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Michael Fertig
Christoph M. Schmidt
Mathias G. Sinning

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of Labor

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**Michael Fertig**
*ISG, RWI Essen and IZA*

**Christoph M. Schmidt**
*RWI Essen, Ruhr-University Bochum, CEPR and IZA*

**Mathias G. Sinning**
*Australian National University and IZA*

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IZA

P.O. Box 7240
53072 Bonn
Germany

Phone: +49-228-3894-0
Fax: +49-228-3894-180
E-mail: iza@iza.org

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# ABSTRACT

# The Impact of Demographic Change on Human Capital Accumulation*

This paper investigates whether and to what extent demographic change has an impact on human capital accumulation. The effect of the relative cohort size on educational attainment of young adults in Germany is analyzed utilizing data from the German Socio-Economic Panel for West-German individuals of the birth cohorts 1966 to 1986. These are the cohorts which entered the labor market since the 1980's. Particular attention is paid to the effect of changes in labor market conditions, which constitute an important channel through which demographic change may affect human capital accumulation. Our findings suggest that the variables measuring demographic change exert a considerable though heterogeneous impact on the human capital accumulation of young Germans. Changing labor market conditions during the 1980's and 1990's exhibit a sizeable impact on both the highest schooling and the highest professional degree obtained by younger cohorts.

JEL Classification: J11, J24, C25

Keywords: demographic change, schooling, vocational training

Corresponding author:

Christoph M. Schmidt
RWI Essen
Hohenzollernstr. 1-3
45128 Essen
Germany
E-mail: schmidt@rwi-essen.de

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# 1 Introduction

During the last fifty years all European societies have transformed their demographic composition to a considerable extent. European economic and political integration together with an intense immigration experience have been additional relevant factors in this development. The most remarkable influence on European demographics, however, has been exerted by post-war baby booms and baby busts. The demographic burden induced by population ageing constitutes long-term societal challenges for all European countries, though with some heterogeneity regarding the precise timing (see e.g. Fertig and Schmidt (2003) for a more detailed discussion). In this context, Germany provides an interesting case study. According to the Federal Statistical Office (2006), Germany will soon have one of the highest shares of older people in all industrialized countries. The proportion of elderly relative to the labor force is projected to rise from 34% in 2010 to 64% in 2050, due to a pronounced decline in fertility rates and a simultaneous rise in life expectancy. It is uncontroversial that this demographic change will have a direct impact on the pay-as-you-go pension system (Börsch-Supan, 1999). Furthermore, it seems safe to argue that social security systems on the whole, most notably the public health care system will be affected directly by ageing societies as well.

However, the discussion on the consequences of demographic change often neglects other, similarly important potential consequences of population ageing. In general, an ageing society implies not only a reduction of overall labor supply and an increasing old-age dependency ratio, but also a decline in the *relative* labor supply of younger workers. Thus, population ageing might affect the level and composition of the labor force in a much more complex way than is often recognized. This relative shift in labor supply might impinge upon a variety of different aspects of individual and societal welfare, among which educational attainment is of special interest. Börsch-Supan (2002), for instance, argues that it is unlikely that the decline in the relative labor supply of the young will be offset by higher capital intensity so that labor productivity has to increase considerably to keep production on its current

level. An increase in productivity, however, typically requires higher human capital accumulation. Thus, the educational attainment of young cohorts is of vital interest for any economy coping with demographic change.

This paper, therefore, investigates whether and to what extent demographic change has an impact on the human capital accumulation of younger cohorts. In this endeavor, we utilize data from the German Socio-Economic Panel (SOEP) for West-German individuals of the birth cohorts 1966 to 1986 who entered the labor market since the 1980's. In addition to the direct measure of demographic change (i.e. the relative cohort size of 18-21 year old individuals relative to the total population), we consider labor market variables which capture important indirect effects of demographic change on human capital accumulation. It will become transparent that the variables measuring demographic change have a substantial impact on the human capital accumulation of young Germans. However, there is also remarkable heterogeneity in these effects for different cohorts. Our findings further suggest that both the highest schooling and the highest professional degree obtained by younger cohorts was determined by changing labor market conditions during the 1980's and 1990's.

The remainder of this paper is organized as follows. Section 2 discusses the relationship between relative cohort size and educational attainment with a special focus on the German case. In Section 3 the empirical strategy and the utilized data are described in detail. Section 4 reports and discusses the empirical results and Section 5 offers some conclusions.

# 2 Demographic Change and Human Capital Accumulation

This section provides an overview on demographic and labor market developments in Germany since the 1970's and discusses their potential consequences for the human capital accumulation of younger cohorts. It is well documented that Germany

experienced a remarkable decline in birth rates during the 1970's. The number of life births (per 1,000 people) in (West) Germany declined from 13.4 in 1970 to 10.1 in 1980, 10.0 in 1990 and 9.4 in 2000 (see Fertig and Schmidt (2003)). The most pronounced drop in birth rates happened after 1972. Since 1973 death rates exceed birth rates in Germany. During this period, Germany also experienced a steady decline in child and old-age mortality rates and, correspondingly, an increase in life expectancy. Together, these developments resulted in a considerable shift in the population age structure. Most notably, the population share of younger cohorts declined remarkably. Columns (1) and (2) of Table 1 depict the population and labor force share of 18-21 year olds between 1984 and 2007, which demonstrate the falling share of young individuals over time. This process results in a sharp increase in predicted old-age dependency ratios for Germany (as well as almost all other European countries, see e.g. World Bank (1999)).

In terms of its economic repercussions, population ageing is first and foremost equivalent to a decline of the labor supply of younger relative to that of older workers, and also to the number of retirees. It is rather uncontroversial that this relative shift in labor supply has a direct effect on the German social security systems, especially the pension systems but also the health and old-age care insurance (see e.g. Börsch-Supan (1999) for a more detailed discussion of this issue). This is the principal reason for the attention given both in the public discussion and the academic literature to the effects of demographic processes on old-age dependency ratios. Yet, ageing also affects the composition of the economically active population, and thus might exert important influences reaching far beyond increasing social security contribution rates.

After all, even if members of large birth cohorts exhibit the same life-cycle behavior concerning human capital acquisition and labor supply as members of small birth cohorts, their sheer prevalence might change their economic prospects (and perhaps also the aggregate outcome). However, it is very likely that demographic change will also display indirect effects via behavioral responses of individuals. The following labor market related outcomes might response to population ageing by changes in the behavior of agents: (i) the structure of wages, the income distribution and savings;

(ii) the level and structure of employment and unemployment; (iii) the organization of work; (iv) the structure of product demand and (v) the human capital accumulation of smaller cohorts. These various direct and indirect effects are intimately related and might exert repercussions on demographic change itself, i.e. specifically on family formation and fertility, as well as on the (early) retirement decisions of older workers. The following discussion concentrates on the last of these potential responses, i.e. on the human capital accumulation decision of the young.

More formally, it is instructive to view each birth cohort as a different production factor. The typical life-cycle of a specific cohort comprises human capital acquisition and labor market entry in younger years, household and labor market production in medium age, and at some point exit of the labor market. In this process, large birth cohorts experience generational crowding throughout their complete lives, unless large-scale immigration of a subsequent birth cohort counteracts this pattern. However, given the current immigration policy in Germany, it seems to be very unlikely that this will happen.

Thus, for the purposes of our analysis, we model demographic change by variations in the population-age structure reflected in the relative cohort size of individuals who are in the prime age of entering the labor market or pursuing post-secondary education, i.e. 18-21 year old individuals. In this context, workers of different age are assumed to be different factors of production which are imperfect substitutes. Thus, changes in relative cohort size of this specific age group directly translate in shifts of relative labor supply (see e.g. Welch (1979)).

In a completely competitive setting in which all factors are fully employed, more abundant factors exhibit a relatively low marginal productivity. Hence, the relative shift in labor supply induced by an ageing population might have an effect on the relative wages of younger and older workers and, therefore, on the income distribution of a society. All other things equal, population ageing implies that young workers become scarcer which might result in a rise of their relative wage. The precise extent to which wages of the young increase decisively relies upon the degree of substitutability between different age groups in the production process and the

institutional framework of the labor market. More precisely, in a system of unionized wage bargaining, like for instance in Germany, it is easily conceivable that wages do not (fully) respond to changes in relative labor supply since older and, in the case at hand, larger cohorts might have more bargaining power. Thus, changes in labor supply might – at least to some extent – rather be reflected in changes of age-specific relative unemployment (see also below).

A large body of literature analyzing the United States baby boom cohorts (see e.g. the seminal papers by Connelly (1986); Freeman (1979) and Welch (1979)) documents a response of wages to relative shifts in labor supply with larger cohorts experiencing lower wages. The empirical evidence for European countries is rather small, though, and no clear picture emerges. Wright (1991) for the case of UK provides evidence that larger cohorts have lower earnings but this effect does not persist as the cohorts age. Klevmarken (1993) reports no significant cohort effects for Swedish data. However, Dahlberg and Nahum (2003), utilizing alternative data for the case of Sweden, find significant effects of cohort sizes on earnings, which vary across education levels.

For Germany, despite the rather strong decline in relative cohort sizes of the young, the relative income position of full-time working 18-21 year old individuals has degraded since 1990 (see Column 3 of Table 1). This indicates that the relative income of young Germans is related to a variety of factors. In addition to cohort size, changes in human capital levels and correspondingly, labor supply seem to be important factors. However, aggregate economic developments might play a decisively role as well.

Due to intergenerational dependence in educational attainment, which is especially pronounced in Germany (see e.g. Fertig (2003) or Woessmann (2004)), the human capital accumulation of young workers should increase if the share of highly educated parents in each cohort increases. However, the structure of a cohort with respect to parental education might unfold an indirect impact as well (see Connelly and Gottschalk (1995)). Since a higher share of highly educated in a cohort reduces the returns to education this might be a disincentive for parents to invest into

the human capital of their children. Therefore, a higher share of highly educated parents might have a detrimental impact on the human capital accumulation of a young cohort. Empirically, this phenomenon is quite well researched for the United States (see e.g. Connelly (1986), Connelly and Gottschalk (1995), and Stapleton and Young (1988)). These studies demonstrate that due to the decline in the private returns to education in response to larger relative cohort sizes, the human capital accumulation of relatively large cohorts decreases. Unfortunately, for Germany no comparable evidence exists.

Furthermore, the labor market situation in Germany during 1980's and 1990's is characterized by a persistently high and increasing overall unemployment rate (see Column 4 of Table 1). Schmidt (2000a,b) demonstrates that the German labor market is characterized by a rather low dynamic. On the one hand, one observes a low probability of losing one's job, but on the other hand, the probability to find a new job once one is unemployed is also low. The latter holds especially for individuals with a rather low qualification level.

Column 4 of Table 1 indicates a large excess supply of labor. However, at the same time we also observe considerable excess demand for specific kinds of labor in some sectors (see e.g. Zimmermann et al. (2002)). This excess demand mainly applies to higher qualification levels, though. The dismal labor market situation motivated policy makers to intensify the use of measures of active labor market policy (ALMP), with the explicit aim to reduce unemployment and simultaneously excess demand by qualifying the unemployed. However, international experiences with the effectiveness and efficiency of ALMP measures are rather disillusioning (see Schmidt et al. (2001) for an international comparison of measures and results, and Kluve and Schmidt (2002) for a European perspective).

Finally, one observes a relatively large increase in unemployment of older workers (Column 5 of Table 1). This is probably at least to some extent a reflection of the German education and apprenticeship system which enables young adults to remain in university or vocational training for an increasingly long period of time. However, the already mentioned system of unionized wage bargaining might also contribute to

this disproportional increase of unemployment among the elderly by preventing wages from (fully) responding to demographic processes. If youth unemployment indeed responds negatively to population ageing, this in turn could act as a disincentive to invest in human capital since opportunity cost in terms of foregone earnings are higher for these cohorts. Clark (2002), for instance, reports strong positive effects of youth unemployment on the participation of young workers in further education for the case of UK.

In sum, population ageing might act as an additional incentive for younger cohorts to invest in human capital if the relative shift in labor supply results in a rise of young workers' wages, since the returns to education for this age group will increase. All other things equal, this should lead to higher human capital accumulation by the young. However, it is also conceivable that a shrinking labor force which reduces labor market competition and therefore youth unemployment as well as the structure of the cohort with respect to parental education might counterbalance this effect. Consequently, from a theoretical point of view, the net impact of population ageing on the human capital acquisition of younger cohorts is ambiguous. Therefore, the matter is entirely empirical.

# 3 Empirical Strategy and Description of Data

In the empirical investigation of this paper individual-level data from the German Socio-Economic Panel (SOEP) and aggregate data from the Federal Statistical Office is utilized to analyze the relationship between human capital accumulation, demographic change and the labor market situation of young workers in Germany. The SOEP is a representative longitudinal study of private households in Germany which started in 1984. It collects information on all household members, consisting of Germans living in the old and new German states, foreigners, and recent immigrants to Germany.

Our empirical application focusses on a comparison of birth cohorts within a cross-section. Specifically, we utilize data from wave 2007 for West-Germany to

investigate the effect of variations in relative cohort size, relative income and youth and overall unemployment rates on human capital accumulation. In addition, data for West-Germany was retrieved from waves 1984 to 2007 to generate the relative income measure reported in Table 1. Since young people in the German schooling and apprenticeship system typically decide around the age of 18 to 21 whether they enter the labor market or participate in further education, our analysis concentrates on this particular age group. When considering aggregate variables, we refer to the year when members of a birth cohort were 18 years old, i.e we assume that individuals take economic and demographic conditions at the beginning of the decision period (age 18 to 21 years) as a basis of their education decisions. We further restrict our sample to the birth cohorts 1966 to 1986 (i.e. 18 year olds over the period 1984-2004), which allows us to generate a relative income measure for all birth cohorts (since 18 year olds observed in 1984 were born in 1966) and consider the situation of all 18 to 21 year olds over the period 1984-2004 (since 21 year olds observed in 2007 were born in 1986).[1]

To examine the relative importance of the determinants of human capital accumulation, two outcome variables are considered: the highest schooling degree and the highest professional degree (including university education). Both variables are measured on an ordered scale. We have coded both dependent variables such that zero denotes the lowest, two the highest and one the medium category. In particular, the highest schooling degree of the respondent is divided into the following categories: 0: no schooling or completed secondary (*Hauptschule*); 1: intermediary degree (*Realschule*); 2: upper secondary or technical school degree (*Fachhochschulreife/Hochschulreife*). The highest professional degree is coded as follows: 0: no vocational training; 1: vocational training and equivalent (apprenticeship, vocational school, health care school, technical school, civil service training, other training); 2: university degree and equivalent (technical college, university). In the empirical

[1]We also carried out similar calculations considering the relative cohort sizes of 16 to 21 year old individuals born between 1968 and 1986. Even though some of the effects became insignificant, the overall results did not change qualitatively. The estimates are available from the authors upon request.

analysis, an ordered Probit framework is applied to take the ordered nature of the dependent variables into account. Ordered Probit analysis is a single-equation technique which assumes that there is an unobservable latent variable $y^*$ which linearly depends on a set of exogenous variables denoted by $x$ and an unobservable error term $\nu$, i.e.

$$y^* = \beta' x + \nu. \tag{1}$$

One does not observe $y^*$ directly but $y$, where $y$ is defined as

$$\begin{aligned}
y &= 0 \quad if \quad && y^* \leq 0, \\
y &= 1 \quad if \quad 0 \quad \leq && y^* \leq \mu_1, \\
y &= 2 \quad if \quad \mu_1 \quad \leq && y^* \leq \mu_2, \\
&\vdots \\
y &= L \quad if \quad \mu_{L-1} \quad \leq && y^*.
\end{aligned}$$

where the $\mu$'s are unknown threshold values to be estimated. We assume that the error term is normally distributed with zero mean and a standard deviation of one, i.e. $\nu \sim N(0,1)$.[2]

The explanatory factors $x$ comprise four sets of variables, each set including one or more variables. These variables are (i) *individual characteristics* (i.e. gender, citizenship and living environment at age 15), (ii) *parental background information* (i.e. highest educational degree of mother and father, highest professional degree of mother and father, indicator for parents being young at birth of respondent, indicators for mother and father being young at death), (iii) *variables measuring demographic change* (i.e. relative own cohort size of 18-21 year olds (relative to total population), an indicator for cohorts born in 1978 or later, an interaction term between relative cohort size and this indicator variable, and a measure of the cohort structure (share of highly educated fathers)) and (iv) *variables measuring*

[2]Since the ordered Probit model assumes that the coefficients are the same for transitions between different categories, we also estimated a generalized ordered Logit model. The estimates of this model did not change the overall results qualitatively and are available upon request.

*labor market conditions* (i.e. youth unemployment rate, overall unemployment rate and labor income of 18 to 21 year old full-time employed persons).[3,4]

Individual characteristics and family background variables are the standard explanatory variables in empirical investigations on human capital accumulation. The augmentation with respect to variables measuring demographic change are supposed to capture the change in the German population age-structure during the considered period. In particular, in the beginning of the 1970's Germany experienced a remarkable drop in birth rates. As a result, both population and labor force shares have declined substantially between 1984 and 1995 (see Table 1). After 1995, a moderate increase in population and labor force shares may be observed. To account for this specific development, we employ an indicator variable for the birth cohorts before 1978 and an interaction term between this indicator variable and the relative cohort size.

Furthermore, a measure for the structure of the cohort with respect to parental education is employed. Following Connelly and Gottschalk (1995), the share of highly educated fathers is utilized to account for the potentially negative impact of parents being less willing to invest in the human capital of their children if the supply of highly educated individuals in a cohort increases. Since higher education, especially attending university, is more costly than regular schooling, a more pronounced impact of the cohort structure on the highest professional degree is expected. In addition to parental education, demographic characteristics of the parents may affect educational attainment of their children. Specifically, we may expect that parents who were young at birth of their child face higher financial constraints, potentially limiting investments in the human capital of their child. Consequently, we include an indicator variable for parents being young at birth of the respondent in our model. Moreover, since financial constraints are typically even more severe for lone parents,

[3]An additional model specification was estimated to demonstrate that omitting the interaction term between the indicator for cohorts born in 1978 or later and the relative cohort size does not change the overall relative cohort size effect substantially. The estimates are available from the authors upon request.

[4]For a description of all explanatory variables see Table A1 in the Appendix.

indicator variables for mother and father being young at death are considered.

In addition to the direct measure of demographic change (i.e. the relative cohort size), our model includes a set of variables describing labor market conditions. Specifically, the relative income measure and the youth and overall unemployment rates presented in Table 1 are used as explanatory variables in our empirical models. As mentioned earlier, we refer to the year when members of a birth cohort were 18 years old when considering aggregate variables, i.e. we use aggregate variables of the period 1984-2004 to examine the birth cohorts 1966-1986.

The interpretation of the estimated coefficients of ordered Probit models is quite difficult since due to the non-linearity of the model they do not display the effect of a unit-change in one of the independent variables on the dependent variable. However, it is possible to calculate the marginal effects from the coefficient estimates. In this endeavor, the cohort size measure deserves special attention due to the interaction term. A unit-change in cohort size translates into a different responses in the outcomes depending on the value of the indicator variable "born in 1978 or later". Furthermore, one has to decide at which mean the impact of cohort sizes is evaluated, i.e. at the overall mean of this variable or the group-specific means. Since quantitative results change considerably, we calculated the marginal effect of the cohort size measure for both cases. A detailed description of these calculations is given in the Appendix.

The estimations comprise different specifications for both outcome variables. To demonstrate the changes in results in response to adding specific groups of explanatory variables, these specifications differ in the number of explanatory factors employed. Particularly, we estimate the following models separately for males and females. Specification (1): Individual characteristics and parental background information plus relative own cohort size, an indicator for a change in the trend of population and labor force share for the birth cohorts 1978 and later, an interaction term between the two variables and measures of cohort composition (i.e. the share of highly educated fathers) and relative income; Specification (2): Specification (1) excluding relative income, but including youth and overall unemployment

rates. Specification (3): Specification (2) plus relative income.

Finally, while analyzing the effect of aggregate variables on micro units, the possibility of a within-group correlation of random disturbances has to be taken into account. Since individuals of the same birth cohort share the same observable characteristics on an aggregate level, it seems likely that they also share unobservable characteristics that may lead to correlated errors and cause the standard errors of the parameter estimates to be seriously biased downward (see Moulton (1990)). In the following analysis, standard errors are adjusted to account for possible correlations of error terms within birth cohorts.

# 4 Empirical Results

The following tables summarize the estimation results for the central variables of interest in the different specifications for both outcome variables. The complete estimates of Specification (3) are reported in Tables A3 and A4 in the Appendix.[5,6] The complete estimates of Specifications (1) and (2) are available from the authors upon request.

## 4.1 Estimation Results for Males

The estimation results for the highest schooling degree and the highest professional degree for males are summarized in Table 2. With respect to schooling degrees, the variables measuring demographic change display a remarkably stable impact across specifications. However, while the overall effect is significantly positive in

[5]From Appendix-Tables A3 and A4 it becomes transparent that parental education exhibits a highly significant impact on respondents educational attainment.

[6]We applied several likelihood ratio tests to compare the estimates of separate models for females and males with the estimates of a pooled model. The test results indicate that the estimates of the separate models are significantly different from those of the joint model. Therefore, we only present the results of model specifications which were estimated separately for females and males. The estimates of the joint model and the results of the likelihood ratio tests are available from the authors upon request.

Specification (1), it becomes insignificant at conventional levels after controlling for unemployment. We further observe a significantly negative effect for younger birth cohorts, i.e. those individuals born in 1978 or later. The significantly positive coefficient of the indicator variable of younger birth cohorts suggests that men of more recent cohorts are more likely to attain a high schooling degree than comparable men who were born before 1978. Furthermore, we find evidence for a positive effect of relative income on the highest schooling degree of men, suggesting that a relative income increase creates incentives to obtain a high schooling degree. A significantly positive effect may also be observed for the share of highly educated fathers, indicating that the highest schooling degree is determined by the cohort composition. Finally, the effects of youth and overall unemployment rates on the highest school degree are not significant.

The estimates in the second part of Table 2 suggest a negative impact of the relative cohort size on the highest professional degree of men after considering unemployment rates. Although the overall effect in Specification (3) is only significant at a 10%-level, a highly significant deviation may be observed for younger cohorts. Moreover, while the coefficients of the share of highly educated fathers and the relative income measure are insignificant, our estimates reveal that an increase in the youth unemployment rate increases the propensity to receive a professional degree. This result suggests that many young persons obtain a professional degree to avoid unemployment. At the same time, the effect of the overall unemployment rate is significantly negative, indicating that an improvement in the overall labor market situation creates incentives to obtain higher education.

The corresponding marginal effects of our preferred model (Specification (3)) are summarized in Table 3. The estimates suggest that an increase in the relative cohort size by one percentage point reduces the probability of receiving a high schooling degree ($Y = 2$) by 1.5 percentage points for individuals born in 1978 or later. This effect increases to around 22 percentage points if evaluated at group-specific sample means of the cohort size measure. This seems to be a relatively large effect, but it is important to note that one percentage point corresponds to about 822,000 persons

aged between 18 and 21 years. Such a substantial change may not be realistic in the short-run. However, the Federal Statistical Office (2006) projects a decline in the population share of 18-21 year olds from about 3.6% in 2007 to about 2.6% in 2050. Moreover, a decline in the population share of 18-21 year olds by 0.5 percentage points is expected over the next decade alone. Such a decline would correspond to a decrease in the number of men aged 18-21 years by 1,501,000−1,269,000=232,000 until 2017. Appendix-Table A2 shows that the share of young men with a high schooling degree in 2007 is 33.6% (i.e. 504,336 individuals). To keep the number of men with a high schooling degree at a constant level until 2017, an increase in the probability of receiving a high schooling degree by 6.1 percentage points (i.e. $1,501,000 \times 0.336/1,269,000 - 0.336 = 0.061$) would be required. Given a decline in the relative cohort size by 0.5 percentage points, such an increase corresponds to a marginal effect of $2 \times 6.1 = 12.2$ percentage points. Our estimates further suggest that an increase in the share of highly educated fathers by one percentage point increases the probability of receiving a high schooling degree by 0.5 percentage points. The corresponding effect of the relative income measure is 0.2 percentage points. Finally, due to a change in signs of the threshold values of the Ordered Probit model, a negative effect may be observed for the intercept.

The marginal effects of the demographic factors for professional degrees do not deviate substantially from those observed for schooling degrees. Relative cohort size effects for receiving a high professional degree are between 2.7 and 23.4 percentage points. The share of men with a high professional degree in 2007 is 21.1% (see Table A2). Therefore, a marginal effect of $2 \times (1,051,000 \times 0.211/1,269,000 - 0.211) = 0.077$ would be needed to keep the number of men with a high professional degree constant until 2017. The picture changes somewhat for the marginal effects of cohort composition and labor market situation. Specifically, an increase in youth unemployment rates by one percentage point increases the propensity of obtaining a high professional degree by 0.1 percentage points. This effect is rather small compared to the negative marginal effect of the overall unemployment rate of 11.5 percentage points.

## 4.2 Estimation Results For Females

Table 4 provides the estimated coefficients and t-values for women. The estimation results for the highest schooling degree reveal that the impact of some of the variables of interest is statistically insignificant. While the overall effect of the relative cohort size is significantly negative, differences between cohorts born before and after 1978 are not significant. In addition, youth unemployment rates have a significantly positive effect on the highest schooling degree, indicating that female students tend to increase their human capital stock in the presence of high unemployment risk.

By contrast, the estimates for the highest professional degree of women suggest that the overall effect of the relative cohort size is only significant at a 10%-level. Again, we do not observe significant differences for cohorts born before and after 1978. Moreover, labor market conditions have a sizeable impact on the highest professional degree of women. Specifically, increasing relative incomes, declining overall unemployment rates and increasing youth unemployment rates create incentives to obtain a high professional degree.

Table 5 reports the corresponding marginal effects for our preferred model (Specification (3)). The overall relative cohort size effect on the highest schooling degree is between 8.1 and 8.4 percentage points. The expected reduction in the population share of 18-21 year olds by 0.5 percentage points until 2017 corresponds to a decline in the number of women aged 18-21 years by $1,427,000 - 1,213,000 = 214,000$. Since the share of women with a high schooling degree is 35.2% in 2007, a constant number of women with a high schooling degree until 2017 would require and increase in the share by 6.2 percentage points (i.e. from 35.2% to 41.4%) or a marginal effect of 12.4 percentage points. Hence, our estimates suggest a decline in the number of women with a high schooling degree in the coming years, because a marginal effect of 0.084 corresponds to an increase in the share of women with high schooling degree from 35.2% to 39.4%.

The marginal effect of the overall relative cohort size on the highest professional degree is between 6.1 and 6.8 percentage points (and only significant at a 10%-level).

An increase in the share of 20.2% of women with a high professional degree by 3.6 percentage points would be necessary to keep the number of highly educated women constant until 2017. This would require a marginal effect of 7.2 percentage points, suggesting that the number of highly educated women could remain relatively stable over the next decade. Our estimates further indicate that labor market conditions have a sizeable impact on the highest professional degree of women. Specifically, an increase in the youth unemployment rate lowers the propensity to receive a high professional degree by 1.5 percentage points, while the same increase in the overall unemployment rate causes a decline by 7.1 percentage points. Finally, an increase in the relative income measure by one percentage point increases the probability of receiving a high professional degree by 0.006.

In sum, the empirical findings provide evidence for a negative effect of the relative cohort size on the highest schooling degree of females and both the highest schooling degree and the highest professional degree of males. At the same time, the impact of the relative cohort size on the highest professional degree of females turns out to be insignificant. Moreover, while the highest schooling degree of females is influenced by the overall relative cohort size, both the highest schooling degree and the highest professional degree of males are mainly affected by the relative cohort size of the cohorts who were born in 1978 or later. Furthermore, the share of highly educated fathers positively affects the highest schooling degree of males, providing empirical evidence for an intergenerational dependence in educational attainment between fathers and sons. Finally, labor market conditions have a sizeable impact on human capital accumulation of both males and females. While an increase in relative income creates incentives for human capital accumulation, overall unemployment rates reduce incentives to receive further education. Youth unemployment rates have a positive impact on educational attainment, suggesting that both females and males tend to increase their human capital stock in the presence of high unemployment risk.

# 5 Conclusions

This paper investigates the impact of demographic change – measured by relative cohort size as well as cohort composition – on the human capital accumulation of individuals born between 1966 and 1986 in Germany. These cohorts entered the labor market since the 1980's. In addition to the direct measure of demographic change, we consider labor market variables which capture important indirect effects of demographic change on human capital accumulation. Specifically, we analyze the impact of relative cohort size, cohort structure, relative income and unemployment in an ordered Probit framework for the highest schooling and professional degree of men and women. All models also control for individual socio-demographic characteristics and parental background variables.

Our empirical results provide evidence for a negative impact of the relative cohort size on educational attainment of both males and females. However, relative cohort size effects of cohorts born before 1978 differ substantially from those of cohorts born in 1978 or later. Furthermore, our results suggest that the labor market situation of young people plays a considerable role for investments in human capital. Although the quantitative dimensions of demographic measures suggest that increases in human capital investment may partly offset the decline in the number of highly educated young persons, policy should not expect large increases in human capital investment of younger cohorts due to demographic change alone.

Against the background of a rather strong intergenerational dependence in educational success in Germany and considering the fact that human capital investments depreciate over time if not regularly renewed, there seems to be room for additional incentives for higher investments in human capital for younger as well as older workers. However, instead of selective initiatives policy should embed these incentives in a coherent strategy of life-long learning which is able to reduce the strong intergenerational dependence in human capital accumulation.

# Tables

**Table 1**

Descriptive Statistics: Population and Labor Force Share of 18-21 Year Olds, Relative Income of Full-Time Working 18-21 Year Olds and Unemployment Rates, 1984-2007

| Year | Population share (1) | Labor force share (2) | Relative income (3) | Overall unempl. rate (4) | Youth unempl. rate (5) |
|---|---|---|---|---|---|
| 1984 | 0.052 | 0.080 | 0.595 | 0.045 | 0.044 |
| 1985 | 0.051 | 0.078 | 0.475 | 0.046 | 0.044 |
| 1986 | 0.049 | 0.075 | 0.513 | 0.044 | 0.039 |
| 1987 | 0.047 | 0.072 | 0.550 | 0.044 | 0.036 |
| 1988 | 0.044 | 0.067 | 0.572 | 0.043 | 0.029 |
| 1989 | 0.042 | 0.063 | 0.580 | 0.039 | 0.022 |
| 1990 | 0.038 | 0.058 | 0.614 | 0.036 | 0.020 |
| 1991 | 0.035 | 0.054 | 0.612 | 0.049 | 0.034 |
| 1992 | 0.033 | 0.050 | 0.641 | 0.056 | 0.033 |
| 1993 | 0.031 | 0.048 | 0.635 | 0.064 | 0.035 |
| 1994 | 0.031 | 0.048 | 0.589 | 0.070 | 0.036 |
| 1995 | 0.031 | 0.048 | 0.548 | 0.068 | 0.037 |
| 1996 | 0.032 | 0.049 | 0.540 | 0.074 | 0.041 |
| 1997 | 0.032 | 0.050 | 0.578 | 0.082 | 0.043 |
| 1998 | 0.033 | 0.051 | 0.518 | 0.080 | 0.040 |
| 1999 | 0.034 | 0.053 | 0.525 | 0.077 | 0.036 |
| 2000 | 0.035 | 0.054 | 0.509 | 0.073 | 0.036 |
| 2001 | 0.034 | 0.054 | 0.534 | 0.073 | 0.035 |
| 2002 | 0.034 | 0.053 | 0.488 | 0.077 | 0.035 |
| 2003 | 0.034 | 0.053 | 0.459 | 0.083 | 0.030 |
| 2004 | 0.034 | 0.054 | 0.433 | 0.084 | 0.027 |
| 2005 | 0.035 | 0.055 | 0.468 | 0.093 | 0.043 |
| 2006 | 0.036 | 0.057 | 0.440 | 0.087 | 0.037 |
| 2007 | 0.036 | 0.057 | 0.520 | 0.073 | 0.028 |

Note.–The descriptive statistics presented in columns (1), (2), (4) and (5) are derived from the Yearbook of the Federal Statistical Office. Column (3) reports labor income of 18 to 21 relative to 18 to 65 year old full-time employed individuals from SOEP data in % (based on real Euros of 2000). The overall unemployment rate reported in Column (4) is defined as the number of unemployed persons relative to the population of 18-65 year olds. The youth unemployment rate reported in Column (5) is defined as the number of unemployed persons below 20 years relative to the population of 18-21 year olds.

**Table 2**

Summary of Estimation Results for Highest Schooling Degree and Highest Professional Degree, Males Only

| | Highest Schooling Degree | | | | | |
|---|---|---|---|---|---|---|
| | **Specific. (1)** | | **Specific. (2)** | | **Specific. (3)** | |
| | Coeff. | t-value | Coeff. | t-value | Coeff. | t-value |
| Relative cohort size | 8.727 | 4.25 | 8.835 | 1.07 | 14.230 | 1.81 |
| Born in 1978 or later | 6.271 | 6.06 | 7.749 | 4.85 | 7.339 | 4.55 |
| Relative cohort size 1978 and later | -194.218 | -6.11 | -240.310 | -4.86 | -227.168 | -4.51 |
| Share of highly educated fathers | 1.105 | 3.52 | 1.697 | 4.17 | 1.466 | 3.50 |
| Relative income | 0.941 | 2.68 | | | 0.848 | 2.76 |
| Youth unemployment | | | -6.374 | -0.87 | -7.222 | -0.99 |
| Overall unemployment | | | -0.091 | -0.02 | 2.440 | 0.47 |
| | **Highest Professional Degree** | | | | | |
| | Coeff. | t-value | Coeff. | t-value | Coeff. | t-value |
| Relative cohort size | 17.378 | 2.21 | -36.821 | -2.41 | -30.902 | -1.92 |
| Born in 1978 or later | 9.073 | 3.92 | 5.644 | 2.80 | 5.189 | 3.09 |
| Relative cohort size 1978 and later | -283.444 | -3.95 | -167.805 | -2.74 | -153.201 | -2.95 |
| Share of highly educated fathers | 0.766 | 0.72 | -0.100 | -0.18 | -0.347 | -0.57 |
| Relative income | 1.823 | 1.36 | | | 0.934 | 1.21 |
| Youth unemployment | | | 35.487 | 3.00 | 34.590 | 2.93 |
| Overall unemployment | | | -35.444 | -3.26 | -32.742 | -2.99 |

Note.–Number of observations: 1,557. Robust standard errors. All estimations include full set of control variables.

**Table 3**

MARGINAL EFFECTS OF COHORT SIZE MEASURE FOR MALES ONLY

| | **Highest Schooling Degree** | | | | |
|---|---|---|---|---|---|
| | | | Marginal Effect | | |
| | Coeff. | t-value | Y=0 | Y=1 | Y=2 |
| Relative cohort size[a] | 14.230 | 1.81 | -0.043 | -0.011 | 0.054 |
| Relative cohort size 1978 and later[a] | -227.168 | -4.51 | 0.135 | -0.121 | -0.015 |
| Relative cohort size[b] | 14.230 | 1.81 | -0.041 | -0.014 | 0.055 |
| Relative cohort size 1978 and later[b] | -227.168 | -4.51 | 0.590 | -0.368 | -0.221 |
| Born in 1978 or later (intercept)[c] | 7.339 | 4.55 | 0.143 | -0.002 | -0.141 |
| Share of highly educated fathers[a] | 1.466 | 3.50 | -0.002 | -0.002 | 0.005 |
| Relative income[a] | 0.848 | 2.76 | -0.000 | -0.001 | 0.002 |
| Youth unemployment[a] | -7.222 | -0.99 | 0.023 | 0.003 | -0.026 |
| Overall unemployment[a] | 2.440 | 0.47 | -0.005 | -0.004 | 0.009 |
| | **Highest Professional Degree** | | | | |
| | | | Marginal Effect | | |
| | Coeff. | t-value | Y=0 | Y=1 | Y=2 |
| Relative cohort size[a] | -30.902 | -1.92 | 0.066 | -0.000 | -0.066 |
| Relative cohort size 1978 and later[a] | -153.201 | -2.95 | 0.558 | -0.531 | -0.027 |
| Relative cohort size[b] | -30.902 | -1.92 | 0.073 | -0.015 | -0.059 |
| Relative cohort size 1978 and later[b] | -153.201 | -2.95 | 0.559 | -0.325 | -0.234 |
| Born in 1978 or later (intercept)[c] | 5.189 | 3.09 | -0.058 | -0.039 | 0.096 |
| Share of highly educated fathers[a] | -0.347 | -0.57 | 0.000 | 0.000 | -0.000 |
| Relative income[a] | 0.934 | 1.21 | -0.000 | -0.002 | 0.002 |
| Youth unemployment[a] | 34.590 | 2.93 | -0.000 | -0.001 | 0.001 |
| Overall unemployment[a] | -32.742 | -2.99 | 0.028 | 0.086 | -0.115 |

NOTE.–Number of observations: 1,557. [a] Marginal effect evaluated at sample mean. [b] Marginal effect evaluated at group-specific mean (i.e. sample mean of individuals born before or after 1978, respectively). [c] Marginal effect evaluated at sample mean.

**Table 4**

Summary of Estimation Results for Highest Schooling Degree and Highest Professional Degree, Females Only

| | Highest Schooling Degree | | | | | |
|---|---|---|---|---|---|---|
| | **Specific. (1)** | | **Specific. (2)** | | **Specific. (3)** | |
| | Coeff. | t-value | Coeff. | t-value | Coeff. | t-value |
| Relative cohort size | -6.424 | -1.10 | -23.365 | -2.82 | -24.148 | -2.60 |
| Born in 1978 or later | 2.994 | 1.30 | 0.164 | 0.08 | 0.229 | 0.10 |
| Relative cohort size 1978 and later | -97.501 | -1.40 | -8.806 | -0.14 | -10.857 | -0.16 |
| Share of highly educated fathers | 0.575 | 0.72 | -0.329 | -0.40 | -0.303 | -0.35 |
| Relative income | -0.189 | -0.23 | | | -0.117 | -0.18 |
| Youth unemployment | | | 19.694 | 2.83 | 19.828 | 2.87 |
| Overall unemployment | | | -9.076 | -1.24 | -9.428 | -1.28 |
| | **Highest Professional Degree** | | | | | |
| | Coeff. | t-value | Coeff. | t-value | Coeff. | t-value |
| Relative cohort size | 6.326 | 0.84 | -42.887 | -2.43 | -31.583 | -1.74 |
| Born in 1978 or later | 4.438 | 2.22 | 1.572 | 0.57 | 0.660 | 0.26 |
| Relative cohort size 1978 and later | -143.806 | -2.36 | -49.716 | -0.59 | -20.724 | -0.27 |
| Share of highly educated fathers | 0.666 | 0.64 | -0.104 | -0.10 | -0.473 | -0.45 |
| Relative income | 2.149 | 1.82 | | | 1.684 | 2.12 |
| Youth unemployment | | | 33.579 | 2.33 | 31.669 | 2.29 |
| Overall unemployment | | | -29.018 | -2.50 | -23.942 | -2.13 |

Note.–Number of observations: 1,795, respectively. Robust standard errors. All estimations include full set of control variables.

**Table 5**

MARGINAL EFFECTS OF COHORT SIZE MEASURE FOR FEMALES ONLY

| | **Highest Schooling Degree** | | | | |
|---|---|---|---|---|---|
| | | | Marginal Effect | | |
| | Coeff. | t-value | Y=0 | Y=1 | Y=2 |
| Relative cohort size[a] | -24.148 | -2.60 | 0.064 | 0.020 | -0.084 |
| Relative cohort size 1978 and later[a] | -10.857 | -0.16 | 0.113 | -0.009 | -0.104 |
| Relative cohort size[b] | -24.148 | -2.60 | 0.069 | 0.013 | -0.081 |
| Relative cohort size 1978 and later[b] | -10.857 | -0.16 | 0.097 | 0.022 | -0.119 |
| Born in 1978 or later (intercept)[c] | 0.229 | 0.10 | -0.020 | -0.010 | 0.030 |
| Share of highly educated fathers[a] | -0.303 | -0.35 | 0.000 | 0.000 | -0.000 |
| Relative income[a] | -0.117 | -0.18 | 0.000 | 0.000 | -0.000 |
| Youth unemployment[a] | 19.828 | 2.87 | -0.000 | -0.005 | 0.005 |
| Overall unemployment[a] | -9.428 | -1.28 | 0.002 | 0.021 | -0.024 |
| | **Highest Professional Degree** | | | | |
| | | | Marginal Effect | | |
| | Coeff. | t-value | Y=0 | Y=1 | Y=2 |
| Relative cohort size[a] | -31.583 | -1.74 | 0.073 | -0.005 | -0.068 |
| Relative cohort size 1978 and later[a] | -20.724 | -0.27 | 0.154 | -0.072 | -0.082 |
| Relative cohort size[b] | -31.583 | -1.74 | 0.081 | -0.020 | -0.061 |
| Relative cohort size 1978 and later[b] | -20.724 | -0.27 | 0.116 | 0.004 | -0.119 |
| Born in 1978 or later (intercept)[c] | 0.660 | 0.26 | -0.047 | -0.018 | 0.065 |
| Share of highly educated fathers[a] | -0.473 | -0.45 | 0.000 | 0.001 | -0.001 |
| Relative income[a] | 1.684 | 2.12 | -0.000 | -0.005 | 0.006 |
| Youth unemployment[a] | 31.669 | 2.29 | -0.000 | -0.015 | 0.015 |
| Overall unemployment[a] | -23.942 | -2.13 | 0.036 | 0.035 | -0.071 |

NOTE.–Number of observations: 1,795. [a] Marginal effect evaluated at sample mean. [b] Marginal effect evaluated at group-specific mean (i.e. sample mean of individuals born before or after 1978, respectively). [c] Marginal effect evaluated at sample mean.

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# Appendix – Calculation of Marginal Effects

The standard formulation of the ordered Probit model yields the following probabilities

$$\begin{aligned} Pr(y=0) &= 1-\Phi(\beta' x) \\ Pr(y=1) &= \Phi(\mu-\beta' x)-\Phi(-\beta' x) \\ Pr(y=2) &= 1-\Phi(\mu-\beta' x) \end{aligned}$$

Reformulate equation (1) of chapter 3 as

$$y^* = \beta_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_2 \cdot x_3 + \beta_5 x_5 + ... + \beta_K x_K + \nu, \tag{2}$$

with $x_2$ denoting cohort size and $x_3$ being an indicator for individuals born in 1978 or later. The sample mean of $x_2$ is denoted by $\bar{x}_2$. $\bar{x}_2^0$ is the sample mean of $x_2$ for those individuals with $x_3 = 0$ and $\bar{x}_2^1$ the sample mean for individuals with $x_3 = 1$. The following paragraphs explain the calculation of the effect of a unit-change in $x_2$ and $x_3$ for the probability to report the lowest value of the outcome measure, i.e. $Pr(y = 0)$. For both other outcome measures, i.e. $Pr(y = 1)$ and $Pr(y = 2)$, the calculation follows straightforwardly.

## Marginal Effect of a Unit-Change in $x_2$

For this case one has to distinguish between $x_3 = 0$ and $x_3 = 1$.

For $x_3 = 0$, i.e. the marginal effect of a unit-change in relative cohort size for those individuals born prior to 1978:

*Baseline*: $\hat{Pr}(y = 0|x_2, x_3 = 0)$ with

$$\text{a) } x_2 = \bar{x}_2 \quad \Rightarrow \quad \hat{Pr}(y=0|\bar{x}_2, x_3=0) = 1-\Phi(\hat{\beta}_1 + \hat{\beta}_2\bar{x}_2 + \hat{\beta}_5\bar{x}_5 + ... + \hat{\beta}_K\bar{x}_K)$$

$$\text{b) } x_2 = \bar{x}_2^0 \quad \Rightarrow \quad \hat{Pr}(y=0|\bar{x}_2^0, x_3=0) = 1-\Phi(\hat{\beta}_1 + \hat{\beta}_2\bar{x}_2^0 + \hat{\beta}_5\bar{x}_5 + ... + \hat{\beta}_K\bar{x}_K)$$

*Unit-change*:

$$\text{a) } x_2^* = \bar{x}_2 + 0.01$$

$$\text{b) } \tilde{x}_2^* = \bar{x}_2^0 + 0.01$$

*Result*:

$$\text{a) } M_a^0(x_2) = \hat{Pr}(y=0|x_2^*, x_3=0) - \hat{Pr}(y=0|\bar{x}_2, x_3=0)$$

$$\text{b) } M_b^0(x_2) = \hat{Pr}(y=0|\tilde{x}_2^*, x_3=0) - \hat{Pr}(y=0|\bar{x}_2^0, x_3=0)$$

where

$$\text{a) } \hat{Pr}(y=0|x_2^*, x_3=0) = 1 - \Phi(\hat{\beta}_1 + \hat{\beta}_2(\bar{x}_2 + 0.01) + \hat{\beta}_5\bar{x}_5 + ... + \hat{\beta}_K\bar{x}_K)$$

$$\text{b) } \hat{Pr}(y=0|\tilde{x}_2^*, x_3=0) = 1 - \Phi(\hat{\beta}_1 + \hat{\beta}_2(\bar{x}_2^0 + 0.01) + \hat{\beta}_5\bar{x}_5 + ... + \hat{\beta}_K\bar{x}_K)$$

For $x_3 = 1$, i.e. the marginal effect of a unit-change in relative cohort size for those individuals born 1978 or later:

*Baseline*: $\hat{Pr}(y=0|x_2, x_3=1)$ with

$$\text{a) } x_2 = \bar{x}_2 \Rightarrow \quad \hat{Pr}(y=0|\bar{x}_2, x_3=1) = 1 - \Phi(\hat{\beta}_1 + \hat{\beta}_2\bar{x}_2 + \hat{\beta}_3 + \hat{\beta}_4\bar{x}_2 + \hat{\beta}_5\bar{x}_5 + ... + \hat{\beta}_K\bar{x}_K)$$

$$\text{b) } x_2 = \bar{x}_2^1 \Rightarrow \quad \hat{Pr}(y=0|\bar{x}_2^1, x_3=1) = 1 - \Phi(\hat{\beta}_1 + \hat{\beta}_2\bar{x}_2^1 + \hat{\beta}_3 + \hat{\beta}_4\bar{x}_2^1 + \hat{\beta}_5\bar{x}_5 + ... + \hat{\beta}_K\bar{x}_K)$$

*Unit-change*:

$$\text{a) } x_2^* = \bar{x}_2 + 0.01$$

$$\text{b) } \tilde{x}_2^* = \bar{x}_2^1 + 0.01$$

*Result*:

$$\text{a) } M_a^0(x_2) = \hat{Pr}(y=0|x_2^*, x_3=1) - \hat{Pr}(y=0|\bar{x}_2, x_3=1)$$

$$\text{b) } M_b^0(x_2) = \hat{Pr}(y=0|\tilde{x}_2^*, x_3=1) - \hat{Pr}(y=0|\bar{x}_2^0, x_3=1)$$

where

$$\text{a) } \hat{Pr}(y=0|x_2^*, x_3=1) = 1 - \Phi(\hat{\beta}_1 + \hat{\beta}_2(\bar{x}_2 + 0.01) + \hat{\beta}_3 + \hat{\beta}_4(\bar{x}_2 + 0.01) + \hat{\beta}_5\bar{x}_5 + ... + \hat{\beta}_K\bar{x}_K)$$

$$\text{b) } \hat{Pr}(y=0|\tilde{x}_2^*, x_3=1) = 1 - \Phi(\hat{\beta}_1 + \hat{\beta}_2(\bar{x}_2^1 + 0.01) + \hat{\beta}_3 + \hat{\beta}_4(\bar{x}_2^1 + 0.01) + \hat{\beta}_5\bar{x}_5 + ... + \hat{\beta}_K\bar{x}_K)$$

## Marginal Effect of a Unit-Change in $x_3$

*Baseline*: $\hat{Pr}(y = 0|x_3 = 0, x_2)$ with

$$x_2 = \bar{x}_2^0 \quad \Rightarrow \quad \hat{Pr}(y = 0|x_3 = 0, \bar{x}_2^0) = 1 - \Phi(\hat{\beta}_1 + \hat{\beta}_2\bar{x}_2^0 + \hat{\beta}_5\bar{x}_5 + ... + \hat{\beta}_K\bar{x}_K)$$

*Unit-change*: $x_3 = 1$

*Result*:

$$M^0(x_3) = \hat{Pr}(y = 0|x_3 = 1, \bar{x}_2^1) - \hat{Pr}(y = 0|x_3 = 0, \bar{x}_2^0)$$

where

$$\hat{Pr}(y = 0|x_3 = 1, \bar{x}_2^1) = 1 - \Phi(\hat{\beta}_1 + \hat{\beta}_2\bar{x}_2^1 + \hat{\beta}_3 + \hat{\beta}_4\bar{x}_2^1 + \hat{\beta}_5\bar{x}_5 + ... + \hat{\beta}_K\bar{x}_K)$$

# Appendix – Tables

**Table A1**

Definition of Explanatory Variables

| Variable | Description |
|---|---|
| Individual characteristics: | |
| Female | 1 if respondent is female; 0 otherwise. |
| Native respondent | 1 if respondent has German citizenship; 0 otherwise. |
| Rural area at age 15 | 1 if respondent lived in rural area at age 15; 0 otherwise. |
| Urban area at age 15 | 1 if respondent lived in urban area at age 15; 0 otherwise. |
| Parental background information: | |
| Father low schooling | 1 if father has no or unknown schooling degree; 0 otherwise. |
| Father secondary schooling | 1 if father has completed secondary schooling; 0 otherwise. |
| Father intermediary schooling | 1 if father has completed intermediary schooling; 0 otherwise. |
| Father other schooling | 1 if father has other schooling degree; 0 otherwise. |
| Father high schooling | 1 if father has completed tertiary schooling; 0 otherwise. |
| Mother low schooling | 1 if mother has no or unknown schooling degree; 0 otherwise. |
| Mother secondary schooling | 1 if mother has completed secondary schooling; 0 otherwise. |
| Mother intermediary schooling | 1 if mother has completed intermediary schooling; 0 otherwise. |
| Mother other schooling | 1 if mother has other schooling degree; 0 otherwise. |
| Mother high schooling | 1 if father has completed tertiary schooling; 0 otherwise. |
| Father no vocational degree | 1 if father has no or unknown vocational training; 0 otherwise. |
| Father traditional farming | 1 if father worked in traditional farming; 0 otherwise. |
| Father other vocational degree | 1 if father has other vocational training; 0 otherwise. |
| Father academic | 1 if father has an academic degree; 0 otherwise |
| Mother no vocational degree | 1 if mother has no or unknown vocational training; 0 otherwise. |
| Mother traditional farming | 1 if mother worked in traditional farming; 0 otherwise. |
| Mother other vocational degree | 1 if mother has other vocational training; 0 otherwise. |
| Mother academic | 1 if mother has an academic degree; 0 otherwise. |
| Parents young at birth | 1 if mother or father was younger than 21 at birth of respondent; 0 otherwise. |
| Mother died young | 1 if respondent was younger than 16 when mother died; 0 otherwise. |
| Father died young | 1 if respondent was younger than 16 when father died; 0 otherwise. |
| Variables measuring demographic change: | |
| Relative cohort size | Number of 18-21 year olds relative to total population for birth cohorts 1966-1986. |
| Born in 1978 or later | 1 if birth year of respondent was 1978 or later; 0 otherwise. |
| Relative cohort size 1978 and later | Interaction term between relative cohort size and indicator for cohorts born in 1978 or later. |
| Share of highly educated fathers | Population share of fathers with completed tertiary schooling for each birth cohort. |
| Labor market situation: | |
| Relative income | Labor income of 18-21 relative to 18-65 year old full-time employed persons (in real 2000 Euros). |
| Youth unemployment rate | Unemployed persons below 20 years relative to the population of 18-21 year olds. |
| Overall unemployment rate | Unemployed persons relative to the population of 18-65 year olds. |

**Table A2**

Descriptive Statistics

| | Males | | Females | |
|---|---|---|---|---|
| | Mean | SD | Mean | SD |
| Dependent Variables: | | | | |
| Highest schooling degree = 0 | 0.315 | 0.465 | 0.206 | 0.404 |
| Highest schooling degree = 1 | 0.349 | 0.477 | 0.442 | 0.497 |
| Highest schooling degree = 2 | 0.336 | 0.472 | 0.352 | 0.478 |
| Highest professional degree = 0 | 0.138 | 0.345 | 0.152 | 0.359 |
| Highest professional degree = 1 | 0.651 | 0.477 | 0.647 | 0.478 |
| Highest professional degree = 2 | 0.211 | 0.408 | 0.202 | 0.401 |
| Explanatory Variables: | | | | |
| Native respondent | 0.914 | 0.281 | 0.911 | 0.285 |
| Rural area at age 15 | 0.358 | 0.479 | 0.342 | 0.474 |
| Urban area at age 15 | 0.205 | 0.404 | 0.222 | 0.416 |
| Father low schooling | 0.092 | 0.290 | 0.099 | 0.299 |
| Father other schooling | 0.062 | 0.242 | 0.042 | 0.201 |
| Father secondary schooling | 0.531 | 0.499 | 0.510 | 0.500 |
| Father intermediary schooling | 0.181 | 0.385 | 0.202 | 0.402 |
| Father high schooling | 0.134 | 0.340 | 0.146 | 0.353 |
| Mother low schooling | 0.103 | 0.305 | 0.101 | 0.301 |
| Mother other schooling | 0.049 | 0.217 | 0.042 | 0.200 |
| Mother secondary schooling | 0.539 | 0.499 | 0.516 | 0.500 |
| Mother intermediary schooling | 0.230 | 0.421 | 0.256 | 0.437 |
| Mother high schooling | 0.078 | 0.268 | 0.085 | 0.278 |
| Father no vocational degree | 0.160 | 0.367 | 0.134 | 0.341 |
| Father traditional farming | 0.189 | 0.392 | 0.167 | 0.373 |
| Father other vocational degree | 0.538 | 0.499 | 0.584 | 0.493 |
| Father academic | 0.112 | 0.316 | 0.115 | 0.319 |
| Mother no vocational degree | 0.326 | 0.469 | 0.284 | 0.451 |
| Mother traditional farming | 0.142 | 0.349 | 0.134 | 0.340 |
| Mother other vocational degree | 0.474 | 0.499 | 0.515 | 0.500 |
| Mother academic | 0.057 | 0.232 | 0.067 | 0.250 |
| Parents young at birth | 0.019 | 0.138 | 0.021 | 0.144 |
| Mother died young | 0.010 | 0.101 | 0.012 | 0.108 |
| Father died young | 0.029 | 0.168 | 0.035 | 0.183 |
| Share of highly educated fathers | 0.151 | 0.054 | 0.153 | 0.053 |
| Relative cohort size | 0.040 | 0.008 | 0.040 | 0.008 |
| Born in 1978 or later | 0.324 | 0.468 | 0.336 | 0.473 |
| Relative cohort size 1978 and later | 0.011 | 0.016 | 0.011 | 0.016 |
| Relative income | 0.550 | 0.051 | 0.552 | 0.051 |
| Youth unemployment | 0.036 | 0.007 | 0.036 | 0.007 |
| Overall unemployment | 0.058 | 0.016 | 0.059 | 0.016 |

Note.–Number of observations: 1,557 and 1,795, respectively. See text and Appendix-Table A1 for description of variables.

**Table A3**

Estimation Results for Highest Schooling Degree and Highest Professional Degree – Specification (3), Males Only

| | **Highest Schooling Degree** | | **Highest Professional Degree** | |
|---|---|---|---|---|
| | Coeff. | t-value | Coeff. | t-value |
| Native respondent | 0.002 | 0.02 | 0.079 | 0.59 |
| Rural area at age 15 | -0.131 | -2.10 | -0.036 | -0.49 |
| Urban area at age 15 | 0.061 | 0.79 | -0.081 | -0.74 |
| Father low schooling | -0.901 | -4.97 | -0.764 | -3.61 |
| Father other schooling | -0.774 | -3.05 | -0.556 | -2.32 |
| Father secondary schooling | -0.908 | -4.66 | -0.659 | -3.58 |
| Father intermediary schooling | -0.616 | -3.32 | -0.592 | -3.26 |
| Mother low schooling | -0.448 | -2.35 | -0.357 | -1.39 |
| Mother other schooling | -0.288 | -1.24 | -0.042 | -0.22 |
| Mother secondary schooling | -0.401 | -2.14 | -0.121 | -0.68 |
| Mother intermediary schooling | -0.041 | -0.29 | 0.065 | 0.42 |
| Father no vocational degree | -0.757 | -3.16 | -0.825 | -4.25 |
| Father traditional farming | -0.436 | -2.30 | -0.330 | -1.61 |
| Father other vocational degree | -0.441 | -2.57 | -0.243 | -1.50 |
| Mother no vocational degree | -0.131 | -0.64 | -0.349 | -1.51 |
| Mother traditional farming | 0.260 | 1.14 | -0.122 | -0.54 |
| Mother other vocational degree | 0.208 | 1.14 | -0.084 | -0.40 |
| Parents young at birth | -0.595 | -2.39 | -0.184 | -0.73 |
| Mother died young | -0.726 | -1.70 | -0.547 | -1.71 |
| Father died young | -0.163 | -0.87 | 0.198 | 1.44 |
| Share of highly educated fathers | 1.466 | 3.50 | -0.347 | -0.57 |
| Relative cohort size | 14.230 | 1.81 | -30.902 | -1.92 |
| Born in 1978 or later | 7.339 | 4.55 | 5.189 | 3.09 |
| Relative cohort size 1978 and later | -227.168 | -4.51 | -153.201 | -2.95 |
| Relative income | 0.848 | 2.76 | 0.934 | 1.21 |
| Youth unemployment | -7.222 | -0.99 | 34.590 | 2.93 |
| Overall unemployment | 2.440 | 0.47 | -32.742 | -2.99 |

Note.–Number of observations: 1,557.

**Table A4**

Estimation Results for Highest Schooling Degree and Highest Professional Degree – Specification (3), Females Only

| | **Highest Schooling Degree** | | **Highest Professional Degree** | |
|---|---|---|---|---|
| | Coeff. | t-value | Coeff. | t-value |
| Native respondent | 0.302 | 2.17 | 0.158 | 1.20 |
| Rural area at age 15 | -0.084 | -1.51 | -0.003 | -0.07 |
| Urban area at age 15 | 0.102 | 1.29 | -0.022 | -0.38 |
| Father low schooling | -0.950 | -5.45 | -0.462 | -2.92 |
| Father other schooling | -0.468 | -2.36 | -0.140 | -0.59 |
| Father secondary schooling | -0.745 | -6.24 | -0.533 | -4.50 |
| Father intermediary schooling | -0.380 | -2.57 | -0.242 | -1.84 |
| Mother low schooling | -0.536 | -2.81 | -0.713 | -3.49 |
| Mother other schooling | -0.431 | -2.58 | -0.365 | -1.44 |
| Mother secondary schooling | -0.388 | -2.07 | -0.354 | -2.34 |
| Mother intermediary schooling | -0.081 | -0.45 | -0.234 | -1.65 |
| Father no vocational degree | -0.306 | -1.73 | -0.560 | -3.99 |
| Father traditional farming | -0.370 | -2.29 | -0.366 | -2.21 |
| Father other vocational degree | -0.231 | -1.69 | -0.219 | -1.70 |
| Mother no vocational degree | -0.425 | -2.01 | -0.461 | -3.85 |
| Mother traditional farming | -0.120 | -0.60 | -0.308 | -2.51 |
| Mother other vocational degree | -0.058 | -0.29 | -0.110 | -0.81 |
| Parents young at birth | -0.380 | -2.35 | -0.146 | -0.72 |
| Mother died young | -0.314 | -1.15 | -0.042 | -0.32 |
| Father died young | -0.243 | -1.55 | -0.231 | -1.55 |
| Share of highly educated fathers | -0.303 | -0.35 | -0.473 | -0.45 |
| Relative cohort size | -24.148 | -2.60 | -31.583 | -1.74 |
| Born in 1978 or later | 0.229 | 0.10 | 0.660 | 0.26 |
| Relative cohort size 1978 and later | -10.857 | -0.16 | -20.724 | -0.27 |
| Relative income | -0.117 | -0.18 | 1.684 | 2.12 |
| Youth unemployment | 19.828 | 2.87 | 31.669 | 2.29 |
| Overall unemployment | -9.428 | -1.28 | -23.942 | -2.13 |

Note.–Number of observations: 1,795.