible to pass the Abitur with a GPA worse than 4.0). The transition variable distinguishes those upper secondary graduates that enrolled in higher education (universities or universities of applied science) within three and a half years from those who did not.

Table 4 shows the mean upper secondary GPA and the transition propensities to higher education for both social origin groups. Students from highly educated families fare on average a bit better than students from lower educated families (2.31 vs. 2.54). More pronounced are the differences in the transition rates to higher education. Whereas almost 70 percent of the upper secondary graduates with highly educated backgrounds enrol in tertiary education, only about 55 percent of the graduates from low educated families make the transition. If we conduct the same exercise as with the Fauser data and replace the empirical transition probabilities with a

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[10] Expressed in relative terms, secondary effects would account for 67 percent of the unequal transition rates (70 percent according to formula 3a and 64 percent according to formula 3b).

[11] In the 1992 HIS data it is not possible to distinguish West Berlin from East Berlin. Hence, the data includes some (though not many) respondents that obtained their primary and secondary education in the GDR.

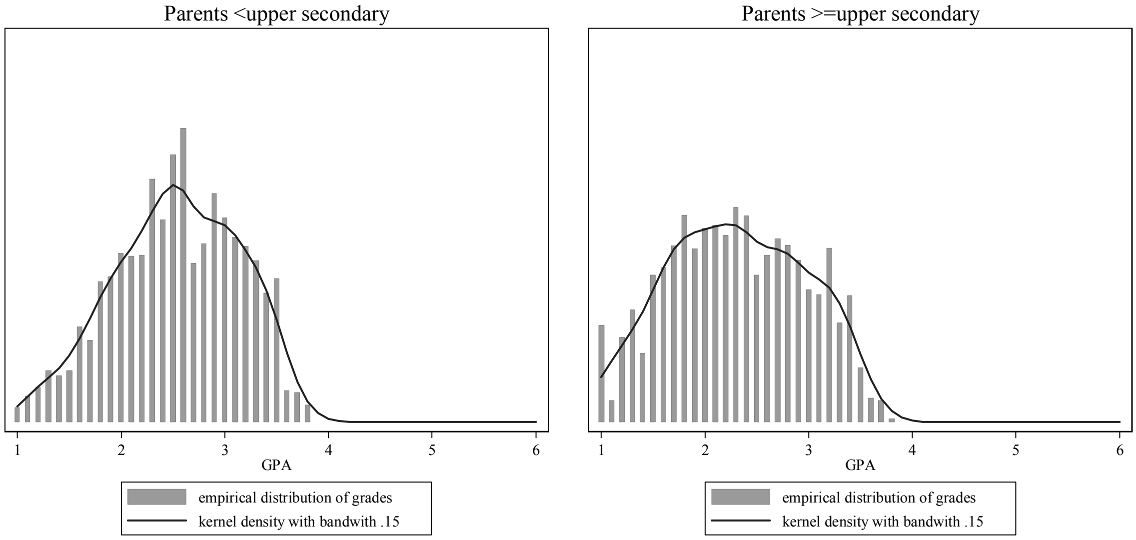
logit function, we basically obtain the same overall transition rates. So, in this case as well, assuming a logistic relationship between GPA and transition probability seems to be viable.

Table 4: Empirical and predicted GPAs and transition probabilities, by social background (HIS data)

		Parental education			
Performance distribution	Transition function	< upper secondary		>= upper secondary	
		GPA	trans. rate	GPA	trans. rate
empirical	empirical	2.54	54.62	2.31	69.74
empirical	logit prediction	2.54	54.62	2.31	69.74
kernel density (0.05)*	logit prediction	2.54	54.60	2.31	69.67
kernel density (0.10)*	logit prediction	2.54	54.55	2.32	69.49
kernel density (0.15)*	logit prediction	2.54	54.49	2.33	69.34
kernel density (0.20)*	logit prediction	2.55	54.41	2.33	69.16
kernel density (0.25)*	logit prediction	2.55	54.31	2.34	68.94

*numbers in brackets denote the bandwidth that was used for kernel density estimation.
Data: HIS upper secondary graduates survey 1992 (weighted data).

Figure 6: Fitting kernel density estimates to categorical performance data (HIS data)



Since we have empirical values for GPA at the decimal level already, it is not necessary to estimate kernel density functions in the HIS data. However, the distribution of grades looks rather jagged (cf. Figure 6). And although it does not make much sense in statistical terms, I decided to apply kernel density smoothed distributions in the HIS data as well, because it will facilitate the intuitive understanding of my conceptual approach when the curves in the graphs describe rather continuous curve progressions. In this case, I opted for kernel density estimations with a bandwidth of 0.15. This – although again arbitrary – seems to be a reasonable compromise (cf. Table 4 and Figure A2 in the appendix) and won't bias the general findings much compared to the version using empirical distributions.

Figure 7 depicts the performance distributions and transition propensities of upper secondary graduates by social background. Again, primary effects become visible by the more positively skewed performance distribution of students from highly educated families. Secondary effects become visible by the fact that the transition function of students with lower educated parents is situated below the function of students from educated families.

Figure 7: Performance distributions and transition functions to higher education, by social background

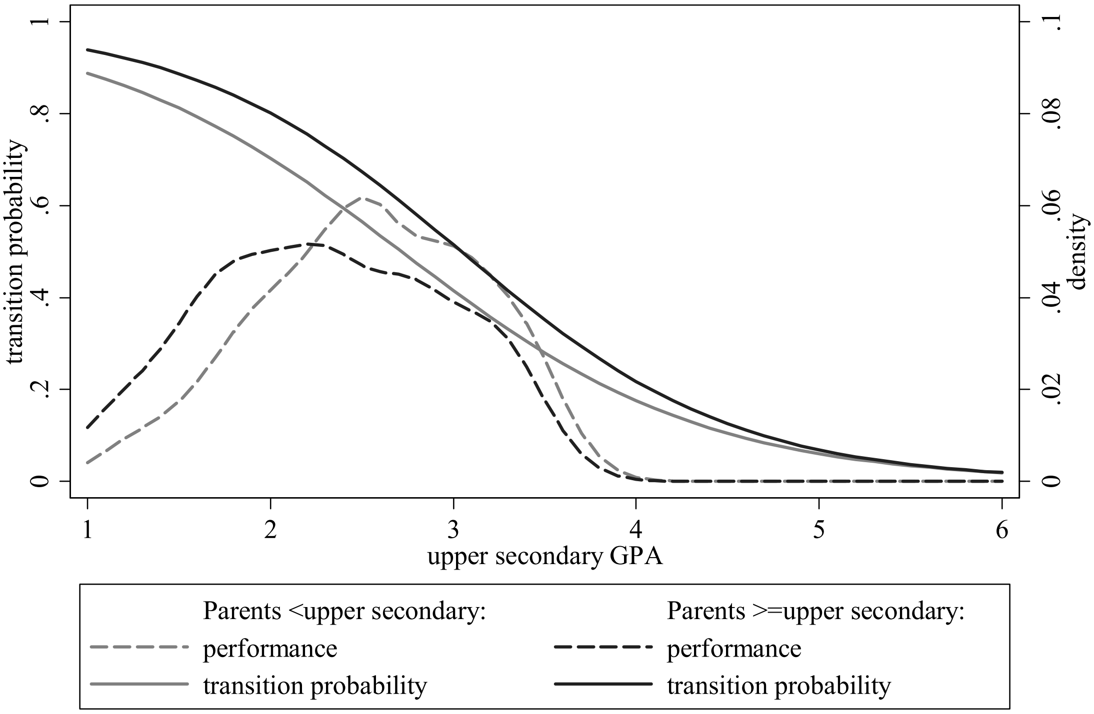


Table 5 lists again the factual and counterfactual transition rates as well as the mean GPA values of those upper secondary graduates that make the transition to higher education. As we already know from Table 4, in the factual situation there is a gap in the transition rates of about 15 percentage points (54 vs. 69 percent).[12] If we assign the transition function of students from educated backgrounds to students from low educated backgrounds, their transition rate will increase by almost 10 percentage points to 63.99. If we alter the performance distri-

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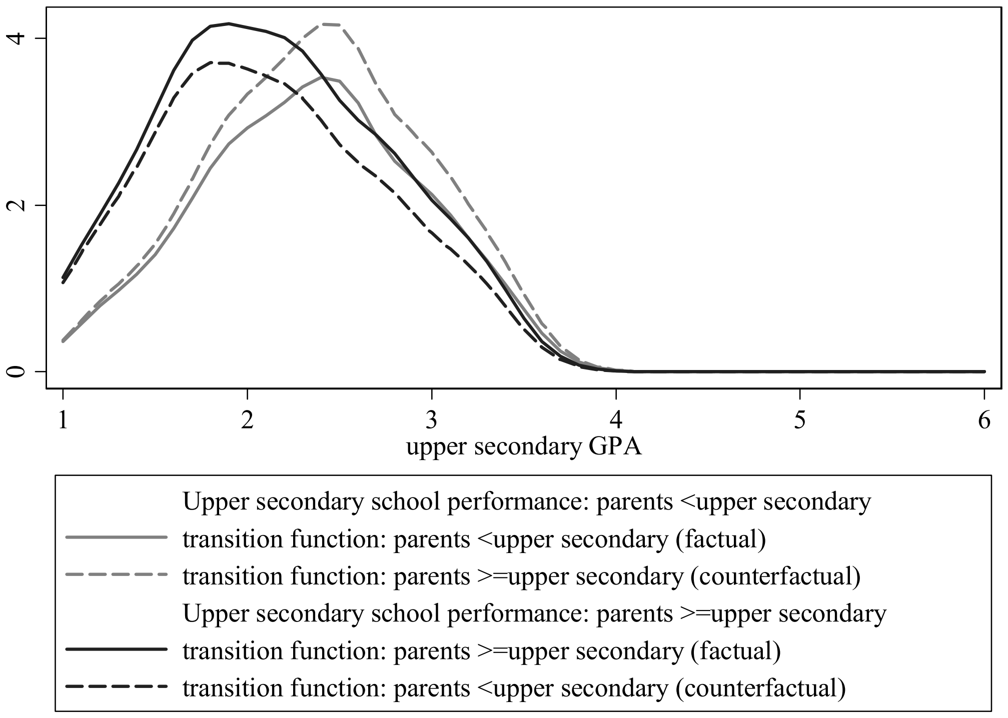
[12] The 1992 data belongs to a period where transition rates to higher education experienced a slump (cf. Lörz and Schindler 2009). This explains the comparatively low values for both groups.

bution of students from low educated backgrounds while maintaining their transition function, the transition rate will only increase by about 6 percentage points to 60.10. Hence, secondary effects are somewhat more influential than primary effects in creating inequalities in that transition.[13] As regards the performance distribution of higher education entrants (cf. also Figure 8), manipulating secondary effects shows only negligible impact on the average performance level.

Table 5: (Counter)factual transition rates into higher education and mean GPA of highered students

Upper secondary school performance distribution	Transition function to higher education	Higher education students' average GPA	Transition rate to higher education
< upper secondary	< upper secondary	2.36	54.49
< upper secondary	>= upper secondary	2.38	63.99
>= upper secondary	< upper secondary	2.14	60.10
>= upper secondary	>= upper secondary	2.17	69.34

Figure 8: Factual and counterfactual performance distributions, higher education students only



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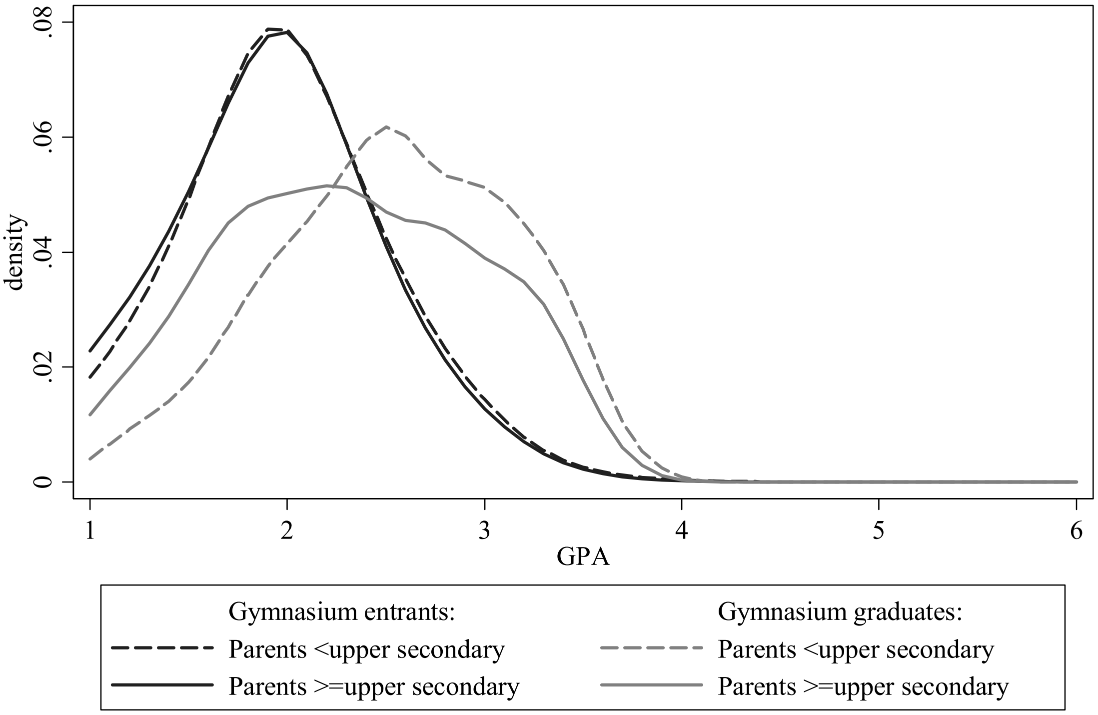
[13] Expressed in relative terms, secondary effects would account for 63 percent of the unequal transition rates. This figure is surprisingly low if evaluated against the figures reported by Schindler and Reimer (2010), who find that secondary effects on average account for about 80 percent. However, they consider class background instead of education and their analyses rely on all upper secondary graduates of a cohort rather than of a specific subsample. I replicated my analysis with the 1990 graduate survey and an identical operationalization. There, secondary effects account for 76 percent of the unequal transition rates to tertiary education. I conclude that the 1992 survey somewhat underestimates the impact of secondary effects. But since the aim of this paper is rather of a conceptual nature, I will report the results using the 1992 survey anyway.

The development from Gymnasium enrolment to Gymnasium graduation

We already set up the transitions from elementary education to the Gymnasium and from the Gymnasium to higher education. What is still missing is the sequence at the Gymnasium, i.e. between enrolment and graduation. Unfortunately, there is no dataset which covers this period and provides the necessary information that I would need for the analyses. As already outlined above, I make use of the Fauser and HIS datasets in order to compute socially selective performance developments during secondary education and of figures recalculated from Hillmert and Jacob (2010) in order to obtain social background specific dropout rates.

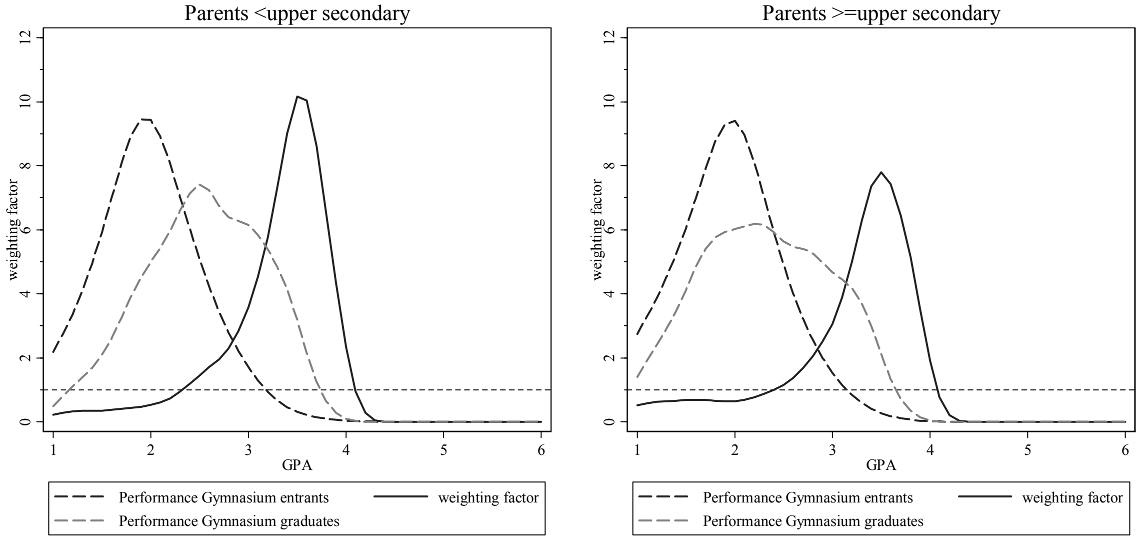
Figure 9 depicts the performance distributions of gymnasium entrants and graduates by parental education (rescaled to identical group sizes). The curves for Gymnasium entrants reflect the grade point averages from the fourth grade, the curves for Gymnasium graduates are based on the Abitur GPA. Since essentially the top performers of elementary school make the transition to the Gymnasium, their grade distribution is of course much more concentrated at the top of the grading scale. On the other hand, grades in the upper secondary certificate are distributed again over the entire scale, which is the reason why their curves look broader.

Figure 9: Performance distributions of Gymnasium entrants and graduates, by social background



While the distributions of Gymnasium entrants are almost congruent across both social backgrounds, the distributions of the graduates differ. The upper secondary grade distribution of graduates from highly educated families is somewhat more skewed towards the better grades than the distribution of students from lower educated families. This means that although the starting position is almost the same for Gymnasium entrants of both groups, students with highly educated backgrounds manage to be more successful in improving their performance throughout secondary education relative to students from low educated families. In other words, the average performance development at the Gymnasium seems to be more favourable for students from educated families.[14]

Figure 10: Weighting factors for the transformation of performance distributions, by social background



For my simulation exercise I will take advantage of the possibility to extract information from the comparison of the performance distributions of the two datasets. As a measure of performance development I compute a weighting factor, which can be obtained through dividing the social background specific graduates' performance curves by the respective Gymnasium entrants' curve at each point of the GPA scale. This results in a weighting score for each value of the GPA scale.[15] Figure 10 displays these weighting factors by parental education. Since the weighting factors enable us to generate the Gymnasium graduates' performance distribu-

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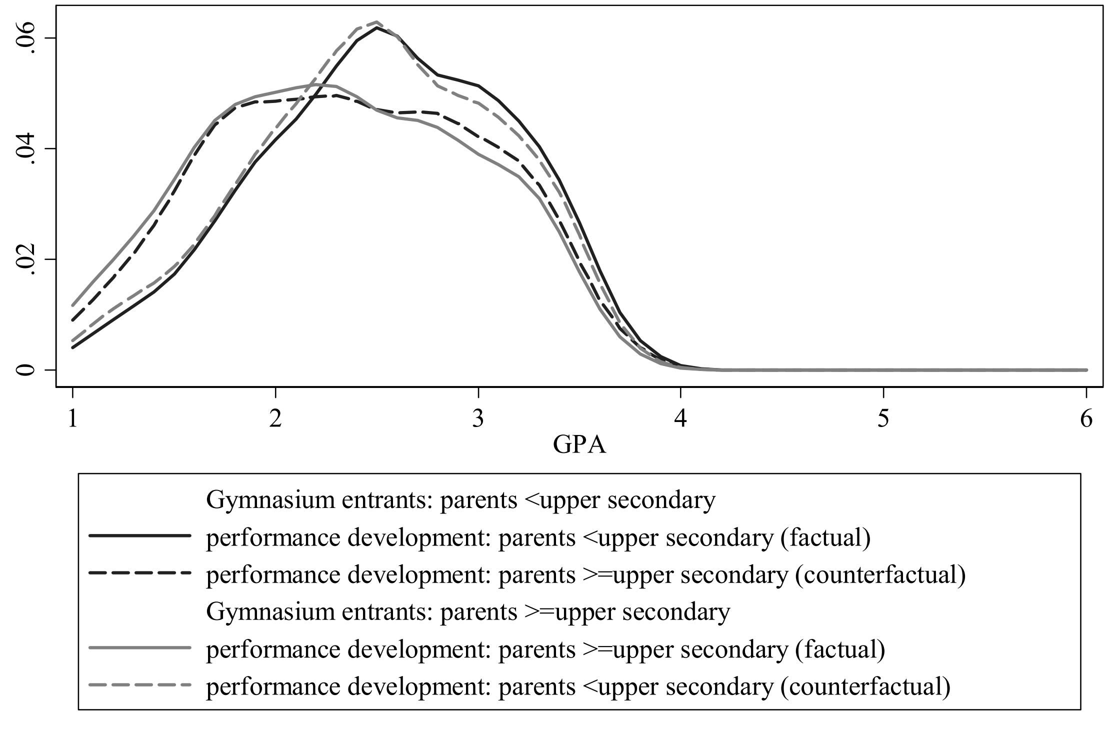
[14] As already indicated above, 'performance development' should not be understood in the sense of 'learning progress' since the performance distributions of upper secondary graduates are influenced by Gymnasium dropouts (and 'drop-ins') as well.

[15] Apart from calculating the factual performance development for each social background group, it is also possible to construct counterfactual performance developments that induce Gymnasium entrants from low educated families to end up with the same graduates' performance distribution as students from highly educated families (and vice versa). Figure A3 in the appendix displays the respective weighting factors.

tion out of the Gymnasium entrants' performance distribution (by simple multiplication), this opens the way for counterfactual considerations. We can combine the performance distribution of Gymnasium entrants from low educated families with the performance development of students from highly educated families (or vice versa). This would result in an estimation of counterfactual performance distributions of Gymnasium graduates. Figure 11 displays the four possible factual and counterfactual combinations. Assigning the performance development of students with highly educated backgrounds to students from low educated families would result in an improvement of their upper secondary grade distributions. Instead, assigning the performance development of students from low educated families to students from highly educated families would lead to a worsening of the upper secondary performance of the latter. Since the performance curves at the beginning of the Gymnasium are almost identical for both groups, assigning counterfactual performance developments leads to upper secondary grade distributions that are similar to those of the other group's factual situation.

Figure 11: Factual and counterfactual performance distributions, higher education graduates



Apart from assigning counterfactual secondary school performance developments to *factual* performance distributions of Gymnasium entrants, we could as well combine them with *counterfactual* performance distributions of Gymnasium entrants (cf. the distributions in Figure 5). This is a property which I will make use of in the subsequent simulation exercises.

However, altering the performance development does not provide us with information of how many students from each social background group drop out of the Gymnasium during their secondary school career. One possibility of obtaining that figure would be to consider the social composition of both Gymnasium entrants and Gymnasium graduates (cf. Table 6). From the official school statistics we can obtain the global numbers of entrants and graduates for the respective years. This enables us to compute the actual cell frequencies for each social background group, and hence, their dropout rates as well.[16] Following this procedure provides us with estimated net dropout rates of about 31 percent for students from low educated families and 6 percent for students from highly educated families.

Table 6: Calculating Gymnasium dropout rates

Parents' education	Gymnasium entrants (%)	Gymnasium graduates (%)	Gymnasium entrants (abs)	Gymnasium graduates (abs)	Net dropout rate
< upper secondary	55.71	47.78	61,602	42,277	0.31
>= upper secondary	44.29	52.22	48,974	46,205	0.06
	100.00	100.00			
global no. of students from school statistics			110,576	88,482	

Sources: German Federal Statistical Office, Fauser data, HIS data.

One constraint of this solution is the requirement that the estimates of the social compositions of entrants and graduates are indeed representative of the real compositions. At least with regard to the Fauser data I clearly have doubts, since the mode of data collection was not following a random sampling design. Even with the HIS data one could question whether they represent the real social composition of students, given rather high nonresponse rates. Although the HIS provides sample weights, these weights are not correcting for distortions in the social background variables. Therefore, I am reluctant to use the dropout rates from Table 6 in the following analyses. Instead, I will draw on figures that I have deducted from Hillmert and Jacob (2010). In their paper, the authors utilize data from the German Life History Study and compare the survival rates of two social background groups across different educational transitions. Their distinction of social background is identical to the distinction which I use in this paper (less than upper secondary vs. upper secondary or more).

Table 7 list the values taken from their study. In the group of students from low educated families, the number of Gymnasium dropout exceeds the number of later entries, which results in a net dropout rate of about 20 percent. In the group of students from highly educated

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[16] I thank Christian Kerst from HIS for pointing to this possibility of obtaining dropout rates.

families Gymnasium late entries and dropouts even out, resulting in a net dropout rate of zero. In the subsequent simulation I will work with these dropout rates, when estimating the factual and counterfactual numbers of students that reach higher education.[17]

Table 7: Net Gymnasium dropout rate according to Hillmert and Jacob (2010)

	Parents' highest education			
	< upper secondary		>= upper secondary	
	absolute	percent	absolute	percent
Gymnasium beginners	242	100.00	106	100.00
Later entries	44	18.18	14	13.21
Gymnasium dropouts	-92	-38.02	-14	-13.21
Net survival	194	80.16	106	100.00
Net dropout	48	19.84	0	0.00

Data taken from Hillmert and Jacob (2010).

Simulating the joint impact of primary and secondary effects across different transitions

In the preceding steps I have shown the setup for counterfactual manipulation at each single transition on the way to higher education: from elementary school to Gymnasium entry, from Gymnasium entry to graduation, and from upper secondary graduation to tertiary education enrolment. In the final analysis I will now consider the cumulative impact of manipulating either primary or secondary effects at one or more transitions. I will take into account that performance distributions change as a result of previous manipulations. All subsequent steps will then be based on these counterfactual performance distributions. In this joint consideration there are six variables that can be altered between the values of students from low educated families and students from highly educated families:

1) the performance distribution at the end of elementary school,
2) the transition function from elementary school to the Gymnasium,
3) the performance development at the Gymnasium,
4) the net dropout rate at the Gymnasium,
5) the performance distribution of Gymnasium graduates,
6) and the transition function from Gymnasium graduation to higher education.

There are ($2^6+2^5-4=$) 92 counterfactual situations that can be constructed that way. I won't show all of them but rather present the most interesting ones in Table 8. The table is organised

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[17] However, even these figures are far from perfect. They rely on a older birth cohort (1964) and the estimates are based on relatively small sample sizes.

as follows: I start with a hypothetical number of 100 students in column 1. Column 2 indicates the elementary school grade point average of the social background group, which is denoted in column 3. The symbol ‘U’ marks students whose parents possess at least an upper secondary degree, the symbol ‘<U’ identifies students whose parents have less than upper secondary education. Column 4 indicates the transition function from elementary school to the Gymnasium, respectively. Column 5 displays the number of students that would enter the Gymnasium, given the combination of columns 3 and 4. Column 6 displays their GPA, respectively. Column 7 denotes the group from which the performance development at the Gymnasium is derived and column 8 indicates the net dropout rate at the Gymnasium. I use 20 percent for students from low educated backgrounds (<U) and 0 percent for students from highly educated backgrounds (U). Column 9 displays how many students would graduate from the Gymnasium, given the respective combination of columns 3, 4, 7 and 8. Column 10 displays their respective upper secondary GPA. Column 11 indicates the performance distribution of upper secondary graduates. The abbreviation ‘cf.’ denotes that the performance distribution is counterfactual, resulting from the preceding combinations.[18] Column 12 indicates which transition function is being used for the transition from upper secondary to tertiary education. Column 13 displays how many students of the 100 that start in elementary school eventually end up in tertiary education, given the counterfactual combinations at the different preceding transitions. Column 14 indicates their corresponding upper secondary GPA. Finally, as a measure of inequality, column 15 displays the odds ratio between the factual proportion of students from educated families that end up in higher education (reference group) and the proportion that results according to the counterfactual combination of the respective row.

Table 8 starts with a description of the factual situations for students from highly educated families (row 1) and students from low educated families (row 2). As we already know, students from highly educated families fare better in elementary school than their classmates from low educated families (col. 2), while 80 of the former and only 39 of the latter group make the transition to the Gymnasium (col. 5). However, the selection processes at this first transition cause the performance distributions of Gymnasium entrants to be quite similar for both groups (mean values of 1.99 vs. 2.02 in col. 6). Differential performance developments and dropout rates at the Gymnasium result in a number of 80 Gymnasium graduates with a

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[18] Inserting the performance distribution of the reference group at this stage is somewhat counterintuitive, since it ‘overwrites’ the counterfactual distributions that emanate from all previous steps. In a strict sense, inserting a ‘U’ in column 9 always implies a manipulation of the performance development in column 5 as well. In Table 8 these situations are indicated by brackets.

GPA of 2.33 for students from educated families and in a number of 32 graduates with a GPA of 2.54 for students from low educated families (col. 9 and 10). In the end, 56 students of the former and only 17 students of the latter group make the transition to higher education (col. 13), which translates into an odds ratio of 6.21 (col. 15). Even among tertiary education students the performance level is still somewhat favourable for students with educated backgrounds (col. 14).

In the following, I will manipulate the progress through the education system for the group with low educated parents by replacing its performance distributions and/or transition functions with the respective values of the other group. Manipulated variables are indicated by a shaded area in Table 8.

I start with manipulating the transition from upper secondary to tertiary education (rows 3-5). Although neutralising the secondary effect in row 3 seems more effective than neutralising the primary effect in row 4 (we gain 3 additional higher education students instead of 2), interventions at this transition result in rather modest increases in the number of students with low educated backgrounds. Even neutralising both primary and secondary effects at this transition only elevates the number of students to 22 instead of 17.

Rows 6-11 display manipulations of the sequence at the Gymnasium. At first sight, neutralising dropout differentials (row 6) seems more effective for achieving higher tertiary enrolment rates (col. 13) and neutralising performance development differentials (row 7) seems more effective for lifting performance levels in higher education (col. 14). But as already stated above, performance development and dropout rates are interdependent. In a more realistic scenario, any reduction of Gymnasium dropout rates (as in row 6) is likely to influence the composition of upper secondary graduates with respect to performance and educational aspirations. And any improvement of the performance development is likely to reduce dropout rates. Row 8 denotes possible margins of the effects that interventions at Gymnasium dropout rates might have. Since dropout is related to performance, any reduction of it would lead to an inclusion of more underperforming students. Hence, the GPA value of 2.54 (row 6, col. 10) can be regarded as a rather optimistic estimation and the performance composition of upper secondary graduates should be worse in a more realistic scenario (row 8, col. 10). Furthermore, if the reduction of dropout is related to an enhancement of educational aspirations in a sustainable manner, the relationship between performance and transition propensity should become weaker in the transition to tertiary education (col. 12). To sum up, reducing Gymnasium dropout rates can have two countervailing effects for the transition from Gymnasium to tertiary education: Inclusion of more underperforming Gymnasium graduates and higher tran-

Table 8: Simulating the cumulative impact of primary and secondary effects on the way from elementary to tertiary education

	Elementary school		Transition to Gymnasium		Gymnasium (enrolment)		Gymnasium		Gymnasium (graduation)		Transition to Tertiary Education		Tertiary Education (enrolment)		
	(1) No. of students	(2) GPA	(3) Perform. Distr.	(4) Transition function	(5) No. of students	(6) GPA	(7) Perform. developm.	(8) Dropout	(9) No. of students	(10) GPA	(11) Perform. Distr.	(12) Transition function	(13) No. of students	(14) GPA	(15) OR U/<U
(1)	100	2.14	U	U	80	1.99	U	U	80	2.33	U	U	56	2.17	1.00
(2)	100	2.50	<U	<U	39	2.02	<U	<U	32	2.54	<U	<U	17	2.36	6.21
(3)	100	2.50	<U	<U	39	2.02	<U	<U	32	2.54	<U	**U**	20	2.38	5.09
(4)	100	2.50	<U	<U	39	2.02	**cf.**	<U	32	(2.33)	**U**	<U	19	2.14	5.43
(5)	100	2.50	<U	<U	39	2.02	**cf.**	<U	32	(2.33)	**U**	**U**	22	2.17	4.51
(6)	100	2.50	<U	<U	39	2.02	<U	**U**	39	2.54	cf.	<U	21	2.36	4.79
(7)	100	2.50	<U	<U	39	2.02	**U**	<U	32	2.37	cf.	<U	18	2.18	5.80
(8)	100	2.50	<U	<U	39	2.02	<U-	**U**	39	>2.54	cf.	<U-U	21-25	>2.36	≤4.79
(9)	100	2.50	<U	<U	39	2.02	**U**	<U-U	32-39	2.37	cf.	<U	18-23	2.18	5.80
(10)	100	2.50	<U	<U	39	2.02	**U**	**U**	39	2.37	cf.	<U	23	2.18	5.80
(11)	100	2.50	<U	<U	39	2.02	**U**	**U**	39	2.37	cf.	**U**	27	2.21	3.44
(12)	100	2.50	<U	**U**	68	2.21	<U	<U	54	2.79	cf.	<U	26	2.60	3.62
(13)	100	2.14	**U**	<U	53	1.84	<U	<U	42	2.25	cf.	<U	26	2.10	3.62
(14)	100	2.14	**U**	**U**	80	1.99	<U	<U	64	2.50	cf.	<U	36	2.32	2.26
(15)	100	2.50	<U	**U**	68	2.21	<U	<U+	32-54	≥2.79	cf.	<U	17-26	≥2.60	≥3.62
(16)	100	2.50	<U	**U**	68	2.21	<U	<U-U	54-68	>2.79	cf.	<U-U	26-39	>2.60	≤3.62
(17)	100	2.14	**U**	<U	53	1.84	<U	<U	42	2.25	cf.	<U	26	2.10	3.62
(18)	100	2.14	**U**	<U	53	1.84	**U**	**U**	53	2.06	cf.	<U	36	1.92	2.26
(19)	100	2.50	<U	**U**	68	2.21	<U	**U**	68	2.79	cf.	**U**	39	2.62	1.99
(20)	100	2.14	**U**	<U	53	1.84	**cf.**	**U**	53	(2.33)	**U**	<U	32	2.14	2.70
(21)	100	2.14	**U**	<U	53	1.84	**U**	**U**	53	2.06	cf.	<U	36	1.92	2.26

Notes: U=parents with at least upper secondary education, <U=parents with less than upper secondary education; cf.=counterfactual distribution resulting from previous manipulations

sition rates to tertiary education. Row 9 displays possible margins of the effects that interventions at Gymnasium performance development might have. Dropout rates will decrease to the extent that they are due to primary effects. As a result, counterfactual dropout rates from the Gymnasium will be somewhere between the rates of both groups (col. 8) and in the end, between 18 and 23 students will enter higher education. The more realistic examples in rows 8 and 9 confirm the tendencies that have already been visible in the more naïve examples in rows 6 and 7: reducing Gymnasium dropout is more effective in elevating participation rates and intervening at Gymnasium performance is more effective in retaining performance.

Rows 10 (as a lower bound scenario) and 11 (as an upper bound scenario) display what can be achieved if social inequalities during the Gymnasium sequence could be completely neutralised. This could lead to 23-27 students from low educated families (col. 13) that would enter higher education, which is more compared to intervening at the last transition (row 5).

Rows 12-18 are devoted to the manipulation of the transition from elementary school to the Gymnasium. I start again with the naïve examples that only take into account the changing performance distributions throughout the whole sequence. Neutralising secondary effects (row 12) would result in 68 instead of 39 Gymnasium entrants, in 54 instead of 32 Gymnasium graduates, and in 26 instead of 17 tertiary education students. However, these increased participation rates come at the price of decreasing the mean performance levels at all stages (columns 6, 10 and 14). Neutralising primary effects (row 13) would increase the number of Gymnasium entrants and graduates, but to a lower extent as compared to neutralising secondary effects. Surprisingly, it would result in the same number of 26 higher education students, which would however possess a more favourable performance distribution (2.10 vs. 2.60). Neutralising both primary and secondary effects at the first transition (row 14) would more than double the participation rate in higher education (36 instead of 17 students) and leave the performance distributions after each transition practically unaltered if compared to the factual situation of the underprivileged group.

Rows 15-18 shall again guide through more realistic considerations of interventions at the first transition. Neutralising secondary effects (rows 15 and 16) leads to the inclusion of more underperforming students to the Gymnasium population. This might impact the dropout rates in that they should be even higher than in the factual case. On the other hand, one can assume again that as a consequence of enhanced educational aspirations the part of dropout which is related to secondary effects should indeed decrease. Depending on which mechanism prevails, it either leads to decreases (row 15) or increases (row 16) of participation rates.[19] Rows 17 and 18 describe the lower and upper bounds of interventions at primary effects at the first transition. Depending on which consequences these manipulations have for performance development and dropout during the Gymnasium sequence, early interventions that lead to a neutralisation of performance deficits are able to increase higher education participation rates to 26-36 instead of 17. In both cases, performance levels would be superior to those of the factual scenario.

If we compare the potential impact of single interventions at each of the three transitions, one can state that the earlier they take place, the more effective they are in raising the number of students that end up in higher education. Interventions at elementary school are clearly resulting in the most pronounced increases. But one should also consider that a unilateral neutralisation of secondary effects results in the strongest devaluation of tertiary students' performance if it takes place in elementary school.

I proceed with the simulation of joint interventions at all educational transitions. Since it is not clear whether dropout is more related to primary or secondary effects, I fix it to the value of students from educated families in all scenarios. In row 19, secondary effects are neutralised at each of the transitions. This would increase the number of higher education students from low educated families to 39. However, among them would be relatively more poor performing students (the average GPA would be 2.62 instead of 2.36). In row 20 the performance distributions at all levels are replaced by the performance distributions of students from highly educated families. This would result in 32 higher education students with an average GPA value of 2.14. Row 21 repeats the combinations of row 20 but leaves the performance distribution of Gymnasium graduates (col. 11) to be the outcome of all previous manipulations instead of imposing the distribution of the reference group. A comparison of the upper secondary GPA values in rows 20 and 21 reveals that neutralising primary effects in the first two transitions already leads to a performance composition among upper secondary graduates from low educated backgrounds which is more favourable than the factual performance distribution of students from highly educated families (2.06 vs. 2.33). The combination in row 21 would increase the number of higher education students to 36 with a mean upper secondary GPA of 1.92.

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[19] Note that participation rates can never decrease below the rates of the factual situation, since those who make the transitions in the factual situations are not altered by the interventions.

Discussion

In this paper I have presented a way of considering the cumulative impact of primary and secondary effects across various transitions. It is based on the method proposed by Erikson and colleagues (2005), which originally was designed to consider single educational transitions separately. But due to its properties of not being dependent on individual level data, it can be used as well for the consideration of educational pathways that include more than one transition. This is particularly valuable if, like in the German case, adequate longitudinal data on individual education biographies are missing. My paper was for the most part devoted to the German situation and proposing solutions on how to gather information from different data sources in order to construct an artificial cohort which is progressing from elementary to tertiary education. But the consideration of the cumulative impact of primary and secondary effects can of course be accomplished with real cohort data as well – with much less effort. And I would be happy to encourage replications of my simulation exercise with different data and for different countries.

Some limitations of the study presented above should however be mentioned. First, since the simulation procedure is based on the technique by Erikson and colleagues, it is of course subject to all critique which is directed to their method. This includes the question whether primary and secondary effects really can be distinguished empirically, the role of anticipatory decisions, the way secondary effects are defined under institutional constraints etc. I won't repeat the discussion of drawbacks and advantages here in detail. However, considering the technique for the simulation exercise is based on the notion that the value and the advantages of the method outweigh the disadvantages by far. Second, a simulation study necessarily has to simplify reality to some extent. In this case, assumptions had to be made about how unobservable factors influence the counterfactual sequences. I have presented naïve scenarios which implicitly assume that everything except for performance compositions remains unaffected by the manipulations. This is highly unrealistic but can serve as a way of enhancing the understanding of certain mechanisms if interpreted cautiously. I have also discussed scenarios with reference to more realistic assumptions – although by no means exhaustively. It might have become clear that the more realism is added to the simulation the vaguer become the conclusions that can be drawn. While I could present single numbers in the naïve versions, I could only show more or less plausible margins in the more realistic versions. Third, it is debatable which indicator should be used for operationalizing primary effects. Although the choice was pretty much based on data availability in this paper, drawing on school performance instead of more inherent ability measures, such as cognitive test results or IQ, has some theoretical advantages. Since performance as measured in grades is visible to the student (and others as well) and ability is not, the former should be more relevant for the subsequent educational and labour market career (cf. the discussion in Jackson et al. 2007).[20] Fourth, in my study I have only looked at one specific track of the German education system: the direct pathway from elementary school through the Gymnasium to higher education. However, the German school system provides various alternative routes to higher education, most of which are particularly attracting students with low educated backgrounds. As an example, Table 9 displays a comparison of students that obtained their upper secondary degree at the Gymnasium and students that obtained their degree at any alternative institution. Obviously, alternative routes to upper secondary are much more common among students from low educated families. Moreover, at these alternative institutions both primary and secondary effects seem to operate in the opposite direction: the mean GPA is more favourable among students from low educated backgrounds, while their transition rates to tertiary education are higher. Although performance and transition rates are generally lower at these alternative upper secondary institutions, considering only the Gymnasium pathway overestimates social inequalities.

Table 9: Attendance, GPA and transition rates, by social background and upper secondary institution

upper secondary degree obtained at	Gymnasium		Other institution	
overall attendance rates	56.53		43.47	
parental education	< upper sec	>= upper sec	< upper sec	>= upper sec
within-group attendance rates	45.99	71.35	54.01	28.65
mean GPA	2.54	2.31	2.53	2.63
transition rate to higher education	54.62	69.74	54.71	49.93

Data: HIS upper secondary graduates survey 1992 (weighted data).

Fifth, terminating the simulation study with enrolment to higher education might be considered as a cutting point which is one transition too early. One might wish to include graduation from tertiary education as well. I agree. However, the choice to stop the procedure with tertiary enrolment was again driven by data availability. As soon as data is available that covers the period from higher education enrolment to graduation, this sequence can easily be incorporated by analysing primary and secondary effects of higher education dropout.

Finally, even though the aim of this paper is primarily of a conceptual and methodological nature, its findings also bear some interesting substantive results. Left aside that the data are

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[20] Apart from theoretical reasons which point to a preference for school performance, the use of ability measures can however make sense for empirical reasons, when performance is assumed to be significantly distorted by e.g. anticipatory decisions.

somewhat historical and not dealing with the most recent cohorts, the main message that emerges is that interventions are the more effective the earlier they take place. However, political interventions that are aiming to reduce social inequalities in educational participation and attainment have to find a balance between the reduction of primary and secondary effects. The simulations have shown that a unilateral neutralisation of secondary effects can be very effective in increasing participation numbers at various educational stages. But this disregards that it would strongly devaluate the performance levels of the students at the same time. The shares of underperforming students that end up in higher levels of education would increase substantially. The analyses might suggest that a combined effort to neutralise both primary and secondary effects at early stages of the education system promises the most efficient outcomes with respect to increasing participation numbers in higher education while also retaining acceptable performance levels.

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Appendix

Table A 1: Empirical and kernel density estimated performance cell frequencies, by social background

	Parents <upper secondary		Parents >=upper secondary	
grade	empirical	kernel density	empirical	kernel density
1.0	3.28	0.77	8.72	1.85
1.1		0.98		2.22
1.2		1.23		2.63
1.3		1.53		3.08
1.4		1.91		3.60
1.5	9.23	2.37	17.72	4.20
1.6		2.93		4.87
1.7		3.55		5.58
1.8		4.20		6.26
1.9		4.76		6.77
2.0	29.61	5.15	40.94	6.98
2.1		5.35		6.83
2.2		5.37		6.38
2.3		5.30		5.75
2.4		5.17		5.08
2.5	24.40	5.02	19.19	4.44
2.6		4.84		3.86
2.7		4.66		3.34
2.8		4.46		2.89
2.9		4.23		2.49
3.0	20.91	3.95	9.66	2.14
3.1		3.59		1.82
3.2		3.18		1.53
3.3		2.74		1.25
3.4		2.33		1.01
3.5	8.29	1.96	3.22	0.81
3.6		1.65		0.63
3.7		1.39		0.48
3.8		1.16		0.36
3.9		0.97		0.25
4.0	3.65	0.80	0.40	0.18
4.1		0.65		0.12
4.2		0.51		0.09
4.3		0.39		0.06
4.4		0.28		0.05
4.5	0.52	0.20	0.13	0.03
4.6		0.14		0.03
4.7		0.10		0.02
4.8		0.07		0.01
4.9		0.05		0.01
5.0	0.10	0.03	0.00	0.00
5.1		0.02		0.00
5.2		0.02		0.00
5.3		0.01		0.00
5.4		0.01		0.00
5.5	0.00	0.00	0.00	0.00
5.6		0.00		0.00
5.7		0.00		0.00
5.8		0.00		0.00
5.9		0.00		0.00
6.0	0.00	0.00	0.00	0.00
total	100.00	100.00	100.00	100.00

Figure A 1: Fitting kernel density estimates with varying bandwidth (Fauser data)

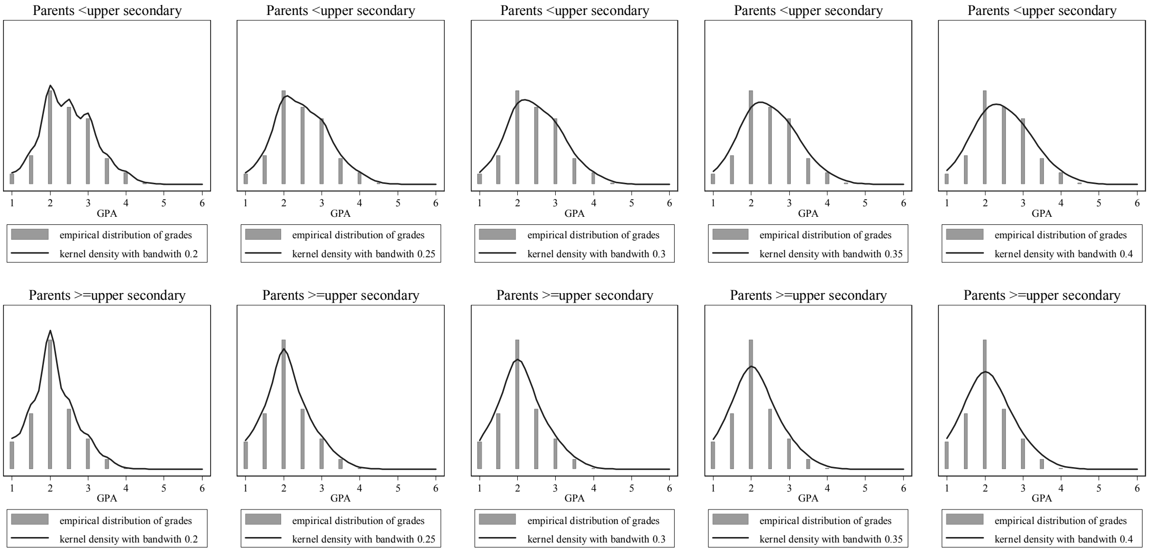

Figure A 2: Fitting kernel density estimates with varying bandwidth (HIS data)

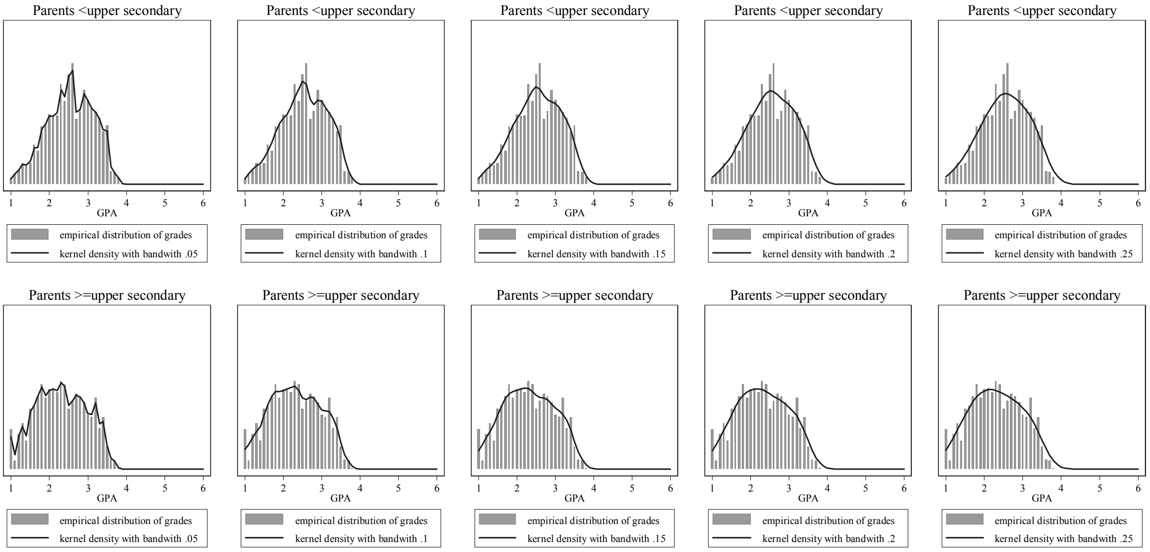

Figure A 3: (Counter-)factual weighting factors for the transformation of performance distributions