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Which background factors matter more in intergenerational educational attainment: Social class, cultural capital or cognitive ability? A random effects approach

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2003-05

The activities of CAM are financed by a grant from
The Danish National Research Foundation

Which background factors matter more in intergenerational educational attainment: Social class, cultural capital or cognitive ability? A random effects approach

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Abstract:
The sociological research literature on intergenerational educational attainment has highlighted three types of theoretical frameworks in explaining to what extent social origins influences people's educational choices and possibilities. The three explanatory frameworks are 1) the socio-economic situation in the upbringing, 2) the "cultural capital" of the home (e.g. the level of education of the parents), and finally 3) the cognitive abilities of the individual. While all three explanatory frameworks have been shown empirically to be of significance in explaining people's educational attainment when analyzed individually or two at a time, then only very few studies have simultaneously included all three frameworks and thus been able to present a coherent picture of the influence of social origins on educational attainment vis-à-vis individual ability. As a consequence very little knowledge exists on the relative significance of each of the three explanatory frameworks in explaining educational attainment when analyzed in a common, multivariate setting. Using data from the Danish Youth Longitudinal Panel Survey we analyse the relative significance of each of the proposed explanatory frameworks in explaining intergenerational educational attainment. By means of a multinomial random effects logit model we find father's social class to be the strongest predictor of educational attainment followed by father's level of education and finally cognitive ability. Furthermore, we find that the direct effect of father's level of education is complex in that it to some extent is transmitted via cognitive ability and is more vulnerable to unobserved characteristics captured in the random effect.

Keywords: Educational attainment, social mobility, multinomial logit regression, random effects model, Denmark.

September 2003

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1. Introduction

Recent comparative studies of educational stratification have shown that in all Western societies an array of economic, social, and cultural background factors are important in determining people's educational attainment (see Treiman and Yip 1989; Shavit and Blossfeld 1993; Müller and Karle 1993; Sieben and de Graaf 2001; Lauer 2003). This is the case in spite of the sustained pursuit of egalitarian policies and expansions of education systems in the post-war period throughout the Western world (Hellevik 1997). Most studies show a stable effect of social origins on relative levels of educational attainment across cohorts in most countries; the possible exceptions in Western Europe being Sweden and the Netherlands in which a modestly declining effect of social origin on educational attainment is observed (Jonsson 1993; de Graaf and Ganzeboom 1993).[1]

The factors shown in the literature to explain intergenerational differentials in educational attainment vary. At the most general level, three frameworks for explaining educational attainment have been proposed: the socio-economic or social 'class' position of parents, the level of 'cultural capital' in the home, and finally the cognitive abilities of the individual. The three types of explanations are often empirically interrelated in that parents' level of education tends to be correlated with their socio-economic status: labour market position and income. Similarly, the cognitive ability of individuals is not a purely individual trait but also reflects intellectual and social stimuli in the upbringing. In other words, the background variables that contribute to intergenerational inequalities in educational attainment are intrinsically interrelated.

While many studies have found significant effects of the three explanatory frameworks separately, or comparing two at a time, only very few studies have included all explanatory frameworks simultaneously when analysing intergenerational educational attainment. This is mainly due to a shortage of data sets which include variables from all three explanatory frameworks, and especially cognitive abilities, but also because authors typically wish to examine the significance of one explanatory framework of particular interest relative to another framework (social class vs. cultural capital, social class vs. cognitive ability etc.). As a consequence, consistent analyses of the relative significance of each of the three explanatory frameworks, when analysed in a common multivariate setting, have so far not been carried out. A small number of studies exist that analyse the effect of social origin on the choice of fields of study in secondary and tertiary education (i.e. "horizontal" educational stratification) that to varying degree incorporate variables from all three explanatory frameworks (Davies and Guppy 1997; van de Werfhorst *et al*. 2003). These studies find that socio-economic origins, cultural capital and cognitive ability all significantly affect which field of study is entered, but they also show that ascriptive characteristics such as social class of origin tend to be of greater relative importance than cognitive ability. Nevertheless, studies of the impact of all three explanatory frameworks on the highest completed level of education, i.e. "vertical" educational stratification, remain extremely scarce.

The aim of this paper is to investigate the relative importance of socio-economic background, the cultural capital of the home, and the cognitive capabilities of the individual in determining educational attainment in adulthood. To do this we use Danish data from the Youth Longitudinal Panel Survey (YLPS) in which data on all three types of background information is available from the 1968, 1973, 1992, and 2001 waves. A second aim in the paper is to situate Denmark within the comparative literature on intergenerational educational stratification. So far Denmark has not been represented in any of the comparative studies on the determinants of educational attainment.

In the following section we discuss previous findings on the effects of socio-economic origins, cultural capital, and cognitive abilities on educational attainment. Section 3 reviews a number of methodological and statistical issues related to conceptualising and analysing educational attainment. Section 4 gives a brief introduction to the features of the Danish education system, while section 5 presents the data set as well as the variables used in the analysis. In section 6 we carry out the empirical analyses of the relative importance of socio-economic origin, cultural capital and cognitive abilities in influencing educational attainment. Section 7 draws together the findings and discusses the results.

2. Previous findings on determinants of intergenerational educational attainment

In this section we present a review of the arguments and findings of each of the three proposed frameworks in explaining inequalities in intergenerational attainment. The three frameworks will be discussed in turn.

The socio-economic perspective

Differences in educational attainment are most often attributed to the economic and occupational or 'class' differentials of social origins. Studies of educational stratification in the early and mid-20th century (e.g. Hauser 1969; Boudon 1974; Hauser and Featherman 1976), as well as recent comparative research suggests that the effects of parents', and especially father's occupational status, class position and income, is strong and stable over time in most Western countries (e.g. Treiman and Yip 1989; Shavit and Blossfeld 1993; Müller and Karle 1993; Goldthorpe 1996). Likewise, previous studies on educational stratification in Denmark find a fairly strong relationship between socio-economic origins and educational attainment and occupational outcomes (Hansen 1995; Jensen *et al.* 1997; Jæger *et al.* 2003). Unfortunately, the few Danish studies that have been carried out only to a limited degree followed the example of the international literature in terms of e.g. coding of variables and methods used, and as such direct comparability with other findings is limited.

The cultural capital perspective

Some authors argue that the socio-economic or class position of individuals is not the only significant determinant of intergenerational educational attainment. Following the *cultural reproduction* theory of e.g. Bowles and Gintis (1976) and Bourdieu (1977a, 1977b, 1984), it is claimed that also the cultural capital in the home of origin constitutes an additional explanatory factor of children's

educational attainment (DiMaggio 1982, DiMaggio and Mohr 1985; de Graaf and Kalmijn 2001). The cultural capital of the home is comprised mainly from parents' level of education, cultural tastes, and aesthetic dispositions.[2] It is argued that cultural capital is important because it conveys to children a practical as well as a normative depiction of the value of education. Children learn sets of norms and practices associated with different types and levels of education (e.g. academic or vocational 'cultural' practices and tastes), and when selecting education they tend to choose the types and levels of education with which they are most familiar and which has positive normative inclinations (Bourdieu 1977b; de Graaf 1986; Aschaffenburg and Maas 1997).

Since education is an important determinant of occupational position, cultural capital and socio-economic position are positively correlated, but empirical studies show a strong independent effect of cultural capital on children's educational attainment sometimes even surpassing that of parents' socio-economic position (DiMaggio 1982; DiMaggio and Mohr 1985). Equally important, longitudinal studies by Jonsson (1987, 1993) and de Graaf and Kalmijn (2001) find that the effects of socio-economic status and cultural capital on children's educational attainment are approximately equal for cohorts born at the beginning of the 20th century compared to those born around 1960. The relative effects of cultural capital compared to socio-economics thus seem to be constant over time. In sum, the empirical evidence suggests that cultural capital can be transmitted from generation to generation and is a significant contributor to educational stratification.

The cognitive ability perspective

In addition to different social and cultural aspects in the upbringing environment, also the intellectual abilities and motivations of the individual are significant in determining educational attainment. However, while several studies have investigated the effects of cognitive abilities *vis-à-vis* social origins on occupational outcomes (Savage and Egerton 1997; Bond and Saunders 1999) and earnings (Hauser and Daymont 1976; Taubman 1976; Heckman and Vytlacil 2001), only very few sociological studies have assessed the impact of cognitive ability on educational attainment itself (see Sewell and Shah 1967; Sewell and Hauser 1980; Shavit and Featherman 1988; Hauser and Huang 1997).[3] As a consequence, the impact of cognitive abilities on educational attainment remains the least investigated aspect of the three explanatory frameworks. Nevertheless, findings from existing studies suggest that cognitive abilities have a positive and significant impact on the level of educational attainment, even when other social origin variables are controlled. This would seem to suggest that cognitive ability is directly associated with educational performance. Furthermore, some studies also find evidence that the relative importance of cognitive abilities as opposed to social origins has increased over cohorts (Bond and Saunders 1999), while other studies find a more or less constant effect of cognitive abilities on educational and occupational attainment (Hauser and Huang 1997; Breen and Goldthorpe 2001).

However, two points regarding the validity of this research that may confound results should be mentioned. First, empirical measures of cognitive ability vary

considerably in their construction and predictive power (Jensen 1986). The empirical effects of cognitive abilities on educational attainment are thus likely to vary depending on which type and quality of test has been deployed and at what age of the respondent the test was conducted. Second, measures of cognitive ability are not independent of social origins. Studies have found systematic variation in observed cognitive abilities that can be attributed to a number of socio-economic background variables (Scarr and Weinberg 1978; Anastasi 1982; Savage and Egerton 1997). Unfortunately, only few studies of intergenerational educational attainment including measures of cognitive ability incorporate into their statistical models the dependability of cognitive ability on social origins when analysing educational attainment.

To sum up, the empirical evidence suggests that socio-economics, cultural capital, and cognitive abilities are all significant predictors of educational attainment. However, since no studies have simultaneously controlled for the effect of all three types of predictors in a multivariate framework, our knowledge of the relative weight of each type of explanatory framework is limited. Studies comparing socio-economics and cultural capital find roughly equivalent effects of the two types of explanatory frameworks (e.g. Jonsson 1987, 1993), while the findings in studies comparing effects of cognitive ability and socio-economics provide mixed results (some of which may be due to considerable variation in the types of variables measuring cognitive ability) (e.g. Hauser and Huang 1997; Bond and Saunders 1999). Consequently, existing research indicates that all three types of explanations matter, but it does not provide an unambiguous picture of which – if any – of the explanations matter more.

3. Methodological issues

Research on intergenerational educational mobility has deployed both continuous and discrete variable frameworks when analysing educational attainment. Early studies typically have as their response variable either the number of years of schooling completed (e.g. Blau and Duncan 1967; Sewell and Hauser 1975; Hauser and Featherman 1976) or the individual probability of continuing schooling at different levels or grades (e.g. Bourdon 1974). In both cases the response variable is continuous and linear regression type models are applied to regress years of completed schooling or the probability of school continuation on a number of socio-economic background variables.

Other studies use a discrete-variable framework of educational attainment. Notably Mare's (1980, 1981) transition model of educational attainment has been widely used in the literature (see Shavit and Blossfeld 1993). Mare suggests that levels of educational attainment should rather be seen as the end point of a sequence of transitions through the education system. The major transitions in most Western education systems are those from elementary to secondary, and from secondary to tertiary education. Consequently, using this conceptualisation of educational attainment it is the probability of making a transition from one level of education to another that is the point of interest rather than the number of years spent in the education system, as analysed in the linear models. In this approach educational transitions are viewed as discrete and ordered events that are

qualitatively rather than quantitatively different, and Mare applies a logistic regression type model to estimate the probability of making transitions from one level of education to the next given a number of social background variables.

However, theoretical as well as methodological criticisms of previous studies of educational attainments have recently emerged. Conceptually, as pointed out by Breen and Jonsson (2000), educational transitions are not always as intrinsically sequential as is assumed in the Mare model.[4] In many cases it is possible to change tracks within educational systems, and the assumption that educational attainment is always progressive, however statistically convenient, is fundamentally reductionist. Furthermore, since the institutional features of educational systems diverge considerably across Western Europe, the impact of family background on the probabilities of making different transitions may vary considerably between countries.

Empirically, recent methodological contributions have highlighted several important econometrical flaws in previous research, and especially in the Mare model (see Cameron and Heckman 1998; McIntosh and Munk 2002). We will not rehearse all criticism but merely focuses on the most important ones related directly to our study and suggest how to deal with them. Most importantly, the Mare model is vulnerable to unobserved heterogeneity problems. This problem arises from the fact that the empirical set of individuals "at risk" of making educational transitions changes over transitions and that this fact is not explicitly accounted for in the model. Biased estimates from unobserved heterogeneity may thus arise, first, when the socio-economic variables in the "risk group" change over transitions and, second, when significant unobserved characteristics such as e.g. individuals' cognitive capabilities or motivation are not included as regressors in the model (se also Mare 1993; Breen 1996). This important source of bias, along with several others problems, yield estimates of parameters that are intrinsically problematic.

One way of dealing with the empirical reductionism and the ordered transitions in the Mare model while maintaining a discrete-variable framework is to treat the educational attainment variable as unordered. This perspective gives rise to the multinomial logit model that has been deployed in a number of recent studies on educational and occupational stratification (e.g. Jensen *et al.* 1997; Hendrickx and Ganzeboom 1998; Breen and Jonsson 2000; Dessens *et al.* 2003). An important argument for using the multinomial framework in this study is that the Danish education system builds on a number of quite heterogeneous pillars, especially at the tertiary level, that are qualitatively different in scope and context and that may not readily be considered as ordered. More information on the Danish education system is provided below.

In addition to the use of a multinomial logit model, a more elaborate statistical approach to deal with the econometrical issues mentioned above is required. In the paper we extend the multinomial logit framework with a random effects model to provide estimates of the effect of socio-economics, cultural capital, and cognitive abilities on educational attainment that are robust to the problems of

unobserved heterogeneity (McIntosh and Munk 2002). Furthermore, since observed cognitive ability has been found also to be function of social origins, in the model we allow cognitive ability to depend on socio-economic origins, cultural capital and also on unobserved variables captured in a random effect. Additionally, by allowing the random effect in the model of cognitive abilities to be correlated with the random effects in the model of educational attainment we add to the realism of the modelling framework.

More specifically, for estimating cognitive ability, y_1, we apply a linear regression model

$$(1)\quad \begin{aligned} y_1 &= \beta_1' x_1 + v_1 + e; e: \ \ N(0,\sigma) \Rightarrow \\ f(y_1) &= \frac{1}{\sigma}\varphi\left(\frac{y_1 - \beta_1' x_1 - v_1}{\sigma}\right); \end{aligned}$$

where β_1 are regression coefficients for at set of exogenous predictor variables x_1 (here socio-economic origin and cultural capital), and v_1 is a stochastic error term. For educational attainment, y_2, we have

$$(2)\quad \begin{aligned} \ln\left(\frac{P(Y_2 = l)}{P(Y_2 = 0)}\right) &= \alpha_l + \beta_{2l}' x_{2l} + v_l \Leftrightarrow \\ P(Y_2 = l) &= \frac{\exp(\alpha_l + \beta_{2l}' x_{2l} + v_l)}{1 + \sum_s \exp(\alpha_s + \beta_{2s}' x_{2s} + v_s)}; l = 1,...L \end{aligned}$$

where $P(.)$ is the probability for an individual i that the unordered, discrete level of education variable Y takes the value $1,...,L$ relative to the baseline level 0, β_{2l} are regression coefficients for at set of exogenous predictor variables x_{2l}, and v_{2l} is a stochastic error term.

For the random effects we propose a discrete distribution, taking c different values. This essentially put our model in a latent class framework, see Mclachlan and Peel (2000), although we might also conceptually think of the discrete distribution as an approximation of any unknown distribution of the unobserved variables that enters the model as random effects, see Lindsay (1983):

$$(3)\ P(V_1 = v_{1j}, V_{21} = v_{21j}, V_{22} = v_{22j}, V_{23} = v_{23j}, V_{24} = v_{24j}) = p_j; j = 1,..,c$$

where c is the number of distinct classes in the data and where v_{21j}, v_{12j}, v_{13j}, v_{14j}, p_j, $j = 1,..,c$ are parameters to be estimated. Together equations (1) to (3) yield the joint probability of observing a particular level of ability, a particular category of educational attainment and membership of a latent class.

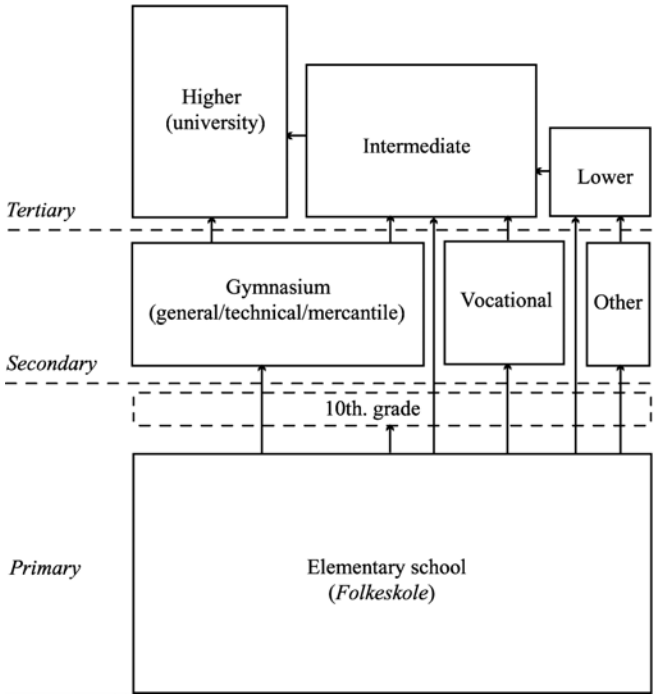
As we do not observe individual membership of latent classes, we have to estimate parameters of the model based on a likelihood function where the latent classes have been marginalised out of the joint probability of y_1, y_2 and v. This amounts to estimating a diskrete mixture model that may be acomplished through

the EM-algorithm (see Dempster, Laird and Rubin 1976). The application of the EM-algorithm for our model is outlined in the appendix.

4. Features of the Danish education system

In comparison with other European countries the Danish education system has several distinct features that are important in this analysis. First, it has no tracking mechanisms at the elementary level, while at the tertiary level one finds a high level of compartmentalization between lower, intermediate, and higher educations. The basic structure of the Danish education system is outlined in figure 1.

Figure 1: An outline of the Danish education system



Elementary school consists of nine years of compulsory schooling with the additional possibility of an optional 10th year. There are no forms of tracking in elementary schooling, and consequently no distinction between lower and higher secondary education exists in the modern Danish education system.[5] Secondary education consists primarily of a high school academic track of three years called *gymnasium* (general, technical or mercantile gymnasium and the higher preparation exam which is two years), vocational education, as well as a small number of alternative types of secondary education. Vocational education typically consists of a mixture of theoretical schooling at branch specific schools and practical training in apprenticeships. Vocational educations typically last between two to four years.

Tertiary educations in Denmark are made up by a variety of education types and lengths. The lower tertiary educations (1-2 years in length) are in many respects similar to vocational educations in that they embrace a range of mostly technical

vocations and lower public sector professions (e.g. social and health services, agricultural or industrial diplomas, short mercantile educations). The main difference is that these educations are typically taken "on top" of some other form of education and that they last only one to two years.

Medium tertiary level education is three or four years in length, and this group comprises a large group of educations typically aimed at the Danish public and welfare sector: elementary school teachers, nurses, child care workers, and social workers. Also a significant number of technical branches, e.g. electrical, construction and mechanical engineering, belong in this group.

Finally, higher tertiary educations pertain to educations at university level, nearly all of which take five years to complete.[6]

As was mentioned, one finds a high degree of compartmentalization in tertiary level education in Denmark. This is not least due to the fact that the different levels of education each have their own and secluded institutional systems of teaching, pedagogical philosophies, and labour market segments. For example, intermediate tertiary education (3-4 years) has its own system of schools (for nurses, elementary school teachers etc.), whereas higher tertiary education at the university level (5 years) has much more theoretical schooling and is kept exclusively in the university system. Lower tertiary educations (1-2 years) are a more mixed lot consisting of different types of mostly practical educations aimed at lower-level professionals in public services as well as mercantile and technical educations. These educations have only a marginal attachment to the intermediate and higher educations.

As a consequence, one also finds that the contemporary Danish educational system tends to produce a high degree of *de facto* 'path dependency' in educational careers. After completing elementary education, the first major differentiation of a cohort of young people takes place between those who attend secondary educations (typically gymnasium educations) (approximately 45 percent of a cohort), vocational educations (app. 35 percent) and those who stop their educational career (app. 15 percent) (Andersen 1997). A second major transition is made after secondary education, at which students either stop their educational careers or move on to different levels of tertiary education. Additionally, a formal prerequisite for attending university level is a high school or equivalent diploma, while for intermediate and especially lower tertiary education admittance may also to a considerable extent based on other non-academic credentials. As a consequence, one finds a number of typical 'trajectories' in the Danish education system through which students move.

5. Data

Data for this study comes from the Youth Longitudinal Panel Survey (YLPS). The survey consists of an original cross-sectional panel of about 3000 respondents born around 1954 who were interviewed for the first time in 1968 at age 14 when they attended 7th grade of elementary school. Additional waves have been conducted in 1969 (parents), 1970, 1973, 1976, 1992, and finally in 2001 when

respondents were around 47 years old. The survey contains elaborate information on the educational and occupational histories of the respondents as well as several batteries on attitudes on a wide variety of issues (politics, work life, childrearing etc.). Additionally, information on the educational and occupational records of the parents of the respondents, as well as a wide range of indicators of the socio-economic, social, and physical conditions of the home, is available. Finally, several standard tests of cognitive abilities measuring verbal, spatial, and inductive-logical skills were conducted when respondents were 14 years old (see Härnqvist 1968; Ørum 1971, 22-30). Taken together these tests provide a comprehensive measure of general cognitive ability.

Variables in the analysis

The variables in the analysis are presented in this section. The marginal distributions of the variables are shown in table 1 below.

Table 1: Marginal distribution of variables in the analysis

Respondent's educational attainment at age 38 (1992)	Percent	N
No education beyond elementary	17,6	471
Vocational	30,2	806
Lower tertiary	26,5	706
Intermediate tertiary	17,2	460
Higher tertiary	8,5	226
Total	100,0	2669
SOCIO-ECONOMIC VARIABLES		
Father's social class (EGP5)		
I/II (Professional and managerial employees, self-employed with 10+ employees)	21,9	527
III (Routine non-manual professionals)	9,3	224
IV (Self-employed and small employers (1-9 employees)	30,4	734
V/VI (Skilled workers)	17,0	411
VII (Unskilled and semi-skilled workers)	21,4	516
Total	100,0	2412
CULTURAL CAPITAL VARIABLES		
Father's level of education		
Elementary	71,3	1879
Lower secondary	22,7	597
Upper secondary	6,0	157
Total	100,0	2633
Cognitive ability[#]	Mean = 0 Std. error = 0.016	
CONTROL VARIABLE		
Gender		
Male	49,1	1231
Female	50,9	1276
Total	100,0	2507

[#] See text for definition of variable.

The response variable, respondents' level of educational attainment at age 38 in 1992, is coded in a fivefold scheme corresponding to the main classifications of educational levels in Denmark. The first category is completed elementary school but with no other qualifying education. The second category consists of all types of vocational educations. Tertiary educations, as discussed above, are divided into lower (1-2 years), intermediate (3-4 years), and higher (5 years) tertiary educations.

The socio-economic position of the home is operationalised as father's social class position. Following Halpin (1999), we use a reduced version of the seven-category EGP class scheme (see Erikson and Goldthorpe 1992) containing five class categories. These categories to a reasonable degree reflect the major occupational divisions in the Danish labour market. Additionally, this classification of father's class position is validated by the fact that it is highly correlated with other similar variables in the data set, e.g. family income, mother's employment position, housing situation etc.

The cultural capital perspective is operationalised using father's level of schooling as a proxy for the level of cultural capital in the respondents' upbringing environment (cf. Jonsson 1987 and 1993 for a similar approach). Mother's level of education is omitted since in the data we observe a high level of educational homogamy between father and mother's level of education (the gamma coefficient of association is 0.81 at $p < 0.0001$).

The cognitive ability perspective is operationalised by means of a constructed variable measuring the respondent's scores at age 14 on the three cognitive tests of verbal, spatial, and inductive-logical abilities discussed above. The variable measuring cognitive ability used in the empirical analyses has been constructed by applying principal axis factor analysis to the three test items.[7]

In addition to the primary variables on socio-economic origin, the cultural capital of the home, and the cognitive abilities of the individual, gender is included as a control variable. While not of primary concerns in this study, gender has been found to be of significance in educational attainment (see Jonsson 1999; Conley 2000; Lauer 2003).

6. Findings: Multiple determinants of educational attainment

Now, how important are socio-economic origins and cultural capital in the home, as compared to cognitive abilities in determining the level of educational attainment at age 38? First, before turning to the results from the joint multinomial random effect models for educational attainment we consider the linear model of cognitive ability.

Table 2. Regression of cognitive ability on socio-economic origin and cultural capital. Parameter estimates and standard errors in parenthesis

	Cognitive ability
Intercept	-0.08 (0.012)
1. SOCIO-ECONOMICS	
Father's class***	
I/II	0
III	-0,003 (0,011)
IV	-0,034 (0,009)***
V/VI	-0,067 (0,010)***
VII	-0,037 (0,011)***
2. CULTURAL CAPITAL	
Father's level of education***	
Elementary	
Higher secondary	0
Lower secondary	0,066 (0,013)***
	0,047 (0,008)***
3. CONTROL VARIABLES	
Gender (= male)***	0.010 (0,006)

*** p < 0,001, ** p < 0,01, * p < 0,05. N = 1950.

As is shown in table 2, cognitive ability at age 14 is indeed significantly related both to socio-economic origin and father's level of education. As expected, respondents from higher-class socio-economic origins display better cognitive ability scores compared to respondents from lower-class origins. The same situation applies to the cultural capital of the home where we observe that respondents whose fathers have completed lower and higher secondary education score significantly higher on cognitive abilities than respondents whose fathers only completed elementary schooling. Additionally, male respondents have a slightly higher cognitive score than female respondents, but the difference is minimal.

Furthermore, model fit parameters of improvements in log-likelihood and Akaike's Information Criterion (AIC) for a number of estimated linear models for cognitive ability compared to a baseline model including only the intercept term (see appendix table 1) suggest that father's level of education is relative more important than father's social class and gender in explaining respondents' cognitive abilities at age 14. This conclusion is corroborated by the fact that while both social class and father's education are highly significant in explaining cognitive ability, then the improvement in log-likelihood over the baseline model of 122.53 for father's education is superior to that of father's social class of 95.83.

The next step in the analysis is to investigate the results of the multinomial logit random effects model of educational attainment combining the model for cognitive ability with the multinomial model for educational attainment. Fit parameters for these models are displayed in table 3 in which the variables for social class, father's education, and cognitive ability along with gender have been entered in a total of 8 different models.

Table 3: Summary of model fit parameters for joint model of educational attainment and abilities

Model	Model type	Variables	-2 log-likelihood	Model improvement in log-likelihood L^{2*}	AIC
0	–	Intercept only	3869.64	–	3903.64
1	Gender only	G	3750.52	119.12	3704.52
2	Socio-economics	FC + G	3481.43	388.21	3565.43
3	Cultural capital	FE + G	3533.25	336.39	3597.25
4	Cognitive abilities	COGN** + G	3698.82	170.82	3750.82
5	Combined 1	FC + FE	3519.44	253.13	3609,44
6	Combined 2	FC + COGN** + G	3443.93	425.71	3535.93
7	Combined 3	FE + COGN** + G	3499.58	370.06	3571.58
8	Full factorial	FC + FE + COGN** + G	3361.05	508.59	3473.05

* Compared to final model ** Only independent variable in model for attainment. FC = Father's social class, FE = Father's education, COGN = Respondent's cognitive ability, G = Gender.

The table summarises model fit parameters: log-likelihood values, improvements in log-likelihood and the AIC of alternative models compared to the baseline model. In models 2-4 father's social class, father's education, and cognitive ability are entered individually along with the control variable gender. As is evident from table 3, father's social class displays the greatest improvement in log-likelihood of 388.21 followed by that of father's education of 336.39. The improvement for cognitive ability of 170.82 is only about half of those of social class and education. But, as is evident from the AIC statistic, taking into account the number of parameters in the social class, education and cognitive ability variables, differences in explanatory power diminish somewhat. Still, father's social class remains the most significant contributor to explaining educational attainment followed by father's education and finally the respondent's cognitive ability and gender.

In models 5-8 fit parameters for a number of multinomial random effects logit models combining father's social class, father's education, cognitive ability and gender are shown. Again, we find that in combination with other variables father's social class is more important than both father's education and cognitive ability in explaining respondents' educational attainment at age 38. Moreover, the empirical evidence suggests that none of the variables may be excluded from the model and that the full factorial model number 8 provides the best overall fit to the data. Consequently, when analysed in a common multivariate setting, social class, cultural capital, and cognitive ability all play a significant individual role in determining educational attainment.

But how does each of the explanatory frameworks contribute to the chances of acquiring specific types of educations? In table 4 the results from the multinomial regression of father's social class, father's level of education, cognitive ability and gender are shown. For each of the non-ordered educational classifications a set of parameters are displayed that show the estimated log-odds of having attained this level of education relative to the reference category "no education" given the explanatory variables.

Table 4: Multinomial logit regression of educational attainment on socio-economics, cultural capital, and cognitive ability. Parameter estimates and standard errors in parenthesis. Reference category is no education beyond elementary school

	Vocational	Lower tertiary	Intermediate tertiary	Higher Tertiary
Intercept	0.052 (0.49)	1.22 (0.48)**	0.72 (0.47)	-2.33 (1.01)**
1. SOCIO-ECONOMICS				
Father's social class***				
I/II	0	0	0	0
III	-0.72 (0.33)*	-0.50 (0.31)	-0.74 (0.32)**	-1.15 (0.38)**
IV	-0.49 (0.27)	-0.52 (0.26)*	-0.89 (0.27)*	-1.12 (0.32)***
V/VI	-0.84 (0.29)**	-1.09 (0.30)***	-1,97 (0.32)***	-2.67 (0.46)***
VII	-0.31 (0.29)	-0.49 (0.29)	-1.28 (0.31)***	-1.89 (0.41)***
2. CULTURAL CAPITAL				
Father's level of education***				
Elementary	0	0	0	0
Higher secondary	-1.04 (0.43)**	-0.65 (0.39)	-0.45 (0.40)	0.81 (0.44)
Lower secondary	-0.36 (0.22)	-0.11 (0.23)	0.12 (0.23)	0.49 (0.29)
3. COGNITIVE ABILITY				
Cognitive ability***	-0.07 (2.22)	2.89 (2.35)	6.14 (2.11)**	7.67 (2.39)**
4. CONTROL VARIABLES				
Gender*** (= male)	0.80 (0.15)***	-0.19 (0.16)	-0.05 (017)	1.43 (0.24)***

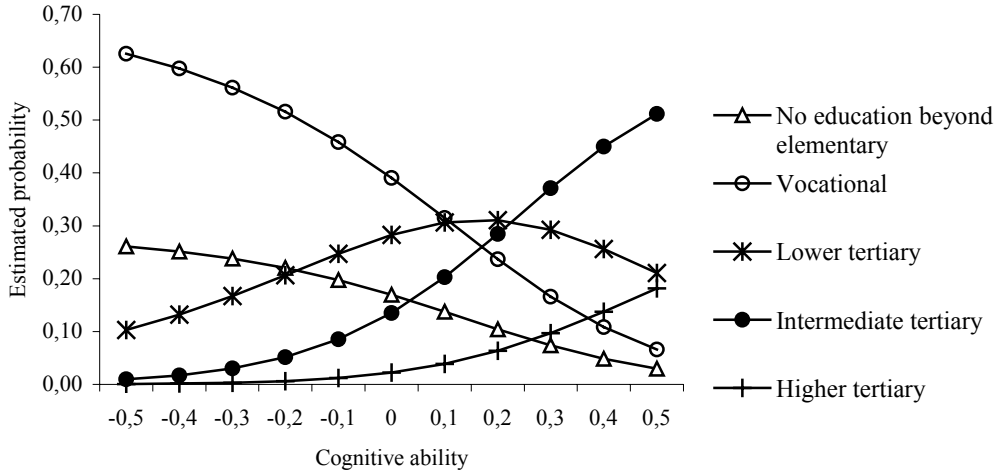
*** p < 0,001, ** p < 0,01, * p < 0,05. N = 1950.

First, the effect of father's social class manifests itself primarily at higher levels of education, and most clearly at higher and intermediate tertiary education. The log-odds of attaining university-level and intermediate-level education are consistently lower for respondents from lower-class social origins (III-VII) compared to respondents whose fathers belongs to classes I /II. With respects to vocational and lower-tertiary educations the impact of social class of origin is much less outspoken. However, where we do observe significant parameters, they all support the conclusion that higher-class respondents are more likely than lower-class respondents to gain some level of education compared to having no education at all. Interestingly, respondents whose fathers were skilled worker (social classes V/VI) have lower log-odds of acquiring any type of education than respondents with unskilled or semi-skilled fathers. This finding, net of the effect of other social origin and ability variables, indicates a higher level of educational mobility among respondents from homes with unskilled or semi-skilled working fathers than homes with fathers who are skilled workers.

With respect to father's level of education, and somewhat in contrast to previous research (e.g. Jonsson 1987, 1993), we observe only very modest effects of cultural capital on respondents' educational attainment. In fact, only for the probability of attaining vocational education do we find significantly lower log-

odds for respondents whose fathers have completed higher secondary education compared to fathers with only elementary schooling. However, given our modelling framework in which father's education was shown to be a significant contributor to the observed cognitive ability, we must expect that some of the effect of cultural capital is transmitted indirectly via ability, and hence the direct effect of father's education is reduced. Second, and as will be discussed later, by allowing random effects in the model we introduce an unobserved component that may be correlated with father's education and thus reduce the direct effect of father's level of education on respondents' educational attainment.

Figure 2. Effect of cognitive ability on educational attainment. Men



As for the effect of cognitive ability we observe positive coefficients for intermediate and higher tertiary education, but no significant effects for vocational and lower tertiary educations are found. Consequently, we find a clear line of division in the impact of cognitive ability in that high cognitive abilities are positively related to the probability of reaching academically oriented education (intermediate and higher tertiary education), whereas they are of little importance when it comes to more practical and vocational educations. To illustrate, in figure 2 the estimated probabilities of having attained the different levels of education given cognitive ability and net of other effects are shown for male respondents. Here we observe that the probability of having no and vocational education decreases as cognitive ability increases. On the other hand, intermediate and higher tertiary education is strongly and positively correlated with ability, especially from average-level cognitive ability and up. These findings are similar to those found in other studies (e.g. Shavit and Featherman 1988; Hauser and Huang 1997). Interestingly, the trend for lower tertiary education is non-linear in that the probability of having attained this type of education increases in the first two-thirds of the distribution of cognitive ability, but within the last one-third of the distribution with the highest cognitive abilities the trend is reversed. This finding suggests that at some specific point of cognitive ability respondents tend

to opt for either intermediate or higher level tertiary education rather than lower tertiary education. The overall trend is similar for women.[8]

To sum up our empirical analyses we find that all three of the explanatory frameworks proposed in the literature: socio-economic origin, cultural capital, and cognitive ability are significant in explaining educational attainment when analysed simultaneously. The analyses have shown father's social class to be the strongest predictor of educational attainment. Additionally, the effect of cultural capital in the form of father's level of education was found to be relatively weak and work indirectly through observed cognitive ability. Consequently, father's level of education matters in intergenerational educational attainment, but it is difficult to establish the exact magnitude of the effect. On the other hand, cognitive ability was positively correlated with choosing academically oriented (intermediate and higher tertiary) educations, but not vocational and lower tertiary educations. Additionally, father's level of education, perceived as a proxy for the level of cultural capital in the home, was found to influence respondents' cognitive score, and in this respect cultural capital probably also manifests itself in the positive effects of cognitive ability on choosing academically oriented educations. However, our analysis cannot reveal how much of the observed effect of cognitive ability on educational attainment is "natural" ability and how much is attributable to social influences.

An important finding is also that father's level of education appears to be more vulnerable to unobserved characteristics than is father's social class and cognitive ability. Using a simple multinomial logit model with the same variables but not incorporating the regression model of cognitive ability and allowing for random effects, we find a strong effect of father's education on educational attainment compared to father's social class and cognitive ability. By extending the complexity of the model we show first that the random effect captures some of explanatory power related to the cultural capital variable, and second that father's level of education may not be a sufficient indicator of cultural capital. However, it is also of importance that by allowing random effects in the multinomial model we probably underestimate the effects both of socio-economic origin, cultural capital, and cognitive ability. On the other hand, we find this cautious strategy preferable to one in which no correction for unobserved characteristics is made, as this type of modelling is more likely to exaggerate the estimated effects of the independent variables on educational attainment.

Table 5: Latent class distribution. Parameter estimates and standard errors in parenthesis. Reference category is no education beyond elementary school

	Mass point.
1. Vocational	
Class 1	0
Class 2	-0.74 (1.03)
Class 3	0.64 (0.79)
2. Lower tertiary	
Class 1	0
Class 2	0.99 (1.09)
Class 3	0.05 (0.85)
3. Intermediate tertiary	
Class 1	0
Class 2	2.62 (1.11)**
Class 3	0.31 (0.76)
4. Higher Tertiary	
Class 1	0
Class 2	5.43 (1.21)***
Class 3	1.71 (1.29)
Cognitive ability	
Class 1	0
Class 2	-0.48 (0.02)***
Class 3	0.19 (0.01)***
Class sizes	
Class 1	0.35
Class 2	0.02 (0.00)***
Class 3	0.63 (0.15)***

*** p < 0,001, ** p < 0,01, * p < 0,05. N = 1950.

To approach the question of the unobserved characteristics captured in the random effect, in table 5 we present the results of the latent class analysis. From the table we observe that three classes have been identified in the data. Classes 1 and 3 comprise 35 and 63 percent of the respondents respectively, whereas class 2 constitutes the remaining 2 percent of the sample. The main differences in educational attainment of significance between the classes are found among classes 1 and 3 where we observe several interesting features. First, compared to class 1, respondents identified to belong in class 3 have higher cognitive ability and are on average more likely to pursue any form of education. This is especially the case with respects to choosing vocational, intermediate and higher tertiary education. Thus, at the general level we find a class 1 consisting of about one-third of the sample that combines low cognitive skills with an inferior level of educational attainment compared to the much bigger class 3 in which higher education is more often pursued. Class 2 is numerically very small and combines the lowest observed cognitive skills among the classes with the highest propensity for reaching intermediate and higher tertiary education. This combination is quite contrary to our other findings, but since this class is very small we will not dwell further on interpreting the exceptional behaviour of this group.

7. Conclusion

The aim of this paper was to investigate the relative significance of the three types of explanatory frameworks proposed in the literature in accounting for inequalities in intergenerational educational attainment. These three explanatory frameworks are the socio-economic or class origins, the amount of cultural capital in the home

operationalised by father's level of education, and finally the cognitive ability of the respondent measured at age 14. Previous studies have found all three frameworks to be individually significant in explaining educational stratification, but since no studies so far have been carried out simultaneously including all frameworks the relative explanatory power of each explanation has remained unknown.

Using a multinomial logit random effects model on Danish data we generally confirm that all three explanatory frameworks matter individually, even when the other two other explanations and gender are controlled. We find father's social class to be the strongest predictor of educational attainment, especially at intermediate and higher tertiary level at which respondents from higher-class backgrounds are clearly advantaged compared to respondents from lower-class backgrounds. Furthermore, we find the effect of cultural capital operationalised by father's level of education to be significant but generally of less importance than socio-economic origins. The reasons for this result are several. First, by allowing cognitive ability to depend on father's social class and level of education when modelling educational attainment some of the effect of father's education is invariably captured in the cognitive ability variable which is highly significant. In this respect the effect of cultural capital on educational attainment in the sense of adding to the propensity to pursue 'academic' education may also be found in the highly significant estimates of cognitive ability on intermediate and higher tertiary education. Second, the analyses suggest that the estimates of father's level of education are affected more negatively by the random effect than are those of father's social class. This would indicate that some of the unobserved characteristics affecting educational attainment might be related to the cultural capital component, although we cannot say anything about the nature of these characteristics. At the conceptual level this finding also suggests that father's level of education may in itself be inadequate as an indicator of the theoretical concept of cultural capital of the home, and more indices of cultural capital should be included in future analyses.

However, by analysing the latent classes we do find that respondents may be divided into two major classes. One class constituting almost two-thirds of the sample have cognitive abilities and a general level of education superior to those in the second class comprising the last one-third of the sample. This suggests that, in addition to the effects of the observed variables already presented, we find a division in educational attainment in which around one-third of the respondents generally have less education and fewer cognitive skills than the majority of the sample. Analysing the reasons for this division may be a topic of further research.

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Appendix. The EM-algorithm

The fundamental idea of the EM-algorithm (Estimation - Maximization) is to maximize the proposed model using synthetic observations for some or all the unobserved variables. By inserting the synthetic values for the unobserved variables, the model is supposed to yield a likelihood function that is easier to optimise. After each optimisation new values of the unobservables are obtained as expectations of a certain function of the observed data. This procedure continues until convergence.

In our case in which the model is a mixture wrt a discrete mixture distribution, it is often suggested that the unobservables are indicator dummies, equal to one when the observation belongs to a particular group and zero otherwise. That is we define:

$z = (z_1', \ldots, z_n')$

where $z_i' = z_{i1}, \ldots, z_{ic}$ and where sub-script i indexes individual observations.

The complete data is:

$((y_{11}, y_{21}, z_1'), \ldots, (y_{1n}, y_{2n}, z_n'))$, where the last sub-script indexes individual observations.

From this we form the complete data log-likelihood function (using equation (1) to (3) in section 3):

$$\ln(L_c) = \sum_{i=1}^{i=n} \sum_{j=1}^{j=c} z_{ij} \left\{ \ln p(\mathbf{v}_j) + \ln p(\mathbf{y}_i \mid v_{1j}) \right\};$$

$$p(\mathbf{y}_i \mid v_{1j}) = f(y_{1i} \mid v_{1j}) p(y_{2i} \mid \mathbf{v}_{2j});$$

$$\mathbf{v}_j = v_{1j},\ v_{21j},\ v_{22j},\ v_{23j},\ v_{24j};$$

$$\mathbf{v}_{2j} = v_{21j},\ v_{22j},\ v_{23j},\ v_{24j}.$$

From the complete log-likelihood function we define a function *Q(.;.)* as the expected value of the complete data likelihood function, where expectation is with the respect to the unobservables and given the observed data. The EM algorithm then works as follows: An M-step that requires the maximisation of $Q(\Psi; \Psi^k)$ wrt. Ψ^k over the parameter space of Ψ, that is, we choose Ψ^k such that:

$$Q(\Psi^{k+1}; \Psi^k) \geq Q(\Psi; \Psi^k); k = 0,1,\ldots..$$

Each M-step is followed by a E-step. This means that at the *(k+1)*'th iteration we have to find the conditional expectation of $\ln L_c(\Psi)$, given the observed data, $\boldsymbol{y}$, using the current fit Ψ^k for Ψ.

In our case the function *Q(.;.)* is:

$$Q(\Psi;\Psi^k) = E_{\Psi^k}\left(\ln L_c\left(\Psi^k\right) \mid \mathbf{y}\right) = \sum_{i=1}^{i=n}\sum_{j=1}^{j=c} E_{\Psi^k}(z_{ij} \mid \mathbf{y})\left\{\ln p(\mathbf{v}_j) + \ln p(\mathbf{y}_i \mid v_{1j})\right\}$$

$$= \sum_{i=1}^{i=n}\sum_{j=1}^{j=c} \Pr_{\Psi^k}(z_{ij} \mid \mathbf{y})\left\{\ln p(\mathbf{v}_j) + \ln p(\mathbf{y}_i \mid v_{1j})\right\},$$

where $\Psi = (\beta_1, \beta_2, \mathbf{v})$. To proceed we need to find $\Pr_{\Psi^k}(z_{ij} \mid \mathbf{y})$. Using Bayes theorem we find that: $\Pr_{\Psi^k}(z_{ij} \mid \mathbf{y}) = \dfrac{\Pr(z_{ij}, \mathbf{y})}{\Pr(\mathbf{y})} = \dfrac{p(\mathbf{v}_j^k)p(\mathbf{y}_i \mid \mathbf{v}_j^k)}{\sum_{s=c-1}^{s=c-1} p(\mathbf{v}_j^s)p(\mathbf{y}_i \mid \mathbf{v}_j^s)} = \tau_j(\mathbf{y}_i, \Psi^k)$,

j = 1,...,c-1

and $\tau_c = 1 - \sum_{j=1}^{j=c-1} \tau_j$.

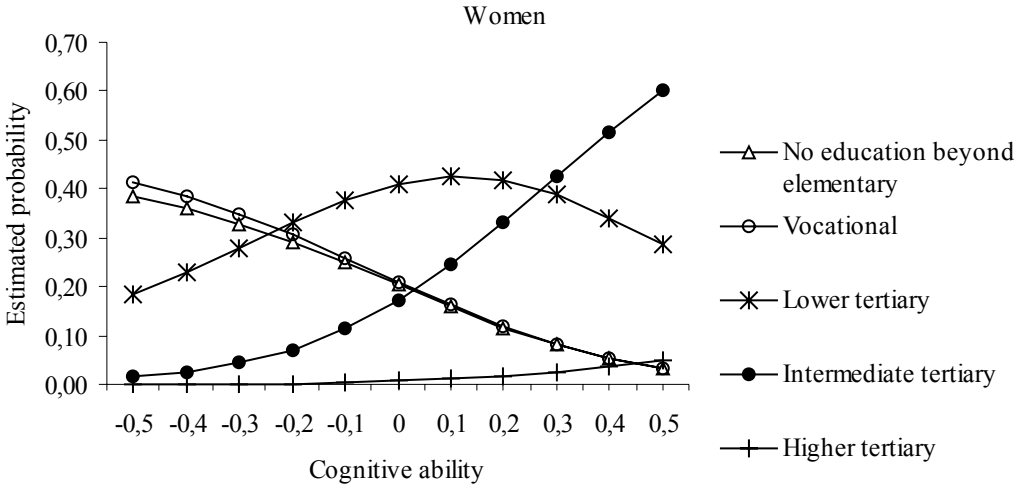
Hence in each E-step we calculate and updated version of z_{ij}^k by $\tau_j(\mathbf{y}_i, \Psi^k)$.

Appendix table 1: Summary of model fit parameters for linear regression model for cognitive ability

Model	Model type	Variables	-2 log-likelihood	Model improvement in log-likelihood L^2	AIC
0	–	Intercept only	3537.30	–	3635.30
1	Socio-economics	FC	3441.47	95.83	3547.47
2	Cultural capital	FE	3414.77	122.53	3516.77
3	Combined 1	FC + G	3408.52	128.78	3516.52
4	Combined 2	FE + G	3413.28	124.02	3517.28
5	Full factorial	FC + FE + G	3361.05	176.25	3473.05

FC = Father's social class, FE = Father's education, COGN = Respondent's cognitive ability, G = Gender.

Appendix figure 1: Effect of cognitive ability on educational attainment.



9. Notes

[1] This general trend of stability in social stratification across generations in the post-war period is also identified in research on intergenerational occupational mobility (Grusky and Hauser 1984; Erikson and Goldthorpe 1992) and income mobility (Björklund and Jannti 2001; Solon 2002). Given the fact that level of education is the one of the most important predictors of occupational position (Shavit and Müller 1998) and income (Björklund and Jannti 1997) this hardly comes as a surprise.

[2] Definitions of cultural capital vary. The 'core' component of cultural capital in studies of intergenerational educational attainment is parents' level of education, which is found also to be a useful proxy for the more 'subtle' aspects of cultural capital (such as cultural practices, aesthetic dispositions etc.) (see DiMaggio 1982; Bourdieu 1984; van de Werfhorst *et al.* 2003). As will be shown in this paper our empirical results suggest that this may not be the case after all.

[3] The publication of Richard J. Herrnstein and Charles Murray's "The Bell Curve" (1994) invoked a new interest in the relationship between genetics, intelligence and social stratification. However, this literature deals with somewhat different issues than those pursued in this paper and will not be reviewed.

[4] For example, admittance to most intermediate tertiary educations (e.g. nursing and elementary school teachers) in the Danish educational system does not universally require high-school or equivalent qualification. A proportion of students in lower and intermediate tertiary educations are admitted on the basis of an individual assessment of other types of qualifications than a high-school diploma, e.g. vocational education or relevant experience in other occupational branches. Similar features exist in most Western European education systems (Ganzeboom *et al.* 1991; Kerckhoff 1995; Shavit and Müller 1998; Breen and Jonsson 2000: 759).

[5] Until 1958, differentiation of students in elementary school in general and academic tracks took place from the 5th grade (*mellemskolen)*, and from 1958 to 1975 from the 7th grade (*realskolen*). From 1975 a mandatory minimum of 9 year of schooling was instated, and at the same time formal differentiation of students was abolished.

[6] The higher tertiary educations in Denmark are based at the (normal and technical) universities, the Danish Royal Veterinary and Agricultural University, and the Business Schools.

[7] The zero-order correlations between the three test items are, respectively, 0,62, 0,64, and 0,75 (all significant at $p < 0,0001$). The standardised Cronbach's alpha for internal consistency of the factor variable is 0,85, and the eigenvalue of the extracted factor is 1,90 meaning that approximately 63 percent of the common variance of the three test items is accounted for. Factor loadings of the three items on the common factor are: verbal = 0,84, spatial = 0,73, and logical-inductive = 0,82.

[8] While not of prime concern in this study, we do observe some differences in the effect of cognitive ability on men and women's educational attainment (the corresponding figure for women is shown in appendix figure 1). Generally, cognitive ability seems to be of higher

significance in educational attainment for women than men. First, compared to men women with low cognitive skills have a higher probability of having no education beyond elementary school. As is evident in figure 2, even low-ability men have a high probability of acquiring vocational education. Second, especially among high-ability respondents women are considerably more likely than men to chose intermediate tertiary over higher tertiary education. This finding is consistent with other studies on the Scandinavian countries (Dryler 1998; Jonsson 1999) and might be explained by the fact that many intermediate level tertiary educations in Denmark are directed towards public employment in the "soft economy" welfare service sectors in which predominantly women work (e.g. health care, school teachers, and social workers).

Acknowledgements.
The authors would like to thank Lars Benjaminsen, Siggi Kristoffersen Brandt, and Niels Ploug for useful comments on an earlier version of this paper.