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How the rise of better educated origin families across cohorts influences sons' and daughters' tertiary education in West Germany?

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Abstract:	In this article, we examine how the improvement of parental education across cohorts affects sons' and daughters' tertiary educational attainment in the process of educational expansion. Using data from the National Educational Panel Study (NEPS), we focus on West Germany and study whether the upgrading of the educational composition of families of origin across cohorts contributes to the convergence of sons' and daughters' tertiary educational attainment over time. In particular, we ask whether the rise of highly educated families, who are assumed to have stronger gender-egalitarian attitudes toward their children, has contributed to daughters faster increase in tertiary education compared to sons. We also examine to which extent highly qualified mothers serve as role models for their daughters. Our empirical analysis shows that the long-term upgrading of families' education across cohorts has in a similar manner increased tertiary educational attainment of both sons and daughters. Thus, women's educational catch-up process cannot be explained by the greater gender-egalitarian focus of highly educated parents. Rather all origin families, independent of their educational level, are following the same secular trend towards more gender egalitarianism. We also find that highly qualified mothers do not serve as particular role models for their daughters. Rather mother's education is equally important for both sons and daughters success in higher education. Finally, we show that the rising proportion of academic families across cohorts is connected to a rising share of downward mobility for both sons and daughters.

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1. Introduction

An important goal of policymakers in the process of educational expansion has been the reduction of gender-specific inequalities in education (Hadjar 2019). It is well-documented that women have caught up with men in educational attainment during the last decades and have even surpassed them at higher educational attainment levels (Becker and Müller 2011; Helbig 2013). For Germany, many studies connected this catching-up process by focusing on women's educational achievements and their cost-benefit evaluations with regard to different educational attainments (Becker and Müller 2011; Becker 2014; Helbig 2012). However, these models provide an incomplete picture of the whole process of educational growth (Blossfeld, P. N. 2020; Mare 1979; Winsborough and Sweet 1976) disregard how the upgrading of the intercohort composition of parents' education might have affected gender-specific educational attainment (Blossfeld, P. N. 2020; Buchmann and DiPrete 2006; Helbig 2012; Ziefle 2017). Ziefle (2017), studying only women, examined whether improvements in the educational structure of parents has consequences for the increase in daughters' higher education entrance certificates among the youngest birth cohorts in Germany. However, we still do not know to which extent the change in educational background composition across cohorts contributed to the catching-up process of women relative to men across cohorts (McDaniel 2012, 592). This paper integrates both the macro-level upgrading of parental education across cohorts and the micro-level changes in educational opportunities of sons and daughters to assess the extent to which daughters' higher education is becoming more similar to that of sons across cohorts. In addition, we examine whether the share of educationally downward mobile sons and daughters

from highly educated families is similar for both sexes across cohorts in Germany. Conversely, we ask whether the increase of highly qualified families of origin across cohorts lead to a similar upward mobility of sons and daughters across cohorts.

Using retrospective data from the Adult Cohort (SC6) of the National Educational Panel Study (NEPS), the aim of this article is to provide a more complete analysis of the impact of educational expansion on tertiary education outcomes of sons and daughters in West Germany. This analysis combines macro- and micro- level changes. In this paper, tertiary education includes degrees from both universities of applied sciences and traditional universities. We focus on higher education because it is the fastest growing educational attainment level in Germany. Tertiary certificates also typically provide access to top occupational positions with high earnings, strong career opportunities, and more job security in the West German labour market (Mayer, Müller, and Pollak 2007).

We begin with a brief description of the evolution of gender-differences in tertiary education in West Germany across cohorts. We then outline the theoretical model that attempts to integrate macro- and micro-level changes in sons' and daughter's tertiary educational attainment. After describing the data, variables and methods, we present the empirical findings and demonstrate how the various macro- and micro-level interactions lead to new gender-specific outcomes of higher education. Ultimately, we summarize our findings and draw some more general conclusions.

2. Gender-specific changes in tertiary educational attainment in West Germany

Using data from the NEPS, we begin with a short description of changes in tertiary educational attainment for men and women across cohorts in West Germany. Figure 1 shows that tertiary educational attainment for both men and women increased markedly from the "1944-1950"

birth cohort to the "1981-1986" birth cohort. In the "1944-1950" birth cohort about 28% of men and only 17 % of women earned a tertiary degree In the "1981-1986" birth cohort these proportions increase to 53 % for women and to 48 % for men (see for similar findings: Autorengruppe Bildungsberichterstattung 2020, 181). Thus, during the observation period, tertiary educational attainment of women increased by 36 percentage points and that of men by only 20 percentage points. Thus, the gender gap in tertiary education has continuously narrowed, and in the youngest birth cohort, women have even slightly overtaken men in terms of tertiary education.

[Figure 1]

3. Theory

During the last few decades, not only men's and women's educational attainments have markedly increased across birth cohorts, but – as a consequence - the educational composition of parents has improved across cohorts in the process of educational expansion. In this paper, we ask to which extend this changing background composition of parental education across cohorts has contributed to the catching-up and surpassing process of daughters with tertiary education relative to sons with a tertiary degree. The impact of the macro-level change in educational background composition across cohorts on sons and daughters changes in the distributions of tertiary education cannot only be studied at the macro level (see Figure 2), since this macro-level analysis would be exposed to an ecological fallacy. The impact of the macro-level change in educational background composition has to be traced via the micro-level educational opportunities of various social groups. In other words, the impact of the upgrading of parental education across cohorts is dependent on the educational opportunities of sons and daughters and their changes across cohorts at the individual level (see Figure 2). The following three micro-level conditions are important for our analysis:

(1) Educational opportunities of children from different social origins and their changes

It is well known that higher educated parents typically provide better learning conditions for their children at home (Bukodi and Goldthorpe 2013; Jackson 2013). Highly educated parents possess academic qualifications that enable them to support their children's cognitive development better throughout their educational careers, which promotes their sons' and daughters' opportunities to earn a higher educational degree (Bukodi and Goldthorpe 2013; Jackson 2013). This effect is commonly referred to as the *primary effect* of social origin (Boudon 1974). Moreover, academically educated families are more likely to send their children to upper secondary schools and institutions of tertiary education, even if their children have comparable educational achievements as children from less educated parents (*secondary effect*) (Boudon 1974). According to *status maintenance theory*, academic families also strive to pass on their advantageous educational degree to their children to avoid intergenerational downward mobility (Breen and Goldthorpe 1997). In our empirical analysis, we therefore expect that children from better-educated families are generally more likely to attain a tertiary degree than children from less educated families. Based on the increase in the proportion of academic families across cohorts, we therefore expect that the share of children with tertiary education from this origin group is increasing, even if the educational decisions of families from different social origin groups remain constant (see Figure 2).

However, several theories suggest that educational decision-making within different social origin groups may have changed over time. According to *modernization theory* (Lenski 1966; Treiman 1970), meritocratic principles gained importance in the education system in modern societies. This means that especially gifted children from disadvantaged social origins should increasingly earn a tertiary education degree across cohorts and that inequality of educational opportunities should decrease. In addition, the costs of education have decreased (e.g. school

fees have been abolished, compulsory schooling has been extended, and the expansion of Gymnasiums and higher education institutions has shortened the geographical distances of children to higher education institutions) in most modern societies (Breen et al. 2009). Thus, children from non-academic families should have benefited in particular from these structural developments.

[Figure 2]

In contrast, *cultural reproduction theory* (Bourdieu 1973) predicts that children from academic families are the major beneficiaries of educational expansion because they take advantage of the increasing supply of places in secondary schools and higher education institutions much more effectively than children from non-academic families. In our analysis, we examine the extent to which the educational opportunities to earn a higher educational degree of children from different social origins have changed across cohorts.

(2) Gender-specific educational opportunities and their changes

The educational upgrading of the social origin structure could also have consequences for gender-specific changes in tertiary education. First, according to the *gender-egalitarian perspective*, better educated families have more gender egalitarian attitudes toward their children's educational attainment, so that their daughters have relatively better educational opportunities than daughters from lower educated families (Buchmann and DiPrete 2006; Helbig 2012). In our empirical analysis, we therefore expect that the compositional shift towards more academic families across cohorts could lead to a more rapid catch-up of women in tertiary education relative to men. Second, the declining gender inequality between sons and daughters could also be reinforced by mothers' own growing higher educational attainment. According to the *gender role model perspective*, mothers serve as examples for their daughters,

which is assumed to affect their educational aspirations (Buchmann, DiPrete, and McDaniel 2008; Korupp, Ganzeboom, and Van Der Lippe 2002; Rosen and Aneshensel 1978). If mothers increasingly hold academic degrees across cohorts, this should in particular improve their daughters' opportunities of obtaining a tertiary degree (Ziefle 2017, 53). In our empirical analysis, we therefore examine whether academic mothers indeed serve as role models for their daughters and promote female higher education.

However, there are four general trends of increasing benefits of higher education for women, which should affect women from all social origin groups to a similar extent (Becker and Müller 2011): First, there is a shift in the occupational structure from relatively unskilled male production jobs to skilled and highly skilled female administrative and service positions (Becker 2014; Busch 2013; Witte 2020). Second, there is a secular liberalisation of gender role perceptions in the whole society (Gallie 2019; Knight and Brinton 2017). Both developments should have led to increasing investment in education by women, rising female labour force participation, and a shift in the family division of work from the traditional male-breadwinner model to a secondary earner or even dual career model (Blossfeld, H. and Drobnic 2001). As a result, across cohorts, women's educational attainment and earnings have become increasingly pivotal to overall family income (Blossfeld, H. and Drobnic 2001; Haupt 2019). Third, women in the older birth cohorts often married up in educational terms, but as education has expanded, women who invest more in their education have a higher likelihood to find a similarly highly educated partner within their networks in school and in the labour market than women with less education today (Blossfeld, H. and Timm 2003; Mare 2016). Fourth, high divorce rates and the rising separation rate of consensual unions, as well as the growing proportion of single mothers increase the incentives of women to achieve greater economic independence through higher educational attainment (Zagel and Breen 2019). In sum, based on these reasons, we expect

women, to increasingly invest in higher education across cohorts, regardless of their social background.

(3) Changing upward and downward moves

Finally, within the framework of our analytical macro-micro-macro model, we can analyse the extent to which the rising proportion of academic families at the macro level and the changes in inequality of educational opportunities at the micro level affect the shares of educationally downward mobile sons and daughters differently. Conversely, we are able to examine how the declining proportion of non-academic families at the macro level and their change in educational opportunities at the micro level to attain an academic degree are related to sons' and daughters' upward mobility.

4. Data, variables and methods

Data set

In our study, we use data from the Adult Cohort (SC6) of the NEPS[1] (Blossfeld, H., Roßbach, and von Maurice 2011). This longitudinal survey employs a two-stage sample selection design with municipalities as primary and individuals as secondary sampling units (Blossfeld, H. and Roßbach 2019). The Adult Cohort of the NEPS provides annually updated retrospective information on the detailed educational histories of men and women born in Germany between 1944 and 1986. It is therefore a particularly suitable data source for the analysis of long-term changes in gender-specific educational inequalities in West Germany. All ten waves of the

[1] *This paper uses data from the National Educational Panel Study (NEPS): Starting Cohort Adults, doi:10.5157/NEPS:SC6:10.0.1. From 2008 to 2013, NEPS data was collected as part of the Framework Program for the Promotion of Empirical Educational Research funded by the German Federal Ministry of Education and Research (BMBF). As of 2014, NEPS is carried out by the Leibniz Institute for Educational Trajectories (LIfBi) at the University of Bamberg in cooperation with a nationwide network.*

NEPS are included in the empirical analysis. The last panel wave included in our analysis was collected in 2017 and 2018. Since we are interested in academic degrees, we only include individuals aged 30 and older. This selection of cases has yielded an analysis sample of 8,828 respondents, including 4,421 (50.08 %) sons and 4,407 (49.92 %) daughters.

Variables

To describe the evolution of the distribution of social origins across cohorts at the macro level and to analyse changes in tertiary educational attainment by social origin at the micro level, we distinguish the three most important parental educational levels of the German educational system. We use the dominance approach (Erikson 1984) to define the educational level of the family of origin. This means that the highest reported educational attainment of either the father or the mother is used to determine the educational position of the whole family. In addition, we use the individual educational levels of mothers and fathers in some analyses. We distinguish the following three *parental educational levels* coded as dummy variables:

1) *Low qualified parents* who have only a Hauptschul- or a Realschulabschluss or less are coded as (1). Parents who exceed this educational level are assigned the value (0) in the empirical analysis.
2) *Skilled parents* who have completed a vocational training certificate or only an Abitur as well as a Fachhochschulreife are coded as (1) and parents with less or more education are given the value (0).
3) *Highly educated parents* who have graduated from a traditional university or a university of applied sciences receive the value (1). Parents with less education are coded with the value (0).

An important variable for examining long-term changes in the social origin structure and changes in the opportunities of sons and daughters to earn a tertiary degree at the micro level is

birth cohort. We tested several ways to model the cohort trends including birth cohort dummy variables and found that changes in tertiary education are best represented by a linear trend across cohorts. This *cohort trend* variable has a range between 1 for the "1944 birth cohort" and 43 for the "1986 birth cohort".

To examine gender differences in tertiary educational attainment, we include the dummy variable *female* in our analyses (females are coded as (1)).

Analysis method and dependent variable

As shown in Figure 2, we use Coleman's bathtub model (Coleman 1990) as a simple heuristic tool to show how changes in sons' and daughters' growth in tertiary education might be generated by two distinct mechanisms of social change: (1) the upgrading of the parental educational structure at the macro level and (2) the changes in gender-specific educational opportunities of sons and daughters from different educational families at the micro level. Figure 2 reveals how the macro-level upgrading of resources of parents from low to intermediate and high education I=i (i=1,2,3) across cohorts O_{cig} having daughters and sons G=g (g=1, 2), together with micro-level changes in gender-specific inequality of educational opportunities T_{cig} = f(C, I) produce changes in the proportion of tertiary education T_{cg} = f (O_{cig}, T_{cig}) of sons and daughters across cohorts C=c (c=1,…,43) as a matter of simple aggregation. Mathematically, the gender-specific proportions of daughters and sons with tertiary degrees across cohorts T_{cg} can therefore be expressed as the weighted sum of the changes in the educational composition of families across cohorts O_{cig} at the macro level and the changes in gender-specific inequality of educational opportunities T_{cig} at the micro level across cohorts.

$$\underbrace{T_{cg}}_{\text{Macro variable 2}} = \sum_{c=1}^{43}\sum_{i=1}^{3}\sum_{g=1}^{2}\underbrace{O_{cig}}_{\text{Macro variable 1}} * \underbrace{T_{cig}}_{\text{Micro variable}} \quad (1)$$

The gender-specific proportions of families with one of the three educational qualifications in each cohort *at the macro level* $\widehat{O_{cig}}$ are estimated by a binary logistic regression model for sons and daughters that includes only the cohort trend as the independent variable. The cohort trend reflects changes across the single cohorts very well (see Figure 3).

At the micro level, the social origin-specific probabilities of sons and daughters to complete tertiary education $\hat{T}_{cig}$ are estimated by a binary logistic regression model with a covariate row vector (including social origin, cohort trend, being female and several interaction terms) and a parameter column vector β (see Equation (2)):

$$\hat{T}_{cig} = P[T^* = 1 | C = c, O = o, G = g] = \frac{\exp(X'\beta)}{1 + \exp(X'\beta)} \quad (2)$$

with c=1,…,43; i=1,…,3 and g=1,2

T^* is 1 if sons or daughters have a tertiary education as their highest educational attainment and 0 if sons or daughters do not have a tertiary education as their highest educational attainment.

To investigate how tertiary degrees of sons and daughters (G=g) are determined by the three social origin groups (I=i) across cohorts (C=c), we calculate the three proportions $\widehat{P_{cig}}$, which combine the macro and micro developments across cohorts:

$$\widehat{P_{c1g}} = \frac{\widehat{O_{c1g}} * \widehat{T_{c1g}}}{\widehat{T_{cg}}} \quad \text{with c=1,…,43 and g=1,2} \quad (3)$$

$$\widehat{P_{c2g}} = \frac{\widehat{O_{c2g}} * \widehat{T_{c2g}}}{\widehat{T_{cg}}} \quad \text{with c=1,…,43 and g=1,2} \quad (4)$$

$$\widehat{P_{c3g}} = \frac{\widehat{O_{c3g}} * \widehat{T_{c3g}}}{\widehat{T_{cg}}} \quad \text{with c=1,…,43 and g=1,2} \quad (5)$$

Considering tertiary educational attainment, only sons and daughters of academic parents can be downwardly mobile. Therefore, we additionally calculate the proportion of sons and daughters who were downwardly mobile in each cohort as the product of the proportion of academic families and the probability to be downwardly mobile in each cohort.

$$\widehat{D_{c3g}} = \widehat{O_{c3g}} * (1 - \widehat{T_{c3g}}) \quad \text{with c=1,…,43 and g=1,2} \quad (6)$$

Conversely, only sons and daughters from non-academic families can be educationally upwardly mobile in terms of tertiary education. These are the children from low and intermediate educated parents. The estimated proportion of sons and daughters who were upwardly mobile in each cohort is the product of the proportion of non-academic families and their probability to be upwardly mobile in each cohort.

The proportions of upwardly mobile sons and daughters from parents with intermediate education are therefore

$$\widehat{U_{c2g}} = \widehat{O_{c2g}} * \widehat{T_{c2g}} \quad \text{with c=1,…,43 and g=1,2} \quad (7)$$

and from families with low education are therefore:

$$\widehat{U_{c1g}} = \widehat{O_{c1g}} * \widehat{T_{c1g}} \quad \text{with c=1,…,43 and g=1,2} \quad (8)$$

5. Results

Intercohort compositional change of parental education by gender

We begin with a description of the intercohort educational compositional change of origin families during a period of massive educational growth in West Germany. Figure 3 shows the changes in the observed and predicted probabilities (with confidence bands) of parents with low, intermediate or high education for sons and daughters. We plot the observed probabilities as dots and the estimated probabilities as lines. In the upper part of Figure 3, we show the probabilities based on Erikson's (1984) dominance principle, where the highest educational position of both parents defines the educational position of the family. The middle and bottom parts of Figure 3 reveal the changes in probabilities based on mother's and father's education, respectively. The predicted probabilities and their confidence bands (shadow areas) are based on binary logistic regression models. As the plots in Figure 3 show, the estimated probabilities based on a linear cohort trend represent the observed probabilities very well.

[Figure 3]

The upper panel in Figure 3 shows that the evolution of the educational composition of families (based on the dominance approach) is quite similar for both sons and daughters. Across cohorts, there is a clear decline in families with low education (from 13 % in the "1944 birth cohort" to 6 % in the "1986 birth cohort" for sons and for the same birth cohorts from 14 % to 1 % for daughters). The largest proportion of families has an intermediate level of education. The development of these proportions for sons and daughters is non-monotonic: at first increasing and then decreasing. Over the entire observation period, these proportions decrease from 81 % to 60 % for sons and from 70 % to 57 % for daughters. The greatest increase across all cohorts can be found for highly educated families (from 6 % to 35 % for sons and from 7 % to 43 % for daughters).

The middle panel of Figure 3 presents the changes in the composition of mothers with low, intermediate and high education across cohorts. We see for both sons and daughters that the proportion of children born to mothers with low levels of education has declined markedly across birth cohorts (from 60 % to 14 % for sons and from 56 % to 6 % for daughters). Conversely, the proportions of sons and daughters who have a mother with an academic degree have increased sharply across cohorts (from 1 % to 19 % for sons and from 2 % to 17 % for daughters). Of particular interest is that the proportions of mothers with an intermediate education increased sharply for both sons and daughters (from 35 % to 60 % for sons and from 42 % to 77 % for daughters). Overall, the picture of change in the educational composition of mothers across cohorts looks quite different from the upper panel of Figure 3, where the level of families' education is measured using the dominance approach. Mothers have caught up impressively in their educational attainment relative to fathers across cohorts. However, the basic development of the educational composition of mothers is quite similar for sons and daughters.

The bottom panel of Figure 3 shows the change in the educational composition of fathers for sons and daughters across cohorts. The graphs look the same for sons and daughters and are very similar to the graphs in the upper panel based on the dominance approach. This means that the dominance approach partially hides the catch-up process of mothers, as fathers are still more likely to have the higher educational attainment within families. We also see that the proportion of fathers with low educational attainment has decreased (from 15 % to 8 % for sons and from 14 % to 3 % for daughters) and that the proportion of fathers with high educational attainment has increased across cohorts (from 5 % to 27 % for sons and from 17 % to 37 % for daughters). Again, the majority of fathers has an intermediate level of education, and this proportion decreases across cohorts for sons (from 81 % to 65 %) and for daughters (from 70 % to 60 %).

Based on these changes, we conclude that educational growth has led to a dramatic upgrading of the educational composition of parents across cohorts. Sons and daughters in the youngest birth cohorts are much more likely to stem from highly educated backgrounds than earlier birth cohorts. Our analysis below will show to which extent the micro-level mechanisms have changed as well. However, even if the micro-level mechanisms of origin-specific decision-making persisted across cohorts, these intercohort compositional changes alone should lead to a higher average educational attainment for children and more gender equalization in tertiary education. According to *status maintenance theory*, the growth in the composition of families towards academic ones should lead to an increase in tertiary educational demands for sons and daughters. And the gender-egalitarian perspective expects increasing educational attainment for daughters from academic families as the share of academic families increases across cohorts. In addition, the role model of mothers argument suggests that more highly educated mothers serve as examples for their daughters in terms of higher education. Thus, if the proportion of academically educated mothers increases, their daughters should also increase their tertiary educational attainment across cohorts. We will examine these micro-level claims in more detail in the next section, paying particular attention to daughter's catch-up in tertiary education.

Gender differences in the inequality of opportunity at the micro level

We first focus on the dominance approach of social origin and estimate several logistic regression models. In a stepwise approach, the models include the cohort trend, the dummy variables for origin families (with low, intermediate and high education), a dummy variable for females, and all theoretically relevant interaction terms.

Model 1 in Table 1 shows, as expected, that there is a statistically significant and positive cohort trend. This means that in the process of educational expansion, the opportunities to obtain a tertiary degree increase for all children at the micro level, regardless of gender and family

origin. There are also marked differences by parental education. For example, sons and daughters from better-educated families have a much higher probability of attaining a tertiary degree at the micro level. We also included an interaction effect of "social origin and cohort trend" in Model 4 of Table 1, which is not statistically significant. Thus, inequality of educational opportunity did not change much across cohorts. *This finding is in line with status maintenance theory, which expects a persistent effect of social origin across cohorts. Conversely, our empirical findings do not support modernization theory, which expects a decline in educational inequality across cohorts, nor cultural reproduction theory, which expects an increase in educational inequality across cohorts.* Model 2 in Table 1 shows that the dummy variable "female" has a statistically significant coefficient of -0.8559. Thus, in our sample, women are on average significantly less likely than men to earn a tertiary degree. However, Model 2 of Table 1 also reveals a statistically significant coefficient of 0.02 for the interaction term of "cohort trend and female". This means that the advantage of men in tertiary

[Table 1]

educational attainment declines across birth cohorts (-0.855 + 0.02*0= -0.855) and even disappears for the youngest birth cohort (-0.855 + 0.02*42 =-0,015). In addition, Model 4 of Table 1 shows that the first-level interaction term "female and the three social origin groups" and the second-level interaction term "cohort trend, female and the three social origin groups" are not statistically significant. Thus, there seem to be no differences in educational opportunities between sons and daughters from differently educated families. *This finding is not consistent with* the *gender-egalitarian perspective,* which predicts that daughters from academic families have an advantage in obtaining a tertiary degree over daughters from lower educated families. Overall, *these empirical findings support the theory that the catching-up process of females in education is the result of increasing benefits of tertiary education for all women. The liberalisation of gender role norms, the increasing labour market participation of*

women, the rising importance of women's contribution to total family income, the trend toward educational homogamy, and the rising divorce and separation rates all appear to have increased women's benefits from investing in tertiary education across cohorts, regardless of their social origin. This empirical evidence is in line with previous findings for Germany (Becker 2014; Legewie and DiPrete 2009).

Because the interaction terms with the cohort trend in Models 3 and 4 of Table 1 are not significant, we use Model 2 to describe the nonlinear relationships between the independent and dependent variables in the logistic regression model (Mize 2019). Figures 4 and 5 show the estimated probabilities of attaining a tertiary degree (and their confidence bands) for sons and daughters of the three educational family groups across cohorts. Figure 4 shows an impressive increase in the estimated probabilities of attaining a tertiary degree for women for all three social origin groups over the observation period (birth cohorts "1944" to "1986"). Among the social origin groups, women from academic families not only have the highest probability of obtaining a tertiary degree, but they also experience the largest gains in tertiary education across cohorts. Their probability to obtain a tertiary degree has risen from 48 % in the "1944 birth cohort" to 76 % in the "1986 birth cohort". Comparing this probability with the probability of sons from academic families in Figure 5, we find that daughters among the oldest birth cohorts have lower probabilities to complete a tertiary degree. *This finding is not in line with the gender-egalitarian perspective, which claims that the probabilities of obtaining a*

[Figure 4]

[Figure 5]

tertiary degree should be quite similar for sons and daughters from academic families even for older birth cohorts. For daughters from parents with intermediate education, the probability has also increased, from 13 % in the "1944 birth cohort" to 34 % in the "1986 birth cohort"; and

the probability for daughters from families with low education has risen from 6 % in the "1944 birth cohort" to 19 % in the "1986 birth cohort". Thus, the higher the parental education of daughters, the higher the increases in tertiary educational attainment. However, these increases have nothing to do with differences in gender-specific behaviour of better educated origin families (*the gender-egalitarian perspective*). Rather, they are a consequence of different social origin mechanisms that also apply to sons.

Figure 5 presents the changes in the probabilities of obtaining a tertiary degree for sons coming from low, intermediate or highly educated families across cohorts ("birth cohorts 1944" to "birth cohort 1986"). Compared to daughters, these probabilities increased only slightly for the three educational origins. For sons from highly educated parents, the probabilities increased from 69 % in the "1944 birth cohort" to 77 % in the "1986 birth cohort". For sons from intermediate educated families, they increased from 26 % in the "1944 birth cohort" to 35 % in the "1986 birth cohort". And for sons from low educated families, they increased from 14 % in the "1944 birth cohort" to 19 % in the "1986 birth cohort". Thus, *in contrast to women, men were not able to increase their tertiary educational attainment as much during this period of massive educational expansion. This suggests that daughters in particular, regardless of their educational family background, have benefited greatly across cohorts from changing gender roles in modern societies.*

Finally, in Appendix A1, we briefly examine whether mother's education is significantly more important for daughters than for sons. We include mother's and father's education separately into the binary logistic regression model in Appendix A1. In addition, we also introduce interaction terms for "mother's education and female" and "father's education and female", but these turn out to be not statistically significant. We see that both mother's and father's educational resources are statistically significant for both daughters' and sons' tertiary

educational attainment. *This finding does not support the mother role model for daughters argument, which asserts that mother's educational resources are particularly important for daughters*. Moreover, this analysis reassures us that it is appropriate to operationalize social origin using the dominance approach for the enormous catching-up process of mothers in education that we saw in the middle panel of Figure 3.

Changes in the inflow distributions of sons and daughters to tertiary education by social origin across cohorts

In Figure 6, we turn to the inflow distributions of sons and daughters to tertiary education by social origin. We focus on tertiary degrees and show how they have changed in terms of educational family background across cohorts. These distributions reflect the interplay of changes in the structure of family origins at the macro level with changes in the origin-specific opportunities to obtain a tertiary degree at the micro level (see Equation 1). In Figure 6, we describe the cumulative conditional probabilities for sons and daughters to earn a tertiary degree by educational origin across cohorts.

In general, the developments for daughters (left panel of Figure 6) and sons (right panel of Figure 6) are very similar. However, the trend is more pronounced for daughters. It can be seen that the proportions of sons and daughters who stem from low educated families are already low for the oldest birth cohorts and further decrease significantly across cohorts. This is surprising, as the probability of a tertiary degree at the micro level has increased both for sons and daughters from this social origin group across cohorts (see Figures 4 and 5). Yet this social origin group declines more strongly across cohorts, leading to an overall decline in its proportion of tertiary degree holders. In turn, the proportions of sons and daughters from highly educated families who complete tertiary degrees have risen dramatically across cohorts. In the most recent birth cohorts, about 50 percent of tertiary degree holders are sons and daughters

[Figure 6]

from academic families. This increase is due both the upgrading in the social origin structure of sons and daughters and to the increasing likelihood of children from academic families to acquire a tertiary degree across cohorts. Sons and daughters from families with intermediate education were the largest group of tertiary degree holders already in the oldest birth cohorts. However, this has changed across cohorts. This social origin group accounts for a smaller proportion of tertiary degree holders in the youngest birth cohorts, although their opportunities of earning a tertiary degree at the micro level have increased. Thus this decline in the proportion, is the result of the decline of origin families with intermediate education at the macro level.

Gender differences in downward mobility for children from academic families

We now examine whether the proportions of downwardly mobile sons and daughters from academic families have changed differently across cohorts. The proportion of downwardly mobile sons and daughters is the product of the probability of stemming from an academic family and the probability of not earning a tertiary degree in each cohort (see Equation 6). The left and right panels of Figure 7 show a steady increase in the proportion of downwardly mobile sons and daughters from academic parents across cohorts. It has increased from 4 % to 7 % for

[Figure 7]

daughters and from 2 % to 7 % for sons from the "1944 birth cohort" to the "1986 birth cohort". In other words, the proportion of downwardly mobile daughters was already larger than for sons among the oldest birth cohorts. However, the change in the proportion of downwardly mobile sons over the observation period has been larger than for daughters, so that in the youngest birth cohorts the proportions of downwardly mobile daughters and sons have converged. Even though daughters and sons from academic families are less likely to be downwardly mobile at the micro level across cohorts (from 52 % to 24 % for daughters and

from 32 % to 23 % for sons), the proportion of academic families has increased sharply at the macro level (from about 8 % to about 30 % for daughters and sons). The combination of both developments has led to an increasing share of daughters and sons from academic families being educationally downwardly mobile.

Gender differences in upward mobility for children from non-academic families

Finally, we investigate to which extent there are differences in the proportion of educationally upwardly mobile daughters and sons from low and intermediate educated families across cohorts. The proportions of upwardly mobile sons and daughters results from the product of the

[Figure 8]

probability of stemming from a non-academic family and the probability of sons and daughters from non-academic families to earn a tertiary degree in each cohort (see Equations 7 and 8). The left panel of Figure 8 shows that the proportion of upwardly mobile daughters from parents with low educational attainment has remained fairly stable across cohorts and is at a very low level (about 1 %). This is surprising, as the probability of daughters from this educational origin group acquiring a tertiary degree has increased at the micro level across cohorts (from 6 % in the "1944 birth cohort" to 19 % in the "1986 birth cohort"). At the same time, however, the proportion of parents with low educational attainment declined at the macro level (from 18 % to 3 %), resulting in this overall low and stable proportion of upwardly mobile daughters in each cohort. The picture is completely different for daughters from families with intermediate education. Their share of upwardly mobile daughters has increased from 9 % to 21 % across cohorts. Although this social origin group has declined slightly across cohorts (from 71 % to 61 %) at the macro level, the opportunities of obtaining a tertiary degree have increased much

more for daughters from this social origin group (from 13 % to 34 %) at the micro level, leading to an overall increase in the proportion of these upwardly mobile daughters.

The right panel of Figure 8 shows the proportions of upwardly mobile sons of parents with low and intermediate education. These proportions are quite stable across cohorts for sons from parents with low (about 1 %) and intermediate education (about 20 %). The proportions of low and intermediate educated parents have declined at the macro level (from 15 % to 3 % and from 75 % to 64 % respectively). At the same time, however, the opportunities of sons from both educational origin groups to obtain a tertiary degree have increased slightly at the micro level. They have risen from 14 % to 19 % for sons of parents with low education and from 26 % to 35 % for sons of parents with intermediate education. These two opposing developments result in a persistent overall proportion of upwardly mobile sons.

In summary, we conclude that daughters from parents with intermediate education were able to catch up with sons in their upward mobility proportions. The faster change in the proportion of upwardly mobile daughters is the result of their increasing educational opportunities at the micro level.

6. Conclusion

The objective of this article has been to provide a systematic empirical assessment of how the rise of better educated origin families across cohorts influences sons' and daughters' tertiary education in West Germany? So far there exists only one study by Ziefle (2017), which examines the consequences of these macro changes for women's rising completion of higher education entrance certificates. In order to evaluate how the macro level upgrading of origin families across cohorts and the micro level developments of educational opportunities interact

and lead to women's catching-up process in tertiary educational attainment to men, we must examine the changing educational attainment process of both sons and daughters.

There are two macro- and micro-level developments in the educational expansion process that have influenced the rise in sons and daughters tertiary education attainment. First, there has been a dramatic improvement in the composition of the social origin structure that has led to an overall increase in tertiary education attainment. However, this development has not been gender-specific. Both sons and daughters are much more likely to stem from academic families in the most recent birth cohorts. Second, educational opportunities for sons and daughters from all origin families have remained quite stable at the micro level during the period of massive expansion of tertiary education. Our findings suggest that academic families continue to preserve their advantageous educational positions for their progeny. Nevertheless, the demand for tertiary education has increased for sons and daughters in all three social origin groups, but it has increased particularly strongly for daughters. In sum, both sons and daughters alike have benefited from the general upgrading of family education across cohorts, but women have benefited even more from the expansion of the tertiary education system. With our empirical findings, we can thus confirm the earlier finding of Ziefle (2017) that the improvement in the social origin structure contributed to the increase in the educational attainment of daughters. However, at least for tertiary education, we do not find empirical evidence supporting her claim that daughters in particular could benefit from this compositional shift in parental resources (Ziefle 2017).

Proponents of the *gender-egalitarian perspective* claim that women from academic families can increase their tertiary educational attainment across cohorts because these families have stronger gender-egalitarian attitudes. In addition, advocates of the *mother role model perspective* suggest that mothers are role models for their daughters. Thus, if mothers are more likely to obtain tertiary degrees across cohorts, their daughters should be more likely to obtain

tertiary degrees as well. Similar to Buchmann and DiPrete (2006) for the U. S., we find no evidence for these two claims in the German context. Neither of these two hypotheses can explain the massive increase of tertiary degrees earned by daughters relative to sons in Germany. First, the micro-level examination of origin-specific changes in the attainment of tertiary education shows that daughters from academic families already had lower probabilities to obtain a tertiary degree compared to sons among the oldest birth cohorts. This contrasts with the gender-egalitarian perspective. Second, if mothers serve as role models for their daughters, we would expect a significant interaction term between mother's educational resources and being female. However, our micro-level model shows no such effect, so we must reject this hypothesis as well. Instead, we find support for micro-level theories that assert increasing benefits of tertiary education for all women, regardless of their social origin. In our micro-level model, daughters from all social origin groups increased their educational attainment at the same rate and caught up with their male counterparts. This is in line with previous research by Becker (2014) and Legewie and DiPrete (2009). A key contribution of this article, therefore, is that our more detailed model of educational growth allows us to better evaluate various macro- and micro level- hypotheses about women's catch-up with men in tertiary education.

We showed that sons and daughters of parents with low education make up the smallest share of tertiary degree holders and this share continues to decline across cohorts. In turn, tertiary degree holders are very likely to stem from academic family backgrounds which have also increased across cohorts, so that today about half of the tertiary degree holders have an academic family background. Our empirical findings suggest that these patterns are quite similar for sons and daughters. A general conclusion of our findings is that a major driver of this compositional shift of tertiary degree holders is the changing composition of social origin across birth cohorts.

Furthermore, this article is one of the first studies that shows that changes in the distribution of social origin were crucial for changes in the proportion of educationally downwardly mobile sons and daughters from academic families. It could be demonstrated that the proportion of downwardly mobile sons and daughters has risen across cohorts as the pool of sons and daughters from academic families is rising. However, there are important gender differences in this development. Daughters had already a higher share of downward mobility than sons among the oldest birth cohorts. However, the change in the downward mobility proportion has been steeper for sons in our observation window, so that the proportions of downwardly mobile sons and daughters converged in the youngest birth cohorts.

Finally, we also examined gender-specific changes in the upward mobility proportions from non-academic families. We found that the proportions of upwardly mobile sons from low and intermediate educated families and daughters from low educated families have been quite stable across birth cohorts. This stability is the result of countervailing trends: (1) The declines in non-academic families at the macro level and (2) the rising probabilities of earning a tertiary degree of these children at the micro level. One important finding was that the proportion of educationally upwardly mobile daughters from parents with intermediate education increased across cohorts, bringing their upward mobility shares closer to those of sons in the youngest birth cohorts.

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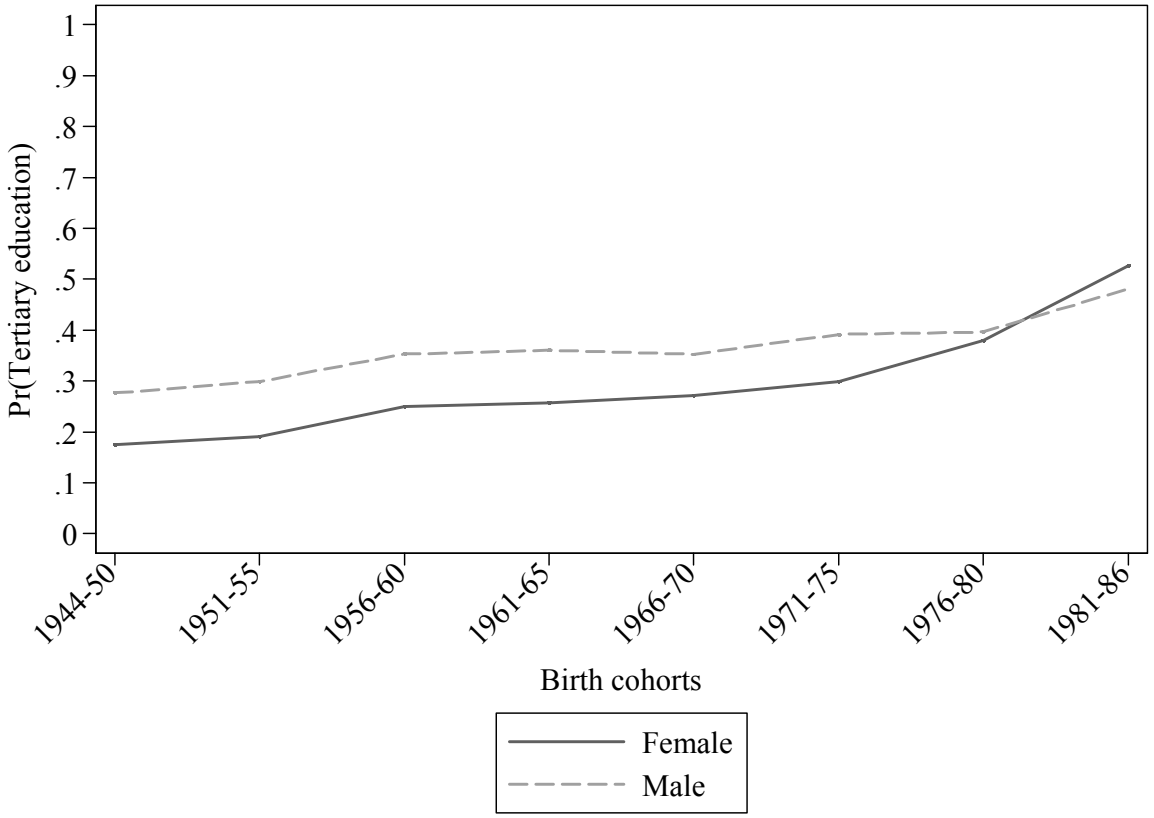
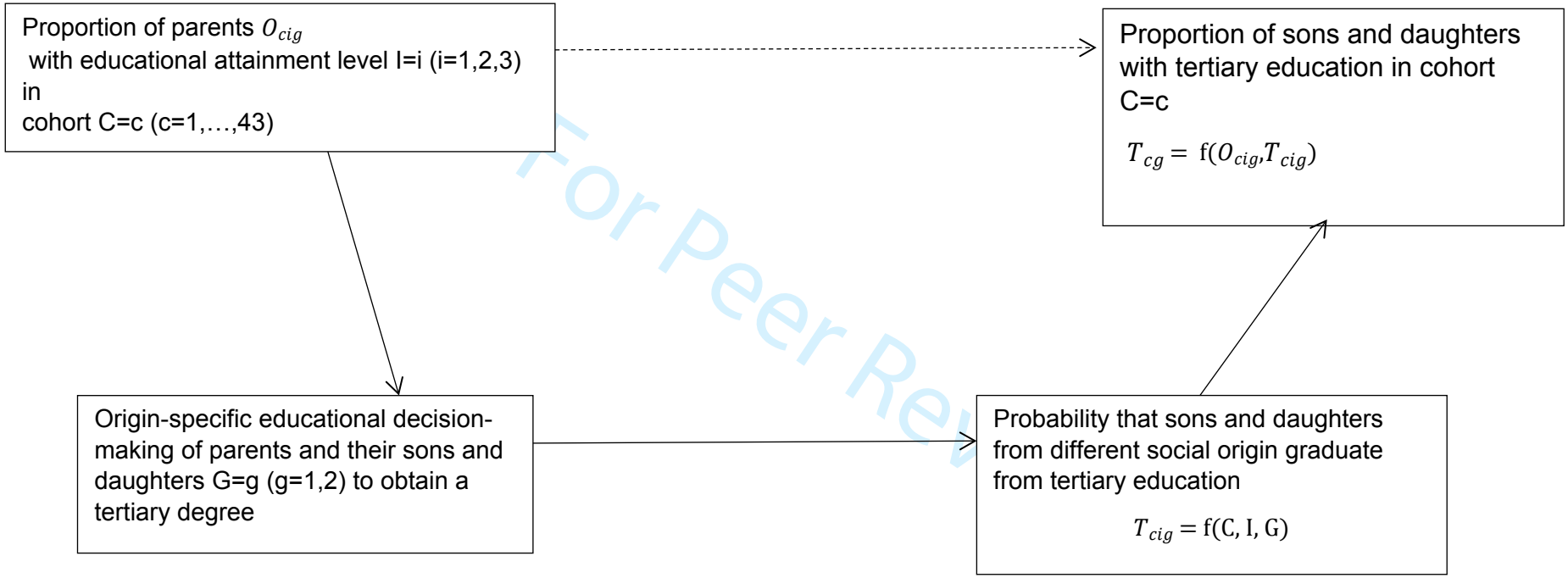
Tables and Figures

Figure 1: Changes in males' and females' tertiary education across birth cohorts



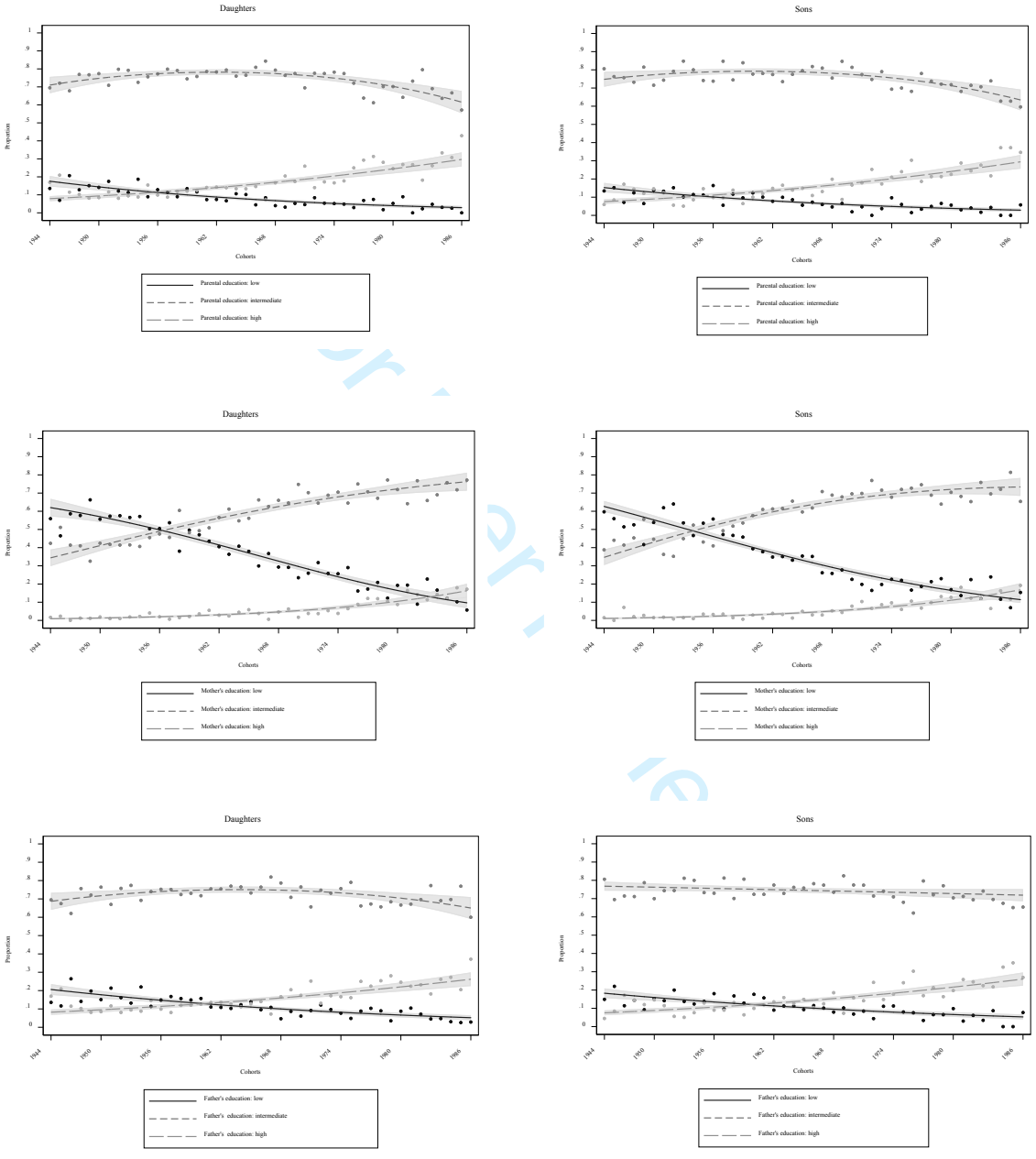
Source: SUF10.0.1 (Blossfeld et al. 2011; doi:10.5157/NEPS:SC6:10.0.1); author's calculations

Figure 2: Macro-micro-macro model showing how changes in the distribution of parents across cohorts and changes in educational decision-making, are related to changes in tertiary educational attainment of sons and daughters across cohorts



Source: Author's own presentation

Figure 3: Change in the proportions of fathers, mothers and families with different educational attainments (parental education according to the dominance approach in 1st row, mother's education 2nd row, father's education 3rd row) for daughters (left panel) and sons (right panel) with observed and smoothed estimated probabilities using a logistic regression model



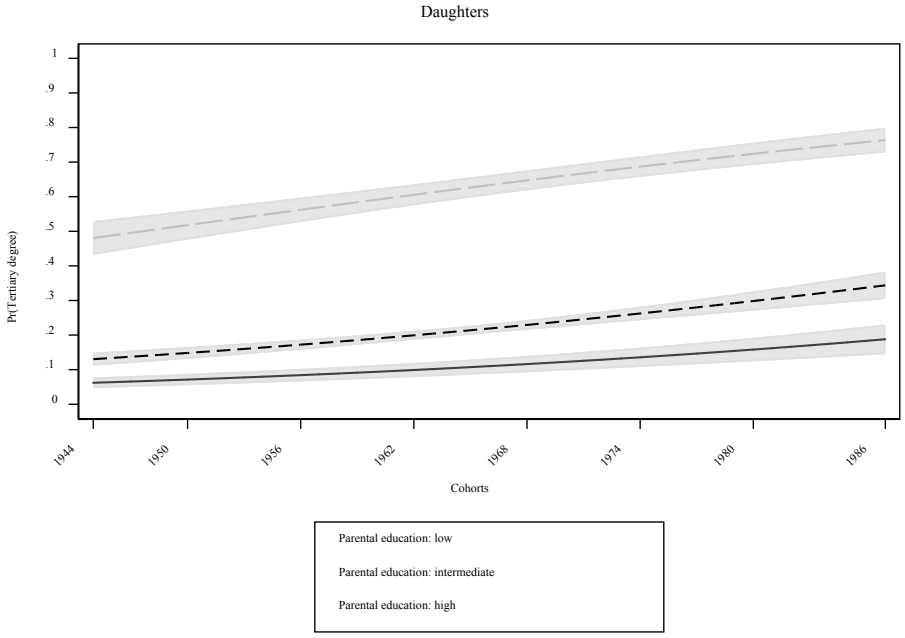
Source: SUF10.0.1 (Blossfeld et al. 2011; doi:10.5157/NEPS:SC6:10.0.1); author's calculations

Table 1: Logit models for the individuals with a tertiary educational degree aged 30 and above

	Model 1	**Model 2**	Model 3	Model 4
Cohort trend	0.018***	**0.010****	0.018***	0.019
	[0.002]	**[0.003]**	[0.002]	[0.016]
Social origin (Ref. Parental education: low)				
Parental education: intermediate	0.817***	**0.817*****	0.834***	1.042***
	[0.116]	**[0.116]**	[0.154]	[0.298]
Parental education: high	2.634***	**2.636*****	2.592***	2.625***
	[0.127]	**[0.127]**	[0.173]	[0.342]
Female (Ref. male)	-0.464***	**-0.855*****	-0.446*	-0.842
	[0.050]	**[0.108]**	[0.225]	[0.458]
Interaction terms				
Female×Cohort trend		**0.020*****		0.023
		[0.005]		[0.024]
Parental education: intermediate×Female			-0.039	-0.063
			[0.232]	[0.475]
Parental education: high×Female			0.072	0.224
			[0.255]	[0.525]
Parental education: intermediate×Cohort trend				-0.011
				[0.016]
Parental education: high×Cohort trend				-0.002
				[0.018]
Parental education: intermediate×Female ×Cohort trend				-0.002
				[0.024]
Parental education: high×Female×Cohort trend				-0.012
				[0.026]
Constant	-2.023***	**-1.858*****	-2.030***	-2.036***
	[0.120]	**[0.126]**	[0.154]	[0.287]
Observations	8828	**8828**	8828	8828

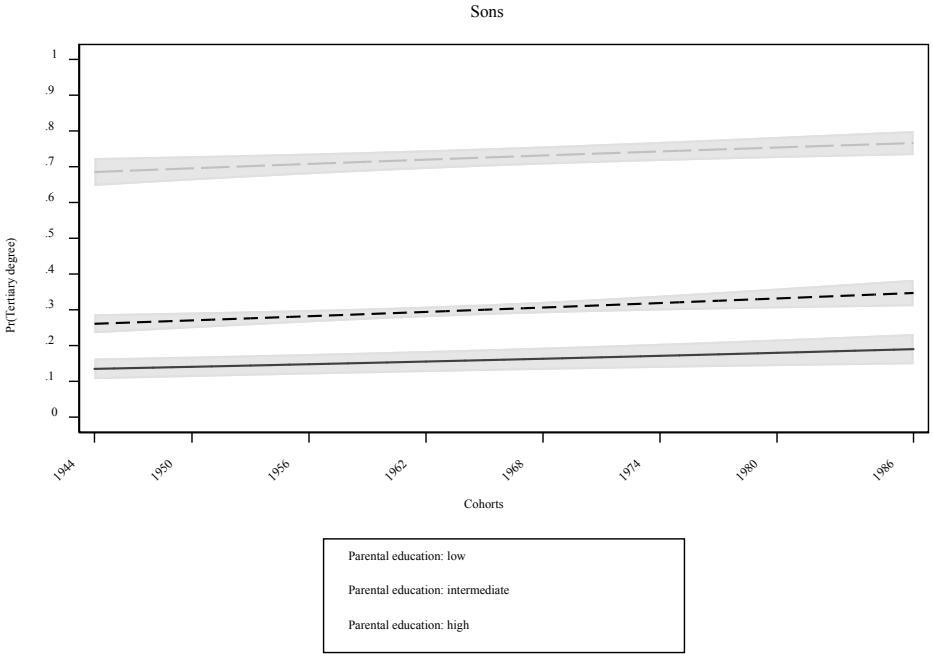
Significance levels: * p<0.05, ** p<0.01, *** p<0.001
Source: SUF10.0.1 (Blossfeld et al. 2011; doi:10.5157/NEPS:SC6:10.0.1); author's calculations

Figure 4: Estimated probabilities of daughters with confidence bands to obtain a tertiary degree for the three social origin groups (estimation is based on binary logistic regressions)



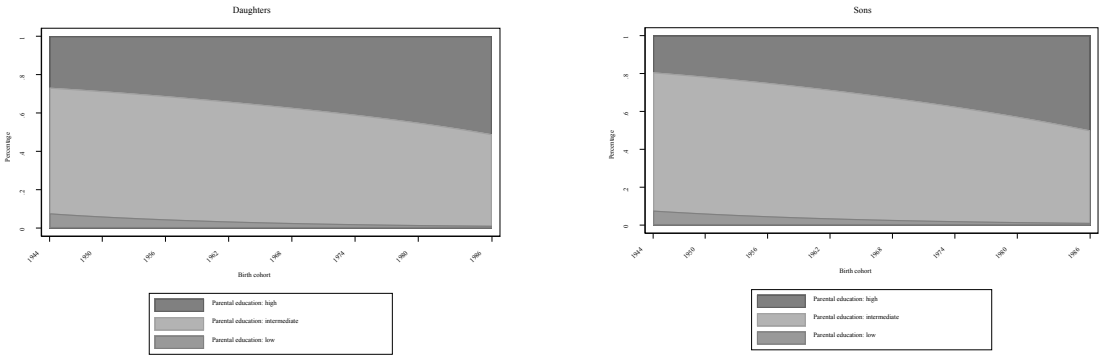
Source: SUF10.0.1 (Blossfeld et al. 2011; doi:10.5157/NEPS:SC6:10.0.1); author's calculations

Figure 5: Estimated probabilities of sons with confidence bands to obtain a tertiary degree for the three social origin groups (estimation is based on binary logistic regressions)



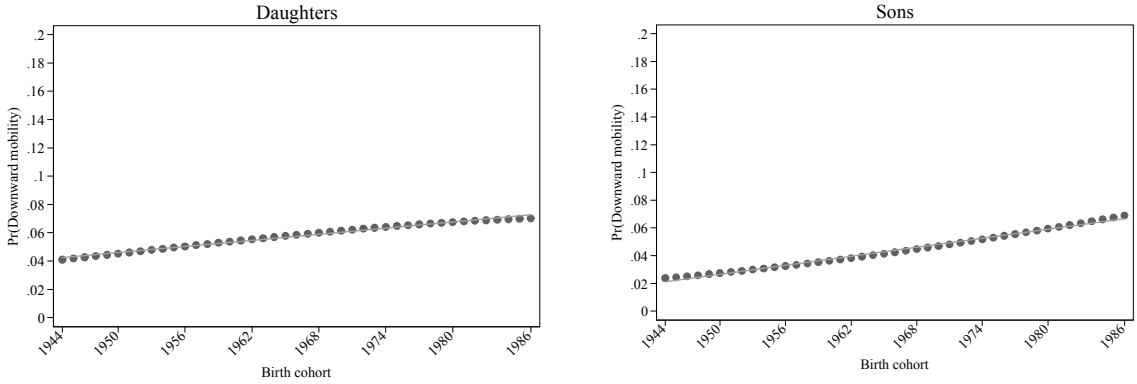
Source: SUF10.0.1 (Blossfeld et al. 2011; doi:10.5157/NEPS:SC6:10.0.1); author's calculations

Figure 6: Change in the inflow distributions of sons and daughters to tertiary education by social origin across cohorts



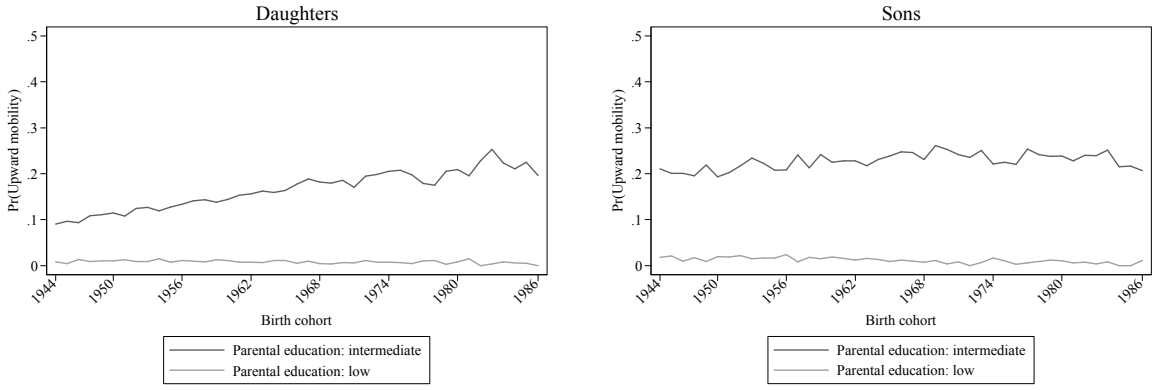
Source: SUF10.0.1 (Blossfeld et al. 2011; doi:10.5157/NEPS:SC6:10.0.1); author's calculations

Figure 7: Change in the probability of daughters and sons from academic families to move educationally downwards



Source: SUF10.0.1 (Blossfeld et al. 2011; doi:10.5157/NEPS:SC6:10.0.1); author's calculations

Figure 8: Change in the probability of daughters and sons from low and intermediate educated parents to move educationally upwards



Source: SUF10.0.1 (Blossfeld et al. 2011; doi:10.5157/NEPS:SC6:10.0.1); author's calculations

Appendix

A 1: Logit model for sons and daughters with a tertiary educational degree aged 30 and above including fathers' and mothers' education

	Model
Cohort trend	0.003
	[0.003]
Mother's education (Ref.: low)	
Intermediate	0.60***
	[0.08]
High	1.72***
	[0.21]
Father's education (Ref.: low)	
Intermediate	0.44***
	[0.13]
High	1.91***
	[0.16]
Female (Ref. male)	-0.70***
	[0.19]
Interaction terms	
Female×Cohort trend	0.02***
	[0.005]
Mother's education: intermediate×Female	-0.07
	[0.12]
Mother's education: high×Female	-0.18
	[0.29]
Father's education: intermediate×Female	-0.16
	[0.19]
Father's education: high×Female	-0.06
	[0.23]
Constant	-1.74***
	[0.13]
Observations	8828

Significance levels: * p<0.05, ** p<0.01, *** p<0.001
Source: SUF10.0.1 (Blossfeld et al. 2011; doi:10.5157/NEPS:SC6:10.0.1); author's calculations