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Early transitions and tertiary enrolment: The cumulative impact of primary and secondary effects on entering university in Germany.

Martin Neugebauer[1] & Steffen Schindler

Abstract
Our aim is to assess how the number of working class students entering German universities can effectively be increased. Therefore, we estimate the proportion of students from the working class that would successfully enter university if certain policy interventions were in place to eliminate primary effects (performance differentials between social classes) and/or secondary effects (choice differentials net of performance) at different transition points. We extend previous research by analysing the sequence of transitions between elementary school enrolment and university enrolment and by accounting for the impact that manipulations at earlier transitions have on the performance distribution and size of the student 'risk-set' at subsequent transitions. To this end, we develop a novel simulation procedure which also seeks to find viable solutions to the shortcomings in the German data landscape. Our findings show that interventions are most effective if they take place early in the educational career. Neutralizing secondary effects at the transition to upper secondary school proves to be the single most effective means to increase participation rates in tertiary education among working class students. However, this comes at the expense of lower average performance levels.

Keywords: Educational inequality, Transition research, Primary and secondary effects, Simulation study, Germany, Social stratification.

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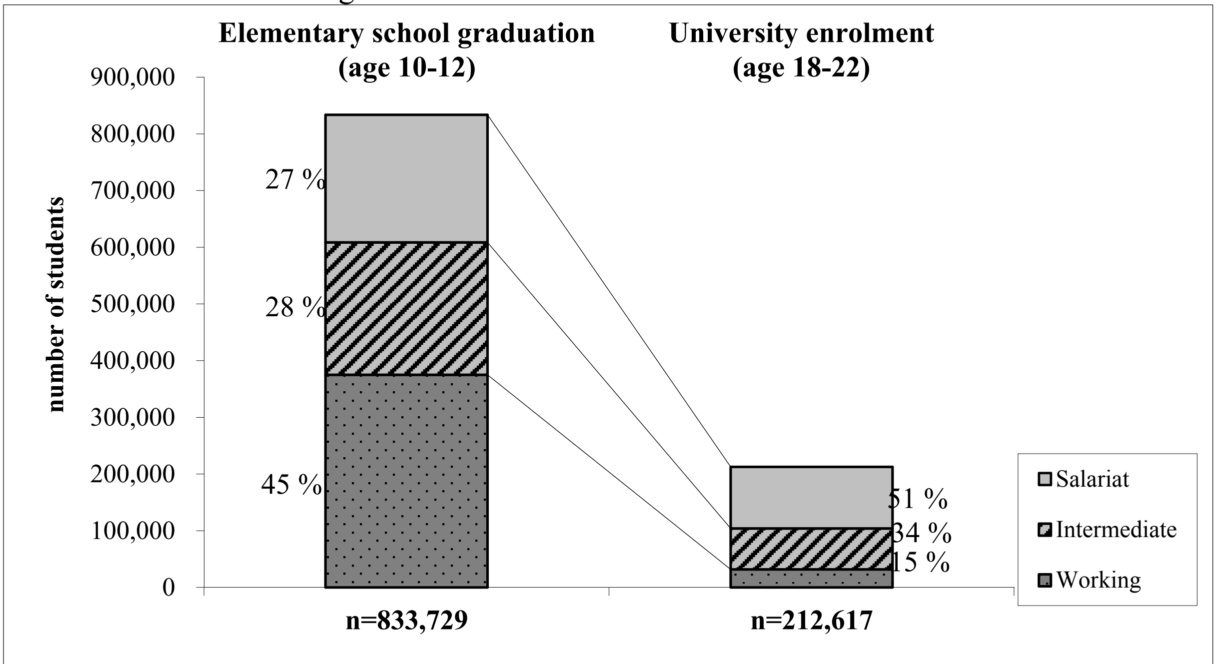
1 Aim and background

Despite decades of educational expansion, university[2] enrolment in Germany is low and socially selective (cf. Mayer et al., 2007). This situation is illustrated in Figure 1. It displays the distribution of class backgrounds from a German birth cohort that has recently reached the age of university enrolment. The figure shows that overall only a small subgroup of the birth cohort (26 per cent) enrols in university, well below the OECD average of 38 per cent (OECD, 2010). Among this subgroup, students of working class origin are severely underrepresented (with a share of only 15 per cent). This suggests that youths from working class families do not or cannot, within the educational system, tap their full potential.

Figure 1 Participation rates of a 1985 birth cohort from different class backgrounds at two educational stages



Notes: We used father's class position as an indicator (3 category EGP). In the first column all students born in 1985 are counted who attended elementary school in 1993. In the second column all students born in 1985 are counted who enrolled in university between 2003 and 2008. Class origins are calculated from Microcensus 1993 at age 8 and from the HIS School Leaver Panel 2004 for first-year university attendance; Total numbers of students are calculated from official statistics (German Federal Statistical Office, Fachserien 11.1 and 11.4.1, different years).

The obvious solution to these two interrelated problems – low university enrolment in combination with high inequality – is to facilitate access to university for students from lower class backgrounds. This reasoning motivates the research question of our paper: how can we increase the number of university students from working class backgrounds?

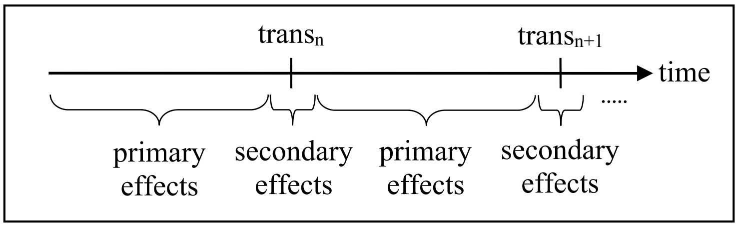
Researchers of social stratification conceive university enrolment as the result of a sequence of successive educational transitions between grades or levels of education (Mare, 1980). At certain transition points in a given educational system, students (and their families) typically have to decide between different educational pathways, or they have to decide whether

[2] We use the term 'university' to refer to any type of tertiary education institutions (General Universities, Universities of Applied Science, Colleges of Education).

to continue schooling or leave. At each transition, social background has an effect on the transition behaviour. It is well known that this inequality in school transitions is not reducible to differences in academic performance (primary effects). That is to say, even at the same level of performance, students from low social origins have a lower propensity of entering the more ambitious pathways than their peers from higher social origins (secondary effects, cf. Boudon, 1974). Primary effects are assumed to depend on differences in socio-cultural resources. In turn, secondary effects are the result of differing educational choices. Such choices are seen as the outcome of cost-benefit considerations or values that actors attach to certain educational alternatives. Note that the above mentioned transition model (Mare, 1980) has important implications for the concept of primary and secondary effects if we are interested in not just a single transition but the educational life course. It follows from the model, that a selective attrition of the population that passes through earlier transitions should lead to an increasingly homogenous student body with respect to the distribution of academic abilities at later transitions (Mare, 1980: 298-299). Consequently, primary effects of social origin should be of reduced importance at the transition to tertiary education. In addition, if students are also becoming increasingly homogenous with respect to unobserved characteristics affecting transition behaviour, such as educational aspirations, secondary effects should be diminished at later transitions as well (Mare, 1980).

The concept of primary and secondary effects is a useful theoretical framework for our research question, even if the underlying mechanisms leading to one or the other are not entirely independent (cf. Jackson et al., 2007). In our reading, primary effects can be seen as a result of influences *prior* to a decision point, while secondary effects are the result of active choices *at a decision point*, made within the constraints set by previous performance. As such, the distinction structures potential interventions which may charge at different time points. The following graph illustrates this:

Figure 2 Temporal model of primary and secondary effects over the educational life-course



We argue that knowledge about the relative contribution of primary versus secondary effects identifies the scope of inequality which can be reduced by implementing policy measures aimed at tackling one or the other effect. With this concept we can identify several critical phases during which educational inequality occurs, and during which students from low status backgrounds are diverted from entering tertiary education. As we are interested in the most effective means to increase the number of working class students at university, we want to know: which of these phases is most responsible for diverting the working class offspring from entering university? And thus: where are potential interventions most promising?[3]

[3] For example: What kind of policy interventions would reduce performance differentials during elementary school? Out of the many possibilities, one can think of all day schooling programs or preschool initiatives to

In this article, we propose a simulation technique which extends a method developed by Erikson et al. (2005). We extend previous research by analysing the sequence of transitions between elementary school enrolment and university enrolment and by accounting for the impact that manipulations at earlier transitions have on the performance distribution and size of the student 'risk-set' at subsequent transitions. The basic idea is to follow groups of students from different class backgrounds through the educational system and to estimate relative group sizes and performance compositions at each educational stage. With this approach we show where working class students 'get lost' along the way to tertiary education. For the purpose of evaluating the scope for policy leverage, we then move beyond the description of factual situations to construct counterfactual situations. They can be used to determine what would happen to mobility or inequality if different interventions were tried than the policies historically observed (Cunha et al., 2006). We simulate the impact of ideal-typical interventions which would successfully neutralize primary or secondary effects or both at different points in the educational career. That is, we estimate the proportion of students from the working class that *would* successfully enter university *if* certain policy interventions were in place to eliminate primary and/or secondary effects.[4] Note that realistic interventions are unlikely to completely eliminate primary and/or secondary effects, and hence would have less noticeable effects. However, we aim to produce upper-bound estimates of potential interventions, to identify the available scope for policy leverage at different phases in the educational life course.

2 Institutional background

Despite some complexities and variation over federal states (cf. KMK, 2010), the ideal-typical sequence of the 'academic route' in Germany is relatively simple and it is chosen by the vast majority of students entering university. Among those, we will simulate how social inequalities in entering university would change by manipulating primary and secondary effects at the transitions which lie in between.

The first major branching point comes around the age of 10 when elementary school children are selected, according to their demonstrated performance, into one of the different secondary school types. About 40 per cent of all students transfer to *Gymnasium* (Autorengruppe Bildungsberichterstattung, 2010), which is the most demanding track, and the only one leading directly to the *Abitur*. *Abitur* is the required entrance qualification for tertiary education.[5] Thus, at an early point in the educational career, most students are largely excluded from later enrolment opportunities in tertiary institutions. Initial secondary track allocation is, however, not necessarily the final destination, as mobility during secondary school is possible. Track mobility can arise from an erratic initial allocation or an unexpected learning development. According to Bellenberg et al. (2004: 81) during secondary school about 15 per

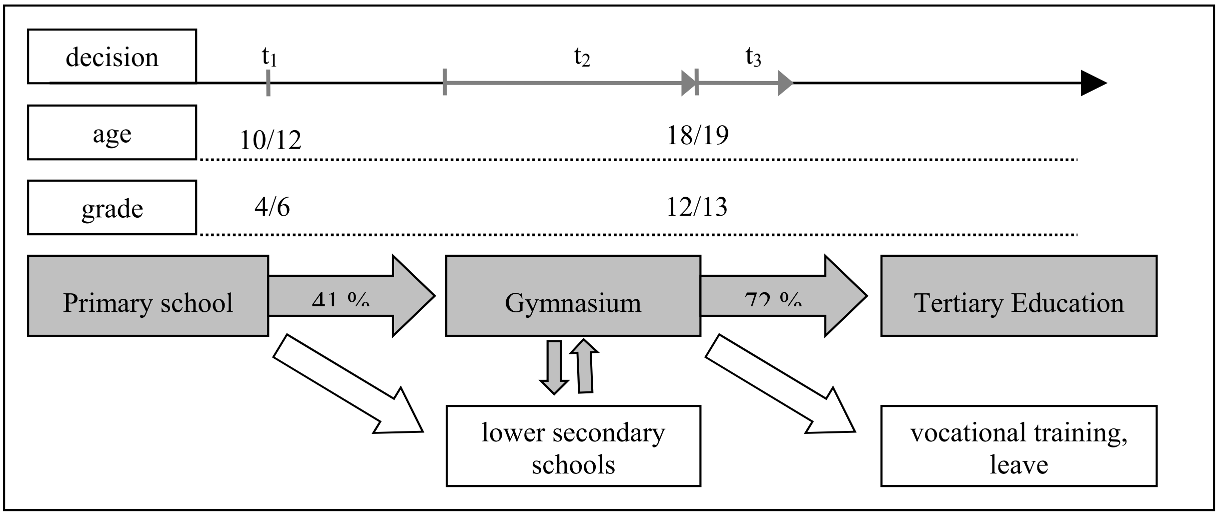
stimulate and monitor learning among disadvantaged children. Early interventions reducing secondary effects could, for example, aim at the provision of information on the long-term benefits of upper secondary education.

[4] We assume that vacancies for more university students will be available. Given that policy makers have an interest in such a development, and given that the labour market calls for more university graduates, we believe this to be a plausible assumption.

[5] In addition, it is possible to obtain eligibility for higher education after phases of vocational training or enrolment at institutions of further education, but the Gymnasium is by far the most important route.

cent of all students at least once change the school type, most of them to a lower track. Thus, unlike the clear cut transition at the end of elementary school, only a minority of students experiences a transition during secondary school.

Figure 3 Stylized educational system in Germany



Notes: The figure displays the path from primary education through the general Gymnasium and from there to tertiary education. In a stylized form, the major decision points with the corresponding age and grade levels are depicted. The numbers in the arrows depict the most recent transition rates (according to Autorengruppe Bildungsberichterstattung, 2010 and Heine, Quast, & Beuße, 2010).

After receiving an entrance qualification to tertiary education, students can enrol in traditional research universities (*Universitäten*) or in universities of applied sciences (*Fachhochschulen*). As an alternative to tertiary education, vocational training is frequently chosen by upper secondary school graduates (~ 30 per cent), as it is associated with relatively favourable employment prospects (Reimer and Pollak, 2010). The availability of this attractive alternative to higher education may divert working class children from a tertiary educational career (Becker and Hecken, 2009). In combination with the fact that only relatively few students obtain eligibility to enrol in university, this may explain the comparatively low share of university graduates in Germany.

3 Previous research

While various studies discuss whether the influence of social origin has changed across cohorts, only few studies analyse whether it changes across transitions within cohorts. From a comparative perspective, Blossfeld and Shavit (1993) conclude, that in 12 out of 13 countries the effects tend to be strongest at earlier transitions and then decline for later transitions (see also Mare, 1980; Müller and Karle, 1993; Breen and Jonsson, 2000). For Germany, a recent study by Hillmert and Jacob (2010) draws a detailed picture of the life-course development of educational careers of a 1964 birth cohort by analysing the most relevant types of educational transitions associated with the academic track. They provide evidence that students are diverted from the academic track at various transition points, including the time span between Gymnasium enrolment and completion (i.e. drop-out). While the above mentioned studies highlight the importance of a longitudinal transition perspective for understanding the process of educational attainment, they do not incorporate the concept of primary and secondary effects in their models. In recent years, however, decomposition methods have been developed to assess the relative importance of primary and secondary effects in binary choice models (Erikson et al., 2005; Buis, 2010; cf. Karlson and Holm, 2011 for an alternative method). These methods have been applied in different countries, but the studies have mostly been restricted to one specific transition, typically the first major transition in the respective educational system (Erikson and Rudolphi, 2010; Jackson et al., 2007; Kloosterman et al., 2009). For Germany, Neugebauer (2010) and Relikowski et al. (2009) estimate that secondary effects account for 43-59 per cent of class differentials at the transition to Gymnasium. For the transition to university, according to Schindler and Reimer (2010), secondary effects are even more pronounced than at the first transition, accounting for 75-91 per cent of the differential between salariat class and working class offspring. However, such estimates can be misleading, as prior selectivities on the way to tertiary eligibility are not considered. To our knowledge the only study which has incorporated the empirical distinction of primary and secondary effects over several subsequent transitions has been carried out by Becker (2009). Becker simulates the extent to which the selective neutralization of either primary or secondary effects at a given educational transition would result in an increase of the number of lower background students that would end up in higher education. While we find Becker's conceptual approach appealing, the study bares several methodological shortcomings.

4 Conceptual approach

We propose a novel technique based on real data, which improves several methodological shortcomings of Becker's approach. First, we analyse actual transitions instead of mere intentions. Second, we recognize the fact that performance is continuous and that transition propensities differ at each level of performance – and incorporate it in our simulation strategy. Third and most importantly, our simulation takes into account the impact that manipulations at earlier transitions have on the performance composition and size of the student group that constitutes the risk-set of any following transition. In order to keep the simulation study in reasonable dimensions, we chose to compare only two groups: students from working class backgrounds with students from salariat backgrounds. We proceed as follows: we start with a hypothetical number of 100 students from each group (100 in order to interpret changes in per cent). From survey data, we observe the proportion of students in each group making the transition to upper secondary school (t_1, henceforth) and their respective performance distribution before and after the transition. Formally,

$$N_{1g}(x) * t_{1g}(x) = N_{2g}(x), \qquad (1)$$

where $N_{sg}(x)$ denotes the number of students at performance level x for a group g in a given situation s (here, s=1 is the end of elementary school and s=2 is the situation right after the transition to the Gymnasium) and $t_{sg}(x)$ denotes the transition propensity to the next educational level (s+1) for each performance value x. The shape of the performance distribution of any group g in any situation s shall be denoted by $D_{sg}(x)$. Accordingly, the result of equation (1) provides us with information on the size of the group that made the transition to the Gymnasium N_{2g}[6] and on the shape of this group's performance distribution $D_{2g}(x)$. In a second step, again using survey data, we calculate changes in group size N_{sg} and performance distribution $D_{sg}(x)$ for the time span between upper secondary school enrolment and completion (t_2, henceforth). As pointed out before, this is not really a transition but a development over several years. Because survival at the Gymnasium is, among other things, caused by performance, the number of students (out of the 100 students from each class) as well as their performance distribution changes during t_2. These events lead to a selective group of students who successfully graduate from the Gymnasium. Formally,

$$N_{2g}(x) * t_{2g}(x) = N_{3g}(x), \qquad (2)$$

We explain in the data section how we compute $t_{2g}(x)$ in our concrete case in order to obtain information on the performance distribution (and the group size) of the subgroup graduating from the Gymnasium. At the transition to university (t_3, henceforth), we again observe (from survey data) class specific transition rates as well as class specific performance distributions before and after the transition. Accordingly, we adjust the number of students that make the transition. Analogous to the prior transitions, we can write

$$N_{3g}(x) * t_{3g}(x) = N_{4g}(x), \qquad (3)$$

Combining formulas (1), (2) and (3), the whole sequence from $N_{1g}(x)$ to $N_{4g}(x)$ can be written as:

$$N_{4g}(x)= N_{1g}(x) * t_{1g}(x) * t_{2g}(x) * t_{3g}(x) \qquad (4)$$

With this model we can estimate, at the group level, the performance distribution (and the group size) of a group of tertiary education entrants, given information on the performance composition at the end of elementary school ($N_{1g}(x)$), and given their subsequent transition functions. Up to this point, our model is based on factual situations. These factual situations serve as a standard of comparison for the next step. In order to estimate the importance of primary and secondary effects at each transition, we are interested in counterfactual questions, such as: what if working class students at t_1 retained their own transition propensities but took on the level of performance of students of salariat background? Departing from formula (4), one is able to conduct counterfactual analyses by replacing the factual components with counterfactual (c) ones:

$$N_{4c}(x)= N_{1c}(x) * t_{1c}(x) * t_{2c}(x) * t_{3c}(x) \qquad (5)$$

[6] $N_{sg} = \sum_x N_{sg}(x)$, where $N_{sg}(x)$ is the number of group members in performance category x.

Our intention is to simulate ideal-typical worlds in which 'no primary' or 'no secondary' effects exist, in order to show the leeway for potential interventions. To this end, we draw on the model of Erikson et al. (2005) to obtain counterfactual components. In this model, it is assumed that the choice characteristics of students of one class can be combined with the performance distribution of students of another class to produce a counterfactual or potential outcome. The importance of primary effects can be estimated by comparing two groups which only differ with respect to their performance distributions. Similarly, the importance of secondary effects can be estimated by comparing the transition rates of an actual and a counterfactual group, which only differ with respect to transition propensities (cf. Jackson et al. 2007 for a more comprehensive description of the method).[7] Note that the method requires only group level information: the performance distribution of each group and the propensity to choose the academic route at each level of performance. Returning to our example ('what if working class students at t_1 retained their own transition propensities but took on the level of performance of students of salariat background?'), we construct a counterfactual group which has the transition propensity of the working class group and the performance distribution of the salariat group and calculate their transition rate. In comparing this transition rate to the factual transition rate of the salariat, we can estimate the importance of secondary effects at t_1. Note that in such a scenario subsequent transition patterns are counterfactual (unobservable), as the student risk-set, defined by the number of ('what-if' working class) students as well as their performance distribution have changed. With our model we can account for these compositional changes and adjust the student 'risk-set' – in terms of performance distribution $D_{sg}(x)$ and group size N_{sg} – for the following transitions accordingly. Note that concerning the transition propensity at subsequent transitions, we have to make an assumption on how the counterfactual group would have behaved had they reached this educational branching point. In different scenarios, we assume that subsequent transition propensities resemble either those of the factual working class or of the factual salariat class. Then we follow the group until they enter university and end up with a hypothetical number of working-class students that *would* enter university *if* secondary effects at t_1 had been neutralized. We can repeat this exercise for a wide range of scenarios, in which we simulate the effects that interventions at various stages have on the composition of students entering university. We show the most interesting ones in the results section.

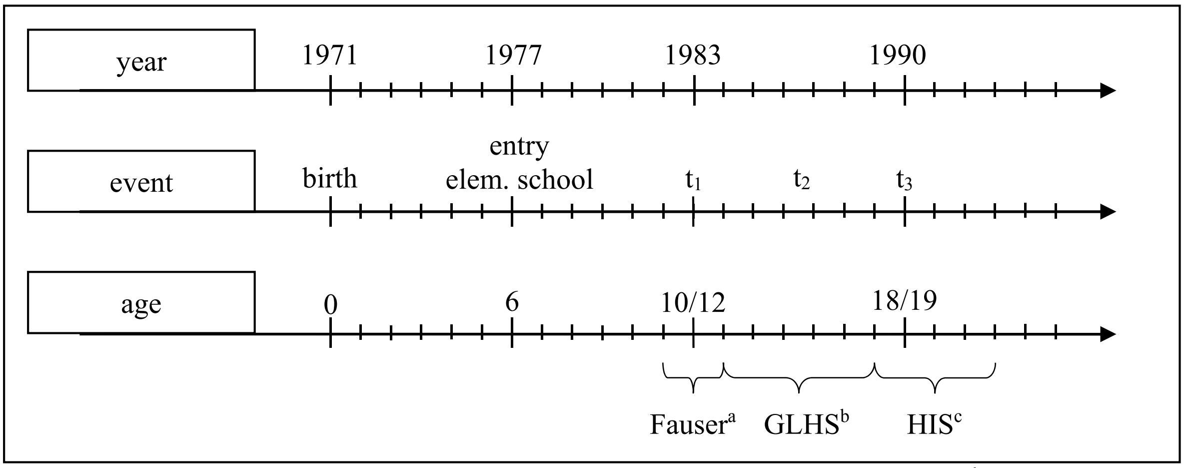
5 Data

As Germany is still lacking proper longitudinal cohort data with information on educational trajectories including performance measures, we constructed a quasi-longitudinal cohort dataset. A valid and viable solution is to collect data at different points in time; when at each time point, the samples are representative of their groups, this approach can effectively track changes at the group level (De Vaus, 2001). In our study, three independent samples of students, born at the same time, are compared to map the educational career across all three branching points. This is not as big a disadvantage as it might seem at first, because our simulation requires only group level variables. Three pieces of information are necessary: comparable

[7] Some implications of the model can be seen problematic. First, secondary effects are treated as residual effects. Thus, in as much as the performance variable is prone to measurement error, the contribution of primary effects will generally be underestimated. Second, "anticipatory decisions" (cf. Erikson et al. 2005: 9733) are likely to lead to underestimation of the secondary effects. The two mechanisms are likely to counteract each other.

categorization of social background across all datasets, group specific performance distributions prior to the transitions and class specific transition propensities at each level of performance. We employ three datasets that correspond to a West German 1971 birth cohort and cover their educational career from the end of elementary school to tertiary enrolment (cf. Figure 4).

Figure 4 Construction of a quasi-longitudinal 1971 birth cohort study



Notes: [a] Fauser: Richard Fauser's 'transition to secondary school' – study (ZA No. 1612); [b] GLHS: German Life History Study 1971 (ZA No. 3927); [c] HIS: Higher Education Information System School Leaver Panel 1990.

For the *transition from elementary school to the Gymnasium*, we employ data from the Fauser-study (Fauser, 1984). The sampling frame consists of families from four different federal states in Germany who had children in the last year of elementary school in the school year 1982/83. The first of two waves was carried out in 1982/83, when children attended the last year of elementary school. The second wave was administered in 1984, after the children had transferred to a secondary school track. We construct a dichotomous variable indicating whether or not a student transferred to the Gymnasium. After listwise deletion, the analytical sample consists of 2620 cases.

For *the sequence from entering Gymnasium to graduating from it* (i.e. obtaining *Abitur*), we draw on data from the 1971 birth cohort in the German Life History Study (GLHS) (Hillmert and Mayer, 2004), which contains detailed retrospective life course information. We limit our analysis to respondents who went through the West German educational system. To obtain net survival rates at the Gymnasium, we calculate how many students with a given social background enter Gymnasium at the beginning (N_{2g}) and how many students with that social background graduate from it (N_{3g}).[8] After listwise deletion, we end up with an analytical sample of 1209 cases.

For the *transition to tertiary education* we draw on the Higher Education Information System (HIS) School Leaver Panel 1990. Graduates were interviewed half a year (wave 1) and three and a half years (wave 2) after graduation. In order to observe actual postsecondary schooling decisions rather than intentions, we use information from the second wave. We construct a dichotomous variable indicating whether or not a student, within 3 ½ years after

[8] We count only those students who have obtained their degree at a Gymnasium before reaching the age of 21. Because there is the possibility of grade repetition (staying down a year) and in a few cases late elementary school enrolment, we choose age 21 instead of 18/19.

graduation, enrolled in a higher education institution. To increase comparability over datasets, we restrict our analysis to students born in 1970/71, who obtained their degree via the conventional academic route and who come from the four federal states that constitute the sampling frame of the Fauser data. After listwise deletion we end up with an analytical sample of 5805 cases. In all analyses we apply sample weights provided by the data producers, which account for selective non-response and panel attrition.

While our strategy of relying on three different data sources might be seen as problematic, we have done anything to maximize comparability across the datasets. In addition, we conducted several sensitivity checks with other datasets and other sample compositions.[9] The results were essentially the same. Thus, although not perfect, we believe to have found a reasonable solution to the lack of real cohort data when analyzing educational careers in Germany.

Social origin. We take class of father as our indicator of students' class background and rely on mother's class in case father's information is missing. We work with a threefold collapse of the Erikson-Goldthorpe schema: salariat or service class (Classes I and II), intermediate classes (Classes III and IV) and working class (Classes V, VI and VII).

Academic performance. At the transition to Gymnasium and the transition to tertiary education, we capture primary effects through grade point averages (gpa), as this measure is comparable across transitions. As there is no ability testing, grades are the most sensible measure for primary effects in Germany (cf. Stocké, 2007). At the first transition, we employ the average of the two most important grades (German and Mathematics) that appeared in the final elementary school report card. At the transition to tertiary education, we use the grade point average obtained in the graduation certificate ('Abitur'). The German grading system runs from 1 to 6: 1 (excellent), 2 (good), 3 (satisfactory), 4 (sufficient), 5 (poor), 6 (insufficient). We do not have performance information (in the GLHS) for 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. However, since we have information on the shape of the performance distribution $D_{2g}(x)$ of Gymnasium entrants from the Fauser data and on the shape of the performance distribution $D_{3g}(x)$ of Gymnasium graduates from the HIS data, we are able to generate a transformation factor which translates the former distributional shape into the latter for each group: $t_{2g}(x) = D_{3g}(x)/D_{2g}(x)$.[10] 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. However, the performance distribution of the Gymnasium graduates is not only the result of their performance development since enrolment; it is also influenced by drop-out from Gymnasium. It is plausible to assume that Gymnasium drop-outs 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. Accordingly, the performance development deducted from the comparison of the grade

[9] Other datasets were, for t_3, more recent HIS Panels, and for t_1 the DJI Kinderpanel 2003/2004 as well as PIRLS 2001 data. For several reasons (among them, the impossibility to construct a quasi-longitudinal cohort) we opted for the presented data bases.

[10] This is possible because grades are measured on the same scale in both datasets. Figure A1 in the appendix shows a graphical representation of the weighting factors for the transformation of performance distributions, by social background.

distributions does not only reflect primary effects of the Gymnasium sequence but is also influenced by secondary effects. As mentioned above, we calculate class-specific net survival rates from the Gymnasium to account for these shifts. Table 1 depicts summary information on educational sequences for each social background group. It shows, separately for each transition, observed transition/survival rates. It also describes mean grade point averages (mean gpa) for the respective population at risk to select 'Gymnasium' and tertiary education, as well as for the subgroups actually selecting these options. In the following analysis we will piece together the single transitions and observe the educational life course up to university enrolment.

Table 1 Transition rates into 'Gymnasium' (t_1), net survival rates from 'Gymnasium' enrolment to completion (t_2), transition rates into university (t_3), and corresponding mean grade point averages for students from different class backgrounds.

		t_1		t_2		t_3	
Social Origin	mean gpa of entire sample	transition rate	mean gpa of subgroup continuing to 'Gymnasium'	net survival rate	mean gpa of entire sample	transition rate	mean gpa of subgroup continuing to university
Salariat	2.16	74 %	1.96	93 %	2.35	82 %	2.27
Intermediate	2.32	56 %	2.00	89 %	2.50	69 %	2.38
Working	2.59	27 %	2.05	82 %	2.59	62 %	2.48
			Odds Ratios				
S/W		7.84		2.68		2.76	
S/I		2.31		1.64		1.97	
I/W		3.39		1.63		1.40	

Notes: Odds calculations based on non-rounded transition rates. t_1: Fauser (n=2620); t_2: GLHS (n=1209); t_3 : HIS (n=5805); own calculations.

6 Results

6.1. The factual educational life course perspective

To begin with, we display in the first panel of Table 2 the factual situation for students from salariat families (row 1) and students from working class families (row 2). The table ought to be read from left to right, following each group's educational life course. We do not show the intermediate class for the sake of brevity. In each class, we have fixed the group sizes to a hypothetical number of 100 students (column 1). This allows for a per cent interpretation for the subsequent educational stages. As we already know from Table 1, students from the salariat class fare better in elementary school than their classmates from the working class (mean gpa of 2.16 vs. 2.59, cf. col. 2). In the next columns, we denote the group from which we draw the performance distribution (col. 3) and the transition function (col. 4). 's' stands for students from salariat backgrounds, 'w' for students from working class backgrounds and 'c' denotes counterfactual situations. As can be seen in column 5, 74 salariat class students and only 27 working class students make the transition to the Gymnasium. However, the selection processes at this first transition cause the performance distributions of Gymnasium entrants to be quite similar for both groups (col. 6). Next, we look at the period between Gymnasium enrolment and graduation (t_2). The group with salariat origin has a net survival rate of 93 per cent, while among the group of students with working class origin only 82 per cent 'survive' and successfully graduate from Gymnasium. Accounting for the net survival leads to 69 (74 * 93 per cent) salariat class students and 22 (27 * 82 per cent) working class students who successfully graduate from Gymnasium (col. 9). Note that the performance distributions for each class at graduation are not identical to the ones at enrolment. We observe two processes here: the overall grade distribution is widening[11], and the difference between classes is widening. Students from salariat backgrounds manage to be more successful in improving their performance throughout secondary education relative to students from working class families. In other words, their average performance development at the Gymnasium seems to be more favourable. This is captured by the class specific transformation functions $t_{2g}(x)$ as described above. The 69 Gymnasium graduates from salariat backgrounds have a mean gpa of 2.35 and the 22 graduates from working class backgrounds have a mean gpa of only 2.59 (col. 10). Out of the 69 salariat class students 56 make the transition to university. Out of the 22 working class students, only 14 enter university (col. 13). As an indicator of social inequalities in tertiary education participation, column 15 denotes the odds ratios of ending up in tertiary education between the salariat class reference group (row 1) and each of the subsequent factual and counterfactual working class rates. In the factual contrast, salariat class students are 7.82 times more likely than working class students to reach tertiary education when following the standard route through the Gymnasium (row 2). Despite selection on performance up to this point, the performance distribution among university entrants is still somewhat more favourable for students from salariat backgrounds (col. 14).

6.2. Counterfactual scenarios

In the following, we manipulate the progress through the education system for the group from working class families by replacing its performance distributions and/or transition functions with the respective values of the other group. Thus, we simulate the impact of ideal-typical policy interventions directed at neutralizing either primary or secondary effects or both at one or more transitions on the number of working class students entering universities. In this joint consideration there are six variables that can be altered: the performance distribution at the end of elementary school, the transition function from elementary school to the Gymnasium, the performance development at the Gymnasium, the net survival rate at the Gymnasium, the performance distribution of Gymnasium graduates, and the transition function from Gymnasium graduation to higher education. Out of the many counterfactual situations that can be constructed that way, we present the most interesting ones in panel 2 of Table 2.[12] Manipulated variables are indicated by a shaded area.

[11] The average grades of Gymnasium entrants are necessarily better than the average grades of Gymnasium graduates, since the former are a selection of the top performers in elementary school, while the latter again receive grades drawn from the entire grading scale.

[12] The simulation tool and our aggregate data can be accessed at www.mzes.uni-mannheim.de/publications/misc/simulation.xls, where it is possible to try out the various combinations of factual and counterfactual scenarios.

Table 2 Factual (panel 1) and counterfactual (panel 2) movements through the German education system

	Elementary school		Transition t_1 to Gymnasium		Gymnasium (enrolment)		Gymnasium (t_2)		Gymnasium (graduation)		Transition t_3 to Tertiary Education		Tertiary Education (enrolment)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
	no. of students	mean gpa	perform. distr.	transition function	no. of students	mean gpa	perform. developm.	net survival rate	no. of students	mean gpa	perform. distr.	transition function	no. of students	mean gpa	odds ratio S/W
(1)	100	2.16	$D_{1s}(x)$	$t_{1s}(x)$	74	1.96	$t_{2s}(x)$	93 %	69	2.35	$D_{3s}(x)$	$t_{3s}(x)$	56	2.27	1.00
(2)	100	2.59	$D_{1w}(x)$	$t_{1w}(x)$	27	2.04	$t_{2w}(x)$	82 %	22	2.59	$D_{3w}(x)$	$t_{3w}(x)$	14	2.48	7.82
(3)	100	2.59	$D_{1w}(x)$	$t_{1w}(x)$	27	2.04	$t_{2w}(x)$	82 %	22	2.59	$D_{3w}(x)$	**$t_{3s}(x)$**	17	2.51	6.21
(4)	100	2.59	$D_{1w}(x)$	$t_{1w}(x)$	27	2.04	$t_{2c}(x)$	82 %	22	2.35	**$D_{3s}(x)$**	$t_{3w}(x)$	14	2.24	7.82
(5)	100	2.59	$D_{1w}(x)$	$t_{1w}(x)$	27	2.04	$t_{2c}(x)$	82 %	22	2.35	**$D_{3s}(x)$**	**$t_{3s}(x)$**	18	2.27	5.80
(6)	100	2.59	$D_{1w}(x)$	$t_{1w}(x)$	27	2.04	$t_{2w}(x)$	**93 %**	25	2.59	$D_{3w}(x)$	$t_{3w}(x)$	15	2.48	7.21
(7)	100	2.59	$D_{1w}(x)$	$t_{1w}(x)$	27	2.04	**$t_{2s}(x)$**	82 %	22	2.46	$D_{3c}(x)$	$t_{3w}(x)$	14	2.35	7.82
(8)	100	2.59	$D_{1w}(x)$	$t_{1w}(x)$	27	2.04	**$t_{2s}(x)$**	**93 %**	25	2.46	$D_{3c}(x)$	$t_{3w}(x)$	16	2.35	6.68
(9)	100	2.59	$D_{1w}(x)$	**$t_{1s}(x)$**	59	2.25	$t_{2w}(x)$	82 %	48	2.83	$D_{3c}(x)$	$t_{3w}(x)$	28	2.74	3.27
(10)	100	2.16	**$D_{1s}(x)$**	$t_{1w}(x)$	42	1.78	$t_{2w}(x)$	82 %	34	2.18	$D_{3c}(x)$	$t_{3w}(x)$	23	2.08	4.26
(11)	100	2.16	**$D_{1s}(x)$**	**$t_{1s}(x)$**	74	1.96	$t_{2w}(x)$	82 %	61	2.50	$D_{3c}(x)$	$t_{3w}(x)$	38	2.39	2.08
(12)	100	2.59	$D_{1w}(x)$	**$t_{1s}(x)$**	59	2.25	$t_{2w}(x)$	**93 %**	55	2.83	$D_{3c}(x)$	**$t_{3s}(x)$**	41	2.76	1.83
(13)	100	2.16	**$D_{1s}(x)$**	$t_{1w}(x)$	42	1.78	$t_{2c}(x)$	82 %	34	2.35	**$D_{3s}(x)$**	$t_{3w}(x)$	22	2.24	4.51
(14)	100	2.16	**$D_{1s}(x)$**	$t_{1w}(x)$	42	1.78	**$t_{2s}(x)$**	82 %	34	2.03	$D_{3c}(x)$	$t_{3w}(x)$	24	1.93	4.03
(15)	100	2.16	**$D_{1s}(x)$**	$t_{1w}(x)$	42	1.78	**$t_{2s}(x)$**	**93 %**	39	2.03	$D_{3c}(x)$	$t_{3w}(x)$	27	1.93	3.44

Notes: The shape of the performance distribution of any group *g* in any situation *s* is denoted by $D_{sg}(x)$ and $t_{sg}(x)$ denotes the transition propensity to the next educational level for each performance value *x*. s=salariat, w=working, c=counterfactual. Manipulated variables are indicated by a shaded area.. Sources: t_1: Fauser (n=2620), t_2: GLHS (n=1209), t_3: HIS (n=5805), own calculations. If we employ the standard decomposition approach (cf. Erikson et al. 2005), this would result in 66 percent secondary effects at t_1 and 88 percent secondary effects at t_3.

6.2.1 Manipulating the transition to university

We start with manipulating the transition from upper secondary to tertiary education (rows 3-5). We neutralize secondary effects at t_3 to evaluate *how many working class students would enter universities if their propensity to choose university education would equal that of their peers of salariat background*. As can be seen in row 3, we gain 3 additional students compared to the factual situation. However, as students with lower performance now have a higher propensity of entering university, this comes at the expense of a somewhat lower (2.51 vs. 2.48) and more heterogeneous performance distribution,. We neutralize primary effects at t_3 to find out *how many working class students would enter universities if their performance distribution at the end of upper secondary school would equal the distribution of their peers of salariat background*. It may seem surprising that a neutralization of primary effects at t_3 does not increase the number of working class students who enter universities. But because performance is not of great importance at t_3 and because the distributions do not differ much between classes (cf. Table 1), a neutralization of primary effects at this stage has no impact.[13] Overall, interventions at t_3 result in rather modest increases in the number of working class students. Even neutralizing both primary and secondary effects at this transition only elevates the number of students to 18 instead of 14. In other words: 18 per cent of all working class students would enter tertiary education in this scenario. Note that neutralizations of primary effects at t_3 automatically imply a counterfactual performance development up to this point (cf. column 7, rows 4 and 5). Performance distributions cannot just be changed by punctual interventions. If performance distributions at t_3 should be identical for both groups, working class students would have to catch up in elementary school or between Gymnasium entrance and graduation.

6.2.2 Manipulating the sequence at the Gymnasium

Rows 6-8 display manipulations of the sequence at the Gymnasium. At first sight, neutralizing survival differentials (row 6) seems somewhat more effective for achieving higher tertiary enrolment rates (col. 13) and neutralizing performance development differentials (row 7) seems somewhat more effective for lifting performance levels in higher education (col. 14), but again effects are comparably small. To answer *how many working class students would enter universities if their net survival rate and performance development during upper secondary school would equal that of students of salariat background* we consider performance development and drop-out rates in combination (row 8). This results in a gain of 2 additional working class students at university with a performance level that is in between the two factual groups.[14]

6.2.3 Manipulating the transition to the Gymnasium

Rows 9-11 are devoted to the manipulation of the transition from elementary school to the Gymnasium. The guiding research question is *how many working class students would enter universities if their propensity to choose Gymnasium would equal that of their peers of salariat*

[13] Since we display rounded numbers we hide the fact that there is a small impact, which is visible only in the decimals of the predicted number of students.

[14] Similar to the argument above, performance shifts at earlier stages imply performance shifts at later stages, which is why counterfactual (c) performance distributions emerge in rows 7 and 8, column 11.

background (row 9)? Neutralizing secondary effects at t_1 would increase the tertiary participation rate of working class students substantially. Leaving all subsequent transition functions unaltered, it would result in 59 instead of 27 Gymnasium entrants, 48 instead of 22 Gymnasium graduates, and in 28 instead of 14 tertiary education students. However, these increased participation rates come at the expense of decreasing the mean performance levels at all stages (columns 6, 10 and 14). This phenomenon occurs because working-class students, who have a comparably low performance distribution, now have the same propensity as students of salariat origin to enter the Gymnasium. Thus, their counterfactual performance distribution at the Gymnasium and at subsequent stages is considerably worse. *How many working class students would enter universities if their performance distribution at the end of elementary school would equal the distribution of their peers of salariat background (row 10)?* Neutralizing primary effects would increase the number of university entrants (23) but to a lower extent as compared to neutralizing secondary effects. This scenario highlights again how early interventions affect the following transitions. Students of this counterfactual group have a more restrictive transition propensity at each point of the performance scale than students of salariat background, while they are equally well performing at elementary school level. This leads to a situation where these students at later stages would possess a more favourable performance distribution compared to students of salariat backgrounds (mean gpa of 2.08 vs. 2.27 in col. 14). Neutralizing both primary and secondary effects at the first transition would increase the participation rate in higher education drastically (38 instead of 14 students) and raise the performance distributions after each transition slightly if compared to the factual situation of working class students.

In summary, if we compare the potential impact of single interventions at each of the critical phases during which educational inequality occurs, one can state that interventions during elementary school or at the transition to secondary school are most promising for raising the number of students that end up in higher education. Note however, that a unilateral neutralization of secondary effects results in lower average performance levels of working class students entering universities.

6.2.4 Manipulating several phases simultaneously

So far, our scenarios accounted for the effects of early interventions on the student risk-set and their performance distribution at subsequent stages. They did, however, not acknowledge that early interventions are likely to also have lagged effects on subsequent transition propensities. If interventions could be introduced which are capable of reducing, say, secondary effects at t_1, (e.g. through increasing aspirations), they are likely to have an impact also on secondary effects at t_2 and t_3. In the following scenarios, we take this possibility into account. In row 12 secondary effects are neutralized at each of the three transitions. Such a scenario reflects the possibility of *lagged effects of an early intervention on later transition propensities, or the effect of joint interventions aimed at neutralizing secondary effects which are simultaneously introduced at t_1, t_2, and t_3.* Technically, we exchange the transition propensities not at one but at all three transitions to simulate such a scenario (cf. formula 5 above). In such a scenario, the number of higher education students from working class families would increase to 41. However, among them would be relatively more poor performing students (the mean gpa would be 2.76 instead of 2.48). Another scenario is simulated in rows 13 and 14. Here, the performance distributions at all levels are replaced by the performance distributions of students of salariat background, i.e. primary effects are neutralized at all stages. Because of the developmental character of primary effects, we have two options here. We can either neutralize primary effects at t_1 and t_3, which would imply a counterfactual performance development at t_2. Or we could neutralize primary effects at t_1 and t_2, which results in a counterfactual performance distribution at t_3. In both scenarios, roughly the same number of students would enter university (22 or 24). Note however, that the performance distribution of the students in university is more favourable, if we let it be the result of all previous manipulations (row 14) instead of imposing the distribution of the reference group (row 13). One might object that neutralizing primary effects at t_1 should also impact the Gymnasium survival rates of working class students. Row 15 repeats the scenario from row 14, but with imposing the salariat survival rates in column 8. This can be considered as an upper bound of joint interventions in primary effects in the potential to raise higher education rates of working class students. Note however, that the number of 27 working class students making their way to higher education (col. 13) under this scenario is still comparatively modest in relation to the situation where all secondary effects are eliminated (row 12). On the other hand, tertiary education performance levels are clearly superior compared to the scenario in which secondary effects at all levels are neutralized (1.93 vs. 2.76). Implications will be discussed in the concluding section.

7 Discussion

Despite decades of educational expansion, low university graduation rates in combination with high inequality have remained to be of great concern to mobility researchers and policy makers alike. In this paper we assessed where the many students from working class families get lost along the educational path leading to university enrolment. Furthermore, we estimated the scope for interventions at the different critical phases during which inequality occurs. To this end, we set up a simulation framework, in which we evaluated the potential of different ideal-typical interventions. Within the framework of primary and secondary effects, we simulated interventions aimed at reducing either primary or secondary effects or both at various time points along the way to university enrolment. We found that neutralizing primary or secondary effects just before or at the transition to university has a negligible effect on enrolment rates. This may come as a surprise to many practitioners, who, for example, hope to increase working class participation rates at university by increasing financial aid. In the light of our findings, one has to conclude that such interventions may come too late. Likewise, interventions during secondary school probably have only modest influences on working class participation rates at university. The main message that emerged from our exercises is: interventions are most effective if they tackle inequalities early in the educational career. This is not to say that later initiatives are misguided. However, interventions aimed at reducing performance differentials during elementary school offer a substantially larger scope to increase the share of working class students entering universities. We estimated a potential gain of 9 percentage points (from 14 to 23) for these types of interventions. Even more so, interventions aimed at reducing choice differentials at the transition to secondary school can potentially raise the share up to 28 per cent (a gain of 14 percentage points). Note however, that interventions have to find a balance between the reduction of primary and secondary effects. We were able to show that a unilateral neutralization of secondary effects can be very effective in increasing participation numbers at various educational stages, but this would come at the expense of a lower average performance distribution of working class students. In such a scenario, Gymnasiums and universities would either have to lower the standard of teaching, or drop-out rates are likely to increase among working-class students. Thus, a more negative performance distribution may offset the positive impact of elevated participation numbers. Leaving students with the negative shock of a drop-out experience may be even worse for self-esteem and future job motivation than not having them enter the 'academic route' at all. In consequence, a combined effort to neutralize 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 and their performance levels. In this respect, our findings are in line with James Heckman who maintains that "early interventions targeted toward disadvantaged children have much higher returns than later interventions" but that if maximum value is to be realized "early investments must be followed by later investments" (Heckman, 2006: 1902). Besides potential negative effects for the standard of teaching, or for the survival rates of working class students at the Gymnasium, other unintended consequences may evolve by reducing secondary effects. The theory of effectively maintained inequality (Lucas, 2001) posits that actors from more privileged social backgrounds secure for themselves advantages wherever possible. If the educational system diminishes as a means of social stratification, it is likely that these actors pursue other means for reproducing their relative advantage. For example, they may strive for more qualitative advantages within the educational system (e.g. private schools), or they may rely on other signals or resources (e.g. social contacts, social skills, informal education) to secure intergenerational status maintenance.

Some limitations of our study should 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 (cf. footnote 7). Second, we simulate only scenarios in which there are no primary or no secondary effects. The reason is that we aim to produce upper-bound estimates of potential interventions, in order to identify the available scope for policy leverage at different phases in the educational life course. As mentioned above, realistic interventions are unlikely to completely eliminate primary and/or secondary effects, and hence would have less noticeable effects. Third, while we are able to simulate how early interventions would change the subsequent group size and performance composition of (what-if) working class students, we have no knowledge on the transition behavior of a group in such a counterfactual scenario. Thus, we have to make assumptions on how such a group would have behaved had they reached a certain educational branching point. In different scenarios, we assumed that subsequent transition functions resemble either those of the factual working class or of the factual salariat class. It might very well be the case, that this overestimates the realistic transition propensity of counterfactual groups. In that sense, our results display, again, upper-bound estimates. Fourth, we assume a simplified binary choice structure of educational decisions along the way to university enrolment. As this simplified path is taken by the majority of university students, we argue that our model, in a parsimonious way, summarizes the general pattern of class differences. However, it does this at the expense of losing information about potentially significant variation within the system (Breen and Jonsson, 2000). For example, the differentiation of pathways to obtain eligibility to study at the tertiary level might be a way of reducing inequality, and policy makers are interested in the effects of this expansion. Fifth, terminating the simulation study with enrolment to higher education might be considered as a cutting point which is one transition too early. We would have liked to include graduation from tertiary education as well, but adequate data sources were not available. As soon as data is available that covers the period from higher education enrolment to graduation, this sequence can easily be incorporated. Our paper was devoted to the German situation and proposed solutions on how to gather information from different data sources in order to construct a quasi-longitudinal cohort which is progressing from elementary to tertiary education. Of course, the consideration of the cumulative impact of primary and secondary effects can be accomplished with real cohort data as well – with much less effort. We would be happy to encourage replications of our simulation exercise with different data and for different countries.

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Appendix

Figure A1 Graphical representation of weighting factors between Gymnasium entrants' performance distribution and Gymnasium graduates' performance distribution, by class