SOCIAL FORSKNINGS INSTITUTTET

James McIntosh
Martin D. Munk

18:2007 WORKING PAPER

FAMILY BACKGROUND AND EDUCATIONAL CHOICES:

CHANGES OVER FIVE DANISH COHORTS

RESEARCH DEPARTMENT OF CHILDREN, INTEGRATION AND EQUAL OPPORTUNITY

FAMILY BACKGROUND AND EDUCATIONAL CHOICES:
CHANGES OVER FIVE DANISH COHORTS

James McIntosh
Martin D. Munk

Working Paper 18:2007

FAMILY BACKGROUND AND EDUCATIONAL CHOICES: CHANGES OVER FIVE DANISH COHORTS*

James McIntosh[1,2] and Martin D. Munk[2]

[1]Economics Department
Concordia University
1455 De Maisonneuve Blvd. W.
Montreal Quebec, H3G 1M8, Canada
and
[2]Danish National Institute of Social Research
Herluf Trolles Gade 11
DK-1052 Copenhagen K, Denmark

October 31, 2007

E-mail Addresses and Telephone Numbers: jamesm@vax2.concordia.ca, +1-514-848 2424-3910 and mdm@sfi.dk, +45-33697710.

JEL Classification Numbers: I20, C35

Keywords: Intergenerational educational mobility, Change, Unobserved heterogeneity, Probability models, Denmark.

Abstract

We examine the participation in secondary and tertiary education of five cohorts of Danish males and females who were aged twenty starting in 1982 and ending in 2002. We find that the large expansion of secondary education in this period was characterized by a phenomenal increase in gymnasium enrollments, especially for females. Not only did the educational opportunities for individuals with disadvantaged backgrounds improve absolutely, but their relative position also improved. A similarly dramatic increase in attendance at university for the period 1985-2005 was found for these cohorts when they were aged 23.

---

*An earlier version of this paper was presented at the European Economic Association meetings in Budapest, August 2007. We thank the participants for their comments as well as Fredrik Gerstoft for research assistance.

1 Introduction

The purpose of this research is to determine whether there have been any changes in intergenerational educational mobility for recent cohorts of Danes. In this paper we first examine participation in secondary education of five cohorts of Danish males and females who were aged twenty starting in 1982 and ending in 2002. This is done by estimating non-linear probability regression models on all five cohorts for both males and females and comparing the degree of dependency of educational attainment outcomes on the respondents' family background across these cohorts. We also look at participation rates in tertiary education at age 23 in 1985 and 2005 for these cohorts to see whether the trends that have appeared at the secondary level are likely to continue on into post-secondary education.

Secondary education is the place to begin the analysis of educational mobility since, as Table 1 shows, there have been phenomenal changes in the way Danish students have made secondary schooling choices in the twenty years prior to 2002. For example, the gymnasium enrollment rate for females aged twenty increased from 37.9% in 1982 to 60.1% in 2002, a huge increase for such a short period of time. Secondary educational attainments and their dependence on family background variables is an important issue in its own right. For individuals who do not continue in the educational system past secondary schooling life-time earnings are much influenced by their educational qualifications. But, of course, the most important reason for looking at secondary educational attainments is because the choices made at the secondary level largely determine what educational opportunities are available at the tertiary level especially for gaining entrance to university.

To summarize our results we find that household background variables explain a significant amount of the variation in secondary educational choices for both males and females. The educational attainment of the respondent's parents and household income in which the respondent resided at age twenty turned out to be the most important variables. However, the occupations of both parents, the number of siblings that the respondent had and whether the respondent's father was unemployed or had a single mother were also significant explanatory variables. Consequently, intergenerational dependence of secondary educational choices continues to be a prominent feature of Danish society. But

the degree of this dependence has lessened over the twenty years under consideration. Summary statistics which measure overall dependence on family background variables have declined by about 11% for males and 19.6% for females. While family background variables have become less important there have been dramatic increases in the intercept terms in some of our statistical models. These capture different effects like changes in the structure of the Danish educational system and social policy as well as possible changes in preferences for educational streams, or changes in the importance of For females non-cognitive skills or ability. For females, in terms of relative importance it is the second set of factors rather than the decline in the dependence on family background variables that is the more important.

These intercept term increases also generate higher probabilities of being enrolled in a gymnasium for respondents coming from socially disadvantaged backgrounds, especially for females. The large increases in gymnasium attendance at age twenty has been matched by an even more impressive increase in the university participation rate, especially by individuals who have parents with low levels of education or low status occupations.

The paper is organized in the following way. The next section reviews the relevant literature on changes in educational mobility. Section 3 outlines the data used in the study. Section 4 describes a new estimation procedure which is based on a generalization of the linear probability model. The results appear in section 5 and are discussed in section 6. The analysis of secondary education is done first, and then secondly we very briefly analyze what has happened at the tertiary level.

2 Literature review

There are a large number of studies that attempt to relate individual performance as measured by educational attainment, earnings, or occupation to the characteristics of the household in which the individual grew up. These are seen as crucial in determining children's outcomes as adults, both in the educational system and in the labour market. This literature is reviewed in considerable detail in McIntosh and Munk (2007) who also found a considerable degree of dependence on family background variables for tertiary educational attainments for Denmark so there is no need for any further discussion other

than to point out that the results that we obtained on Danish sample survey data are similar to what many other researchers had found for the countries they examined.

However, the literature *on changes* in economic, educational, and social mobility over time and across cohorts is not well developed. Especially intergenerational changes in choice of secondary education is not well covered.

In addition to the relatively small number of papers and monographs which deal with the topic, much of the research suffers from serious statistical flaws. In 1998, new standards were imposed on the analysis of educational stratification. In that year Cameron and Heckman published the first of their two classic papers on educational attainment. The main contribution of their work was to expose the flaws in the estimation of the Mare (1980) transition model which has been the preferred vehicle for analyzing educational success. They showed that (1), applying the Mare model to education transitions would lead to biased parameter estimates if there was no correction for unobservables (2), it was not a valid exercise to compare coefficients across transitions or across cohorts (3), the decline in coefficients with higher transitions was an artifact of the logit specification of the transition probabilities and (4), the model was unlikely to be non-parametrically identified.[1]

For the US, Hauser (1998) concluded that "there is no global trend in the intergenerational persistence of education from the 1960's to the 1990's". Cameron and Heckman (1998) report the effects of several family background variables on educational attainment. However, these are mixed with the effect of household income showing a slight decline in importance towards the end of their sample period. On the other hand, their parental education variables retain their importance. For France, Vallet (2004) reports a decline over thirteen cohorts over the period 1908-1972 using log-linear models to examine changes in associations between social origin and educational destination. He also notes that "The decline in origin-destination education association in France therefore seems

[1] The main result for the transition model was "....while the effects of students' origins decline across transitions there is little change across cohorts. There are only two exceptions to this pattern: Sweden and the Netherlands, in which the effects of father's occupation and education on the low and intermediate transitions declined."(Shavit-Blossfeld 1993). McIntosh (2006) using the 2001 Canadian General Social Survey discovered a considerable reduction in the importance of social background variables on educational attainment for Canadians who were born on average around 1965 compared to those born twenty-five years earlier.

largely independent of major secondary school reforms introduced to promote equality of educational opportunity (p. 31)". For Sweden, in many ways close to Denmark, Jonsson (1993), Erikson and Jonsson (1996), Jonsson and Erikson (2000) tried to show a decline in the social inheritance effect on educational attainment, including low and intermediate transitions. Esping-Andersen (2004) examined educational mobility in several countries and found that the results depended on the country with increases in Scandinavia and declines in the UK and US. Marks and McMillan (2003) found a decline in the dependence of educational attainment on social background variables for Australia for cohorts born during the period 1961-1985.

Bynner and Joshi (2002) examined sample survey data from the 1958 and 1970 cohorts in Britain. They found no change in the response of the probability of leaving school at age sixteen to family or social origin variables. Blanden and Gregg (2004) found an increased dependence of tertiary educational attainments on household income over the period 1958 to 1970 using the British National Child Development and British Cohort Surveys. Individuals were aged 33 and 30, respectively. We also find an increase in household income dependence but it is dominated by other factors. In another British study Galindo-Rueda and Vignoles (2005) also found an increase in the importance of some family background variables but a decline in the importance of cognitive ability as a determinant of educational attainment. This is in part due to the fact that low ability children from high economic status families experienced the largest increases in educational attainment. They also looked at secondary education, and discovered that "The reduction of secondary school selection on the basis of age 11 ability is likely to have reduced the role of early cognitive ability in determining a student's eventual outcome." (p. 352). Blanden, Gregg and Machin (2005) examine educational mobility at both the secondary and tertiary levels and find first a rise and then a decline in cohort educational inequality at the secondary level but an increase at the tertiary level. They attribute the latter change to increased financing constraints for higher education. However, it should be noted that most of these studies use a rather limited number of family background variables.

Most of these studies have focused on final educational attainment. The closest study to our work on secondary education is a recent paper by Dustmann (2004) who uses the German Socio-Economic Panel data base to examine the secondary school outcomes of

a sequence of cohorts the first of which was born in 1925 and the last in 1965. He finds using ordered probability models that the probability of completing German high school for respondents with 'working class' parents increases moderately over the ten cohorts and is higher for males than females. This is much lower than for respondents with 'academic' parents whose probabilities also increase with females overtaking males by about 1960. The large gaps between these two probabilities leads him to conclude that considerable educational immobility still exists in Germany.

In summary, results differ by country and sometimes by type of procedure employed. Perhaps the most striking feature of the research on the evolution of intergenerational mobility is the almost uniform neglect of unobservable characteristics.

3 Data and variables

The data used in this study comes from Statistics Denmark register data on five cohorts of twenty year olds. The the five cohorts were born in 1962, 1967.., and the last in 1982. Danish registers are very comprehensive and contain a great deal of information on every individual.[2] Everyone who was aged twenty and was born in Denmark was included in the sample. These registers contain the central population register numbers for the parents of each individual. Hence, for each cohort it is possible to assemble a data set which contains on the individual as well as a set of variables relating to his or her family background. This was done for all five cohorts. Register data for individuals born prior to 1962 is not as comprehensive and is characterized by large numbers of missing values for parental information so 1982 is the earliest cohort.[3]

For the dependent variable our choice is the three category variable: choice of secondary education at age twenty. In Denmark all students are compelled to complete primary education which is grade nine; but about 60% go on to grade ten. After grade nine or ten there are two choices at the secondary level. The individual can elect to enroll in a vocational programme. Welding, carpentry, hair dressing, or being an electrician

[2]The construction of the dataset was built on ideas from an earlier research project about Education and Inequality (see Munk 2003b).

[3]In what follows we refer to a cohort by the year when the respondent was aged twenty and not the year of birth.

are typical options. Vocational programmes can take quite a long time to complete and always involve apprenticeships. Gymnasiums, the other option at the secondary level, offer basically four types: a general program with various theoretical programmes in the humanities, natural and social sciences, a technical program, a business program and a programme called HF (Higher Preparation Exams). After grade nine or ten students can enroll in these programmes which last for about two-four years, most often three years, and provide qualifications which are required for entrance to university. Many programmes involving short or intermediate tertiary educational programmes also require a completed gymnasium certificate for entry. An individual is in a particular category if he or she had ever been enrolled in the programme or had completed it.

The numbers and percentage allocations for all five cohorts are displayed in Table 1. There are number of variables for parental characteristics. Parents education is a six category variable where the first category is no education past grade nine or ten. The second category is a vocational qualification, the third is gymnasium only and the next are three categories of tertiary education which in Denmark are characterized by their durations: short, medium and long. Examples for the three types are police training, primary school teacher training and university, respectively. The residual category is no education past grade nine or ten. There are eight parental occupations; the first three are white collar occupations starting with high level managerial, low level managerial and ordinary employee. Occupations four, five, and six are self-employed and skilled and unskilled blue collar workers and occupation seven is the occupation missing category. For the first cohort there are many parents whose occupations are not known and it does not seem appropriate to combine them with the unemployed so they are represented a separate category for all of the cohorts although there is very little missing parental information for the last cohort. The residual category consists of those who are unemployed or not in the labour force.

The data set also contains the number of siblings, whether the father was unemployed, whether the respondent's mother was a single mother, and standardized (mean zero unit variance) household income, all collected when the respondent was twenty.

Table 4 contains information on university participation rates for two cohorts when they were aged 23 in 1985 and 2005.

4 Estimation methods and models

A natural way to estimate these choices is to estimate an ordered or a mixed ordered probability model. This reflects the theoretical model outlined in McIntosh and Munk (2007) which assumes that respondents maximize the expected future stream of discounted utilities that attach to their educational choice. In that paper we showed that this type of model could be estimated as an ordered or mixed ordered probability model. Secondary educational choices while not being sequential can certainly be ordered in terms of their academic difficulty or long term economic worth. We attempted to apply these ordered models to the data but the results were unsatisfactory in several respects.

Ordered probability models were first estimated and these were compared to mixed models using the Heckman-Singer (1984) procedure. At most two mixtures could ever be estimated and the probability of the second type was always very small indicating that unobserved heterogeneity played a very small role in the determination of secondary educational choices. The more general latent class models that we employed always failed to converge. However, these models were dominated in terms of the Akaike criterion by multinomial logit models. These suggest that the respondents choose different outcomes because they respond differently to their family backgrounds and not because of differences in unobservable factors. A plausible outcome, perhaps, but the conclusion that unobservables are unimportant is hard to accept, especially since there are at least two different types within the gymnasium category: those who will not obtain any further education and those who will go on to some form of tertiary education. The problematic nature of these models is confirmed by their inability to fit the data. Both the ordered probability and multinomial logit models had a low pseudo-R^{2}'s and were simply unable to predict the actual categorical proportions.

Clearly, a different approach is needed. The superiority of the multinomial logit models over the ordered models suggests that single index models are inadequate to explain the data and multiple index models are required.[4] We also want to combine

[4]By an index for individual i we mean $X_i\varphi = \varphi_0 + \sum_{k=1}^{K} X_{ij}\varphi_j$, for example. The ordered probit model is a single index model whereas the multinomial logit model for three unordered categories has two indexes.

this aspect of the model with the idea that the choices are ordered. There are three possible outcomes that the respondent can choose: no education past grade nine or ten, a vocational programme, or the gymnasium programme. We represent these choices by three dummy variables (y_1, y_2, y_3) each of which takes on the values 1 and 0 so that $y_3 = 1$ if the respondent decides to go the gymnasium, for example. Let X be a vector of family background variables. Suppressing the individual subscripts for the moment we specify the probabilities of these events, which are the expectations of these dummy variables, as

$$E(y_1) = F_I(-X\varphi\ ) \tag{1}$$
$$E(y_2) = [1 - F_I(-X\varphi\ )]F_{II}(-X\gamma\ ) \tag{2}$$
$$E(y_3) = [1 - F_I(-X\varphi\ )][1 - F_{II}(-X\gamma\ )] \tag{3}$$

where $F_j(.) \in [0, 1] \quad j = I, II$.

These probabilities, which by construction sum to unity and introduce an ordering into the decision process, are generated by two latent attribute variables A_I^* and A_{II}^*. These attributes are assumed to depend on family background variables but measure two qualitatively different individual characteristics and are defined as

$$A_I^* = X\varphi\ + v_I \tag{4}$$
$$A_{II}^* = X\gamma\ + v_{II} \tag{5}$$

and (v_I, v_{II}) are independent identically distributed zero mean random disturbance terms.[5] We interpret A_I^* as a variable representing the motivation or enthusiasm of the respondent and v_I is its unobserved component. A_{II}^* represents some general measure of suitability for attending gymnasium with v_{II} as its unobserved component. This is, in fact, an institutional feature of the Danish educational system[6]. If $A_I^* \leq 0$ then the respondent

[5] It is possible to allow (v_I, v_{II}) to be jointly distributed. In this case the probability of attending gymnasium is $\int_{-X\varphi}^{\infty}\int_{-X\gamma}^{\infty} h(v_I, v_{II})dv_I dv_{II}$ where $h(v_I, v_{II})$ is the joint distribution of (v_I, v_{II}). We have not explored this alternative yet.

[6] Danish students can go on to gymnasium if they are deemed suitable by their final year teachers. The teachers make an evaluation of suitability based on the individual's intellectual ability, motivation, school performance, and expected success if he or she were to attend a gymnasium.

will choose not to be involved in any further education. The probability that this occurs is $F_I(-X\varphi\ )$ where $F_I(.)$ is the cumulative distribution function of the random variable v_I. If $A_I^* > 0$ then the respondent will enter a vocational or an academic programme. This decision is determined by the second attribute variable. If $A_{II}^* \leq 0$ the respondent selects a vocational education; otherwise an academic stream is selected.

Once these probabilities have been specified a probability model can be estimated by maximum likelihood. Alternatively, if additional unobservable effects need to be accommodated, a non-linear regression model of the form

$$y_1 = F_I(-X\varphi\ ) + u_1 \tag{6}$$

$$y_2 = [1 - F_I(-X\varphi\ )]F_{II}(-X\gamma\ ) + u_2 \tag{7}$$

$$y_3 = [1 - F_I(-X\varphi\ )][1 - F_{II}(-X\gamma\ )] + u_3 \tag{8}$$

can be estimated. (u_1, u_2, u_3) represent unobservable characteristics of the respondent's family background or possible unobservable external effects. Our preference is for the non-linear regression specification since it permits a more general random effects specification. It also gives better predictions of the category proportions than the probability models. In the next section we report some results which compare the two procedures.

This procedure is a generalization of the linear probability model in two directions. In the binary case the linear probability model is a regression of a dichotomous variable y on the vector X. The first generalization is to use a cumulative distribution function, $F(X\varphi)$, for the right hand side which makes all of the fitted values lie in the unit interval. The second generalization is to extend the model to more than two alternatives. This is done by making sure that the probabilities of the three possibilities are non-negative and sum to unity. The estimation of the model is carried out by estimating any two of the three equations. The Jacobian of the model is singular if all three equations are estimated.

All that is left is the choice of functional form for $F_I(.)$and $F_{II}(.)$ and the estimation procedure. Several distribution functions were tried all with the same qualitative results. The results in the next section are based on the cumulative normal distribution function. The estimation procedure is the non-linear seemingly unrelated regression model which makes no assumptions about the correlation structure of (u_1, u_2, u_3). Robust standard

errors are used to correct for possible heteroscedasticity due to the binary nature of the dependent variables.

5 Results

The results for the model outlined in section 3 are shown in Tables 2M and 2F for males and females, respectively for the 1982, 1987, 1992, 1997, and 2002 cohorts. The first point to note is that $||\varphi||$, $||\gamma||$, and $||(\varphi, \gamma)||$ are significantly different from zero indicating the expected dependence of educational choices on family background variables. These are the norms of the parameter vectors.[7] Using the norms of the parameter vectors in the probability functions is a simple way of summarizing the overall effect of family background on educational decisions. There are five cohorts for each gender and there are fifty-eight parameters to be estimated for each model so some summary measures of the results are required. Using the norm of the parameter vector is a simple and appealing measure since all coefficients have equal weight and the sign of the parameter does not matter.

The significance of these norms means that family background variables have a significant impact on the educational choices of twenty year old Danish men and women. While the total effect is important individual variables are also important. To capture the effects of education and occupation we calculate the averages of the φ and γ parameters for the educational and occupational dummies for both fathers and mothers. These are shown as $(\overline{\varphi}_{fe}, \overline{\varphi}_{me})$ and $(\overline{\gamma}_{fe}, \overline{\gamma}_{me})$ in Tables 2M and 2F. Averages of father's and mother's occupations are also included in these tables.[8]

[7] For example, $||(\varphi, \gamma)|| = \sqrt{\sum_{k=1}^{K} \varphi_i^2 + \sum_{k=1}^{K} \gamma_i^2}$. The intercept is not included in these norms.

[8] For males in 1982 the φ coefficients and their standard errors associated with father's education starting with the vocational category are 0.274** (0.019), 0.200 (0.146), 0.359** (0.061) 0.358** (0.040), and 0.313** (0.057). The average of these coefficients which is reported in Table 2M as $\overline{\varphi}_{fe} = 0.267$. The corresponding γ coefficients are 0.205** (0.021), 0.293** (0.102), 0.397** (0.078), 0.214** (0.043), and 0.556** (0.154).

For males in 2002 the φ coefficients and their standard errors associated with father's education starting with the vocational category are 0.151** (0.023), 0.105 (0.060), 0.174** (0.049) 0.234** (0.040), and 0.303** (0.055). The corresponding γ coefficients are 0.155** (0.022), 0.093† (0.055), 0.239** (0.055), 0.229** (0.035), and 0.391** (0.082).

For males in 2002 we also estimated the conventional probability model by maximum likelihood. The estimated parameters were very similar to those obtained from the non-linear probability model.[9] However, as we have already mentioned the non-linear probability regression model fits the data better than the probability model.

In addition to the sets of dummy variables relating to education and occupation there are some individual variables which are important and have captured the attention of other researchers. These are the number of the respondent's siblings, the standardized income of the parental household, whether the respondent's mother was a single parent, and whether the father was unemployed, all of which were collected when the respondent was twenty years old.

The major result of our study is the significant decline in the importance of family background variables as determinants of secondary educational choices for both males and females. The declines in $||(\varphi, \gamma)||$ of 11% for males and 19.6% for females, respectively for the period 1982-2002, although not particularly large, are significant at the 1% level. For females there are significant declines in the individual norms, $||\varphi||$ and $||\gamma||$, of 24.7% and 17.5%. For males there is a significant declines in $||\varphi||$ of 23.3% but not for $||\gamma||$.

Although there is a significant decline in the aggregate measures of dependence some of the variables which define the family background of the respondent actually increase in importance. The pattern varies by both gender and the type of parameter. For males the parameters which increase significantly are φ_{hi} and $\overline{\gamma}_{mo}$; those significantly decreasing are $\overline{\varphi}_{fe}, \overline{\varphi}_{fo}, \overline{\varphi}_{me}, \varphi_{fu}, \varphi_{sib}, \varphi_{sm}, \overline{\gamma}_{fe}$, and γ_{sib}. For females the parameters which increase significantly are φ_{hi} , φ_{sm} and γ_{hi}; those significantly decreasing are $\overline{\varphi}_{fo}, \overline{\varphi}_{me}$, and $\overline{\gamma}_{me}$. In terms of the relative importance of the household background variables the educational attainment of the respondent's mother ranks as the most important variable. The estimated parameter values are larger for this variable than any other. This variable exhibits the largest change as a determinant of both decisions for both genders. Haveman and Wolfe (1995) also note the importance of mother's education in their survey. The second most important variables are father's education and household income. Like mother's education they affect both decisions for both genders. Household

[9] The three norms derived from the maximum likelihood estimates are $||\varphi|| = 1.136$ (0.071), $||\gamma|| = 2.051$ (0.056) and $||(\varphi, \gamma)|| = 2.345$ (0.059) which are very close the values in the first three entries in the last column of Table 2M.

income actually increases in importance over the five cohorts whereas father's education decreases.

As we found in our earlier study, there are large differences between the two genders. There are some significant differences in the parameter estimates. An example is the set of parameters associated with mother's education. These are more important for females than for males. In contrast to father's occupation which was the most important variable in our first study, parental education and household income are the most important variables when register data for the whole population is used. But the biggest difference is in the role that the constant terms play. While these estimated coefficients for the family background variables have declined for both genders the estimated intercept terms have increased significantly over the period for females. These intercept terms represent factors that are unrelated to observable household characteristics. Potential candidates for such factors are ability that is not inherited from their parents, parent attitudes, economic conditions, possibly the 'taste' for more secondary education, or the impact of social policies that affect educational choices. For females, the changes in φ_0 and γ_0 between 1982 and 2002 are larger than those for other parameters and the changes in the norms, $||(\varphi, \gamma)||$. This means that the big increases in female gymnasium attendance rates are due more to changes in the non-household factors listed above than a reduction in the importance of family background variables.

Because the changes in the family background parameters are dominated by the changes in the intercept terms our model also predicts that enrollment probabilities in gymnasium should increase for all female respondents but the largest increases should come from respondents with the most disadvantaged family backgrounds. The reason for this is because respondents with parents with low levels of education or low status occupations have relatively low levels of the indexes $X\varphi$ or $X\gamma$. Since the probability function is highly non-linear increases in $X\varphi$ or $X\gamma$ from low levels will have a much larger impact on the probability of attending gymnasium than would be the case for those respondents with parents with high levels of education or high status occupations.

This is in part what actually happens. The averages of the actual values of the proportions of those enrolled in a gymnasium programme as a function of mother's educational achievement are shown in Table 3 for both males and females. In figures 1 and

2 these probabilities[10] are plotted against the mother's educational category. In each part of Table 3 there are two entries: the first is the actual proportion and the second is the proportion predicted by the model. The averages of the predicted probabilities in each category are always very close to the proportion of the gymnasium attendees in the category indicating that the model does a very good job of fitting the data.

It is easy to see that from Table 1 that over the period 1982 to 2002 much higher proportions of Danish adolescents enrolled in gymnasium programmes, especially for women. However, the biggest percentage changes in enrollment rates came from respondents whose parents were poorly educated or had low status occupations. For example, the estimated probability of a male attending gymnasium, given that his mother had no education past grade nine or ten rose from 0.167 in 1982 to 0.255 in 2002 which is a 52.7% increase. These percentage increases are shown by the thick bold face line in figures 1 and 2. However, it is also important to note that the majority of those attending gymnasium in both 1982 and 2002 came from households from the bottom of the maternal education distributions. The bar graphs in these two figures give the distribution of the mothers by their educational category. In 1982, for example, 61.9% of the population of mothers had no education past grade nine or ten.

While the expansion of gymnasium attendance rates has been facilitated by extending gymnasium education to respondents with poorly educated or low status occupation parents. Probabilities of attending gymnasium have increased only marginally or actually decreased for both females and males with better educated mothers. Gymnasium participation rates for these parental categories were already quite high so the percentage increases here could not be very large. However, mothers of males in the 2002 cohort who had gymnasium only or short tertiary education actually sent fewer of their children to gymnasium than the 1982 cohort. For Given that gymnasium has become much more accessible has Denmark become a fairer society in terms of access to secondary education? The answer to this question is most emphatically yes, especially for females!

The predicted odds ratio of going to gymnasium for a female whose mother had an university education compared to a female respondent whose mother had no education at all is $\frac{0.918/1-0.918}{0.290/1-0.290} = 27.4$ for the 1982 cohort. The figure for the 2002 cohort

[10] These come from columns 3 and 6 of Table 3.

is $\frac{0.899/1-0.899}{0.451/1-0.451} = 10.8$ so that the odds ratio for attending gymnasium for an individual whose mother had no education at all have improved dramatically over the period. For females whose mother had an university degree compared to females whose mother had an vocational education, the figures are $\frac{0.918/1-0.918}{0.478/1-0.478} = 12.2$ and $\frac{0.899/1-0.899}{0.616/1-0616} = 5.5$. These results confirm the same picture. Similar results hold for other educational category comparisons, so the dependence of secondary school attainment on mothers education is decreasing at all levels.

Similar results hold for males when it comes to mothers having no education, but the result does not hold for males whose mother had an vocational education, or other educational categories. For example, for a male respondent whose mother had an university education compared to a male respondent whose mother had no education at all is $\frac{0.809/1-0.809}{0.167/1-0.167} = 21.1$ for the 1982 cohort, and $\frac{0.856/1-0.856}{0.255/1-0.255} = 17.4$ for the 2002 so that the odds ratio for attending gymnasium for an individual whose mother had no education at all have improved over the period. For males whose mother had an university degree compared to males whose mother had an vocational education, the figures are 7.6 for the 1982 cohort and 9.5 for the 2002 cohort. There are alternatives to the choice of mother's education in Table 3. For example Dustmann (2004: 220) defines a disadvantaged category which is composed of parents with no education past grade nine or ten and being in the lowest occupational group. This is what he calls 'working class' parents. The predicted probabilities of going to gymnasium for males in this group increased from 0.088 in 1982 to 0.136 in 2002. For females the increase was much bigger: from 0.172 to 0.286.

While there have been dramatic changes in mobility at the secondary level should they encourage us to believe that similar results will eventually be found at the tertiary level? The results are even more startling than those associated with gymnasium attendance. As Table 4 indicates the percentage of females attending university rises from 6.3% in 1985 to 19.1% in 2005. This is truly a remarkable change and it is accompanied by a similarly large change for those females whose mother had no education past grade 9 or 10. The same pattern holds for males but the changes are not as great.

Tertiary education has also become fairer. For example, for a male respondent whose mother had an university education compared to a male respondent whose mother had no education at all is $\frac{0.492/1-0.492}{0.046/1-0.046} = 20.1$ for the 1962 cohort in 1985, and $\frac{0.550/1-0.550}{0.071/1-0.071} = 16.0$

for the 1982 cohort in 2005 so that the odds ratio for attending university for an individual whose mother had no education at all have improved over the period. The predicted odds ratio of going to university for a female whose mother had an university education compared to a female respondent whose mother had no education at all is $\frac{0.442/1-0.442}{0.032/1-0.032} = 24.0$ for the 1962 cohort. The figure for the 1982 cohort is $\frac{0.5971-0.597}{0.086/1-0.086} = 15.7$ so that the odds ratio for attending university for an individual whose mother had no education at all have improved over the period.

6 Discussion and Conclusions

While there has been a decline in the norms of the parameter vectors associated with the respondent's family background variables for both males and females, the largest declines are of recent origin: 1992-2002 for males and 1997-2002 for females. There are two implications of this. First, it suggests to us that changes in the degree of dependence at the completed tertiary level will not show up until 2009-2012.

Secondly, it raises fundamental questions about causality. By 1980, all impacts of tracking in school had disappeared so that allocating students to an academic or vocational track prior to age fifteen or sixteen was no longer being done. Dustmann(2004: 226) suggests that German educational immobility may be due to "the relatively young age at which the secondary track decision has to be taken". In Denmark tracking was not as pervasive.

Thus, tracking does not appear to be the cause of the decline. However, changes to the gymnasium system that gave students more choice and introduced technical options may have made the gymnasium choice more suitable for members of the two youngest cohorts. In addition there has been a change in attitudes or perceptions about the value of going to a gymnasium in terms of the options it gave to attendees for acquiring tertiary education, Andersen (2004: 60-61).

Social programmes including welfare support and unemployment insurance programmes had been well established prior to the 1990's. But this was a period of considerable change in Danish social policy and there were some new policies that could have

affected educational decisions. Reduced entitlements to welfare programmes (Rosdahl 2003: 123) and the tying benefits to schooling decisions made the costs of not getting more education much higher (Munk 2001: 94, 2003a). Esping-Andersen (2004: 131) has also suggested that the cohorts who were making educational choices in 1990's were the first to fully benefit from the expansion of the day-care programmes at the end of the 1970's.

The cumulative effects of social policy will also have made the gymnasium alternative more accessible to socially disadvantaged groups. Looking at two such subgroups for males: those with household incomes one standard deviation below average and those with a father was unemployed when the respondent was twenty, we find that the probabilities of attending gymnasium for both of these subgroups have doubled over the period 1982-2002.

As we mentioned in the previous section, like secondary education, tertiary education has also become more accessible to less advantaged individuals. Thus it is reasonable to conclude that the trends towards less dependence on family background variables that emerged in secondary education in the 1990's will continue in the tertiary educational system. Of course, this result should be interpreted with some caution since some of the attendees will drop out and there will be entrants at ages above 23. However, as we mentioned above, these changes in attendance behaviour patterns are of fairly recent origin so a comprehensive analysis of tertiary educational attainments will have to be deferred until the relevant data becomes available in four or five years time.

On a more technical issue, Cameron and Heckman (1998: 281) caution researchers about making comparisons of normal ordered probability models across cohorts. When normal probability models are being used the estimated coefficients are of the form β/σ so that changes in the β coefficients could be mistaken for changes in σ. We certainly use normal cumulative distribution functions to define our probabilities. As a check we also used the functions $\sin(X\varphi)^2$ and $\sin(X\gamma)^2$. These generated results which were qualitatively similar to those reported in Tables 2M and 2F and there is no problem about comparing the (φ, γ) across cohorts. Moreover, there were no significant differences in the variances of (u_1, u_2, u_3) over the five cohorts. This suggest to us that it is unlikely that there would be significant differences in the variances of (v_I, v_{II}).

Finally, one of the more important variables which matters in educational choices is household income. Like Blanden and Gregg (2004) we also find highly significant parameter estimates associated with this variable. This is consistent with our results using sample survey data. In Denmark, like Britain, the effect of household income on choices is very dramatic. The probability of attending gymnasium for males coming from households with incomes one standard deviation above average is more than four times as high compared to respondents coming from households with incomes one standard deviation below average. In McIntosh and Munk (2007) we interpreted high household incomes as proxies for parental competence rather than something which eases credit constraints since secondary education is free in Denmark. However, it is possible that higher income households are able to provide more of the things for their children that matter in the human capital accumulation process like access to personal computers, reading materials in the home, choice of high quality day-care etc.

However, it should not be forgotten that in spite of this dramatic increase in the importance of household income; when all factors are considered dependence of secondary educational choices on family background variables has actually declined over the period. It would be interesting to see whether this is what has happened in Britain when a full selection of family background variables is used in addition to household income.

References

[1] Andersen, D. (2004), *4 år efter grundskolen, 19-årige om valg og veje i ungdomsuddannelserne*, Copenhagen: AKF Publisher

[2] Blanden, J., P. Gregg, P. and S. Machin (2005), Educational Inequality and Intergenerational Mobility. Chapter 6 in Machin and Vignoles 2005.

[3] Blanden, J. and P. Gregg. (2004), Family Income And Educational Attainment: A Review Of Approaches And Evidence For Britain. *Oxford Review of Economic Policy* 20 245-263

[4] Bynner, J. and H. Joshi. (2002), Equality and Opportunity in Education: evidence from the 1958 and 1970 birth cohort studies. *Oxford Review of Education* 28: 405-427

[5] Cameron, S. V. and J. J. Heckman (1998), Life Cycle Schooling and Dynamic Selection Bias: Models and Evidence for Five Cohorts of American Males. *Journal of Political Economy* 106: 262-333

[6] Dustmann, C. (2004), Parental background, secondary school track choice, and wages *Oxford Economic Papers* 56 209-239

[7] Erikson, R. and J. O. Jonsson (1996), *Can Education be Equalised? The Swedish Case in Comparative Perspective*, Boulder: WestviewPress

[8] Esping-Andersen, G. (2004), Untying the gordian knot of social heritance. *Research in Social Stratification and Mobility* 21: 115-138

[9] Galindo-Rueda, F. and A. Vignoles (2005), The Declining Relative Importance of Ability in Predicting Educational Attainment. *Journal of Human Resources* XL(2): 335-353

[10] Hauser, R. M. 1998. Intergenerational Economic mobility in the United States: Measures Differentials and Trends. Working Paper, Department of Sociology, Center for Demography and Ecology, University of Wisconsin-Madison

[11] Haveman, R. and B. Wolfe (1995), The Determinants of Children's Attainments: A Review of Methods and Findings. *Journal of Economic Literature* 33: 1829-1878.

[12] Jonnson, J. O. (1993), Persisting Inequalities in Sweden. In Shavit and Blossfeld 1993, 101-132.

[13] Jonsson, J.O. and R. Erikson (2000), Understanding educational inequality: The Swedish experience, L'Année sociologique 50: 342-382

[14] Machin, S. and A. Vignoles (2005), *What's the good of education?* Princeton University Press

[15] Mare, R. D. 1980. Social Background and School Continuation Decisions. *Journal of the American Statistical Association* 75: 295-305

[16] Marks, G. and J. McMillan (2003), Declining inequality? The changing impact of socio-economic background and ability on education in Australia. *British Journal of Sociology* 54: 453-471

[17] McIntosh, J. and M. D. Munk (2007), Scholastic Ability vs. Family Background in Educational Success: Evidence from Danish Sample Survey Data, *Journal of Population Economics* 20 (1): 101-120

[18] McIntosh, J. (2006), Educational mobility in Canada: Results from the 2001 General Social Survey, Working Paper, Concordia University and The Danish National Institute of Social Research

[19] Munk, M. D. (2001), The Same Old Story? Reconversions of Educational Capital in the Welfare State, *Jahrbuch für Bildung und Arbeit* 1999/2000, Deregulierung der Arbeit - Pluralisierung der Bildung? Eds. A. Bolder, W. R. Heinz, G. Kutscha, Opladen: Leske + Budrich Verlag: 87-98 + litt

[20] Munk, M. D. (2003a), Institutionalised Legitimate Informational Capital in the Welfare State. Has Policy Failed? In C. Torres, *The International Handbook on the Sociology of Education: An Assessment of New Research Theory,* Boulder: Rowman & Littlefield Publisher: 285-302

[21] Munk, M. D. (2003b), Livschancer og social mobilitet - forskellige fødselsårganges vilkår. *Dansk Sociologi* 14: 41-58.

[22] Rosdahl, A. (2003), Lediges understøttelsesperiode, In *Drivkræfter bag arbejdsmarkedspolitikken*, edited by P.K. Madsen and L. Pedersen, Copenhagen: The Danish National Institute of Social Research, 100-135

[23] Shavit, Y. and H.-P. Blossfeld (1993), *Persistent Inequality: Changing Educational Attainment in Thirteen Countries*. Boulder Co:Westview Press.

[24] Vallet, L. A. (2004), The Dynamics of Inequality of Educational Opportunity in France. Change in the Association Between Social Background and Education in Thirteen Five-Year Birth Cohorts (1908-1972), Working paper, CREST-CNRS

TABLES

Table 1A

The Distribution of Secondary Educational Choices (Proportions) by Cohort

			Males		
Type of Education	**1982**	**1987**	**1992**	**1997**	**2002**
Gymnasium	9531 (0.253)	12347 (0.307)	14087 (0.374)	13271 (0.418)	11601 (0.418)
Vocational	15854 (0.422)	16881 (0.420)	13082 (0.348)	10823 (0.341)	8743 (0.315)
None	12228 (0.325)	10996 (0.273)	10476 (0.278)	7622 (0.240)	7438 (0.268)
Total	37613	40224	37645	31716	27754
			Females		
Gymnasium	13662 (0.379)	17501 (0.456)	19521 (0.544)	18038 (0.602)	15675 (0.601)
Vocational	9156 (0.254)	10134 (0.264)	7414 (0.207)	5360 (0.179)	4206 (0.161)
None	13229 (0.367)	10789 (0.281)	8963 (0.250)	6567 (0.219)	6222 (0.238)
Total	36047	38424	35898	29965	26103

TABLE 2M

Parameter Estimates For Males

Parameter (se)	**1982**	**1987**	**1992**	**1997**	**2002**
$\|\|\varphi\|\|$	1.422**(0.084)	1.529**(0.074)	1.472**(0.104)	1.364**(0.091)	1.090**(0.072)
$\|\|\gamma\|\|$	2.242**(0.104)	2.232**(0.086)	2.330**(0.096)	2.101**(0.071)	2.096**(0.076)
$\|\|(\varphi,\gamma)\|\|$	2.655**(0.093)	2.706**(0.080)	2.753**(0.096)	2.505**(0.077)	2.363**(0.075)
Father's Education					
$\overline{\varphi}_{fe}$	0.267**(0.032)	0.297**(0.029)	0.237**(0.026)	0.229**(0.026)	0.190**(0.025)
$\overline{\gamma}_{fe}$	0.458**(0.035)	0.458**(0.029)	0.523**(0.028)	0.502**(0.028)	0.471**(0.031)
Father's Occupation					
$\overline{\varphi}_{fo}$	0.226**(0.018)	0.244**(0.019)	0.188**(0.020)	0.189**(0.022)	0.146**(0.022)
$\overline{\gamma}o$	0.214**(0.025)	0.248**(0.024)	0.159**(0.025)	0.211**(0.024)	0.269**(0.026)
Mother's Education					
$\overline{\varphi}_{me}$	0.276**(0.039)	0.128**(0.033)	0.237**(0.026)	0.096**(0.028)	0.184**(0.026)
$\overline{\gamma}_{me}$	0.597**(0.038)	0.571**(0.036)	0.523**(0.028)	0.465**(0.031)	0.451**(0.031)
Mother's Occupation					
$\overline{\varphi}_{mo}$	0.044 (0.029)	0.125**(0.027)	0.116**(0.024)	0.177**(0.027)	0.087**(0.025)
$\overline{\gamma}_{m0}$	0.074**(0.033)	0.089**(0.030)	0.096**(0.028)	0.170**(0.028)	0.200**(0.029)
Number of Siblings					
φ_{sib}	-0.117**(0.007)	-0.131**(0.007)	-0.110**(0.007)	-0.088**(0.008)	-0.069**(0.008)
γ_{sib}	-0.082**(0.009)	-0.069**(0.010)	-0.091**(0.010)	-0.060**(0.0010)	-0.043**(0.01)
Household Income					
φ_{hi}	0.141**(0.018)	0.216**(0.021)	0.240**(0.022)	0.435**(0.045)	0.330**(0.025)
γ_{hi}	0.135**(0.015)	0.111**(0.013)	0.147**(0.018)	0.195**(0.026)	0.156**(0.021)
Father Unemployed					
φ_{fu}	-0.158**(0.026)	-0.186**(0.031)	-0.101**(0.027)	-0.107**(0.029)	-0.071**(0.029)
γ_{fu}	0.010 (0.041)	-0.008 (0.049)	-0.170**(0.036)	0.163**(0.036)	0.076*(0.038)
Single Mother					
φ_{sm}	-0.329**(0.024)	-0.318**(0.021)	-0.298**(0.020)	-0.286**(0.022)	-0.257**(0.022)
γ_{sm}	-0.092**(0.032)	-0.064**(0.025)	-0.088**(0.025)	-0.061**(0.025)	-0.054*(0.027)
Intercept terms					
φ_0	0.488**(0.026)	0.611 **(0.027)	0.534**(0.029)	0.612**(0.033)	0.494**(0.033)
γ_0	-0.653**(0.034)	-0.662**(0.035)	-0.410**(0.036)	-0.434**(0.037)	-0.444**(0.041)
Sample size	37613	41450	40224	37645	27754

†, ∗, and ∗∗ indicate significant at 10, 5, and 1 percent levels, respectively.

TABLE 2F

Parameter Estimates (Standard Error) For Females

Parameter	**1982**	**1987**	**1992**	**1997**	**2002**
$\|\|\varphi\|\|$	1.581**(0.101)	1.552**(0.090)	1.548**(0.112)	1.656**(0.141)	1.191**(0.088)
$\|\|\gamma\|\|$	2.426**(0.157)	1.925**(0.100)	1.925**(0.130)	2.157.**(0.189)	2.001**(0.097)
$\|\|(\varphi,\gamma)\|\|$	2.896**(0.143)	2.473**(0.094)	2.471**(0.122)	2.720**(0.173)	2.329**(0.093)
Father's Education					
$\overline{\varphi}_{fe}$	0.156**(0.030)	0.225**(0.030)	0.179**(0.028)	0.182**(0.029)	0.201**(0.028)
$\overline{\gamma}_{fe}$	0.355**(0.040)	0.399**(0.032)	0.379**(0.032)	0.490**(0.053)	0.439**(0.035)
Father's Occupation					
$\overline{\varphi}_{fo}$	0.299**(0.018)	0.211**(0.019)	0.237**(0.021)	0.205**(0.023)	0.147**(0.023)
$\overline{\gamma}_{fo}$	0.219**(0.025)	0.141**(0.023)	0.129**(0.026)	0.187**(0.027)	0.232**(0.029)
Mother's Education					
$\overline{\varphi}_{me}$	0.355**(0.0043)	0.217**(0.036)	0.248**(0.031)	0.185**(0.032)	0.140**(0.028)
$\overline{\gamma}_{me}$	0.708**(0.051)	0.482**(0.042)	0.516**(0.039)	0.490**(0.053)	0.455**(0.038)
Mother's Occupation					
$\overline{\varphi}_{mo}$	0.113** (0.029)	0.166**(0.027)	0.162**(0.025)	0.205**(0.028)	0.124**(0.027)
$\overline{\gamma}_{m0}$	0.174**(0.033)	0.192**(0.030)	0.127**(0.030)	0.234**(0.031)	0.200**(0.034)
Number of Siblings					
φ_{sib}	-0.105**(0.007)	-0.124**(0.008)	-0.094**(0.008)	-0.086**(0.008)	-0.081**(0.009)
γ_{sib}	-0.025**(0.009)	-0.041**(0.009)	-0.044**(0.010)	-0.057**(0.010)	-0.025**(0.011)
Household Income					
φ_{hi}	0.166**(0.016)	0.235**(0.020)	0.373**(0.028)	0.329**(0.028)	0.336**(0.028)
γ_{hi}	0.070**(0.016)	0.067**(0.013)	0.119**(0.022)	0.115**(0.021)	0.188**(0.027)
Father Unemployed					
φ_{fu}	-0.120**(0.027)	-0.186**(0.032)	-0.086**(0.028)	-0.046 (0.031)	-0.091**(0.031)
γ_{fu}	0.001 (0.041)	-0.012 (0.047)	-0.040 (0.037)	-0.011 (0.037)	0.023 (0.042)
Single Mother					
φ_{sm}	-0.230**(0.024)	-0.282**(0.022)	-0.336**(0.021)	-0.227**(0.023)	-0.309**(0.023)
γ_{sm}	-0.018 (0.031)	-0.031 (0.024)	-0.059**(0.026)	-0.059*(0.028)	-0.046 (0.030)
Intercept terms					
φ_0	0.264**(0.025)	0.578**(0.028)	0.571**(0.032)	0.644**(0.034)	0.649**(0.035)
γ_0	-0.172**(0.033)	-0.041 (0.032)	0.186**(0.036)	0.295**(0.040)	0.197**(0.043)
Sample size	36047	38424	35898	29965	26103

†, ∗, and ∗∗ indicate significant at 10, 5, and 1 percent levels, respectively.

TABLE 3
The Distribution of Secondary Educational Attainments

By Mother's level of Education for 1982 and 2002. Actual/Predicted

Males

		1982			**2002**	
Mother's Education	**None**	**Vocational**	**Gymnasium**	**None**	**Vocational**	**Gymnasium**
.	1	2	3	4	5	6
Category 1	0.384/0.383	0.452/0.450	0.165/0.167	0.362/0.361	0.384/0.384	0.253/0.255
Category 2	0.209/0.207	0.433/0.434	0.358/0.359	0.236/0.233	0.381/0.382	0.382/0.385
Category 3	0.177/0.182	0.173/0.166	0.649/0.653	0.271/0.274	0.180/0.176	0.548/0.550
Category 4	0.150/0.137	0.255/0.263	0.595/0.601	0.194/0.182	0.260/0.266	0.545/0.553
Category 5	0.176/0.175	0.228/0.254	0.567/0.571	0.172/0.170	0.185/0.183	0.643/0.647
Category 6	0.103/0.097	0.107/0.095	0.790/0.809	0.101/0.092	0.065/0.053	0.835/0.856

Females

		1982			**2002**	
Mother's Education	**None** 1	**Vocational** 2	**Gymnasium** 3	**None** 4	**Vocational** 5	**Gymnasium** 6
Category 1	0.430/0.428	0.282/0.282	0.288/0.290	0.322/0.321	0.226/0.227	0.452/0.451
Category 2	0.267/0.264	0.257/0.258	0.476/0.478	0.203/0.204	0.182/0.181	0.614/0.616
Category 3	0.163/0.253	0.082/0.075	0.755/0.771	0.232/0.225	0.093/0.093	0.675/0.682
Category 4	0.163/0.161	0.112/0.111	0.775/0.728	0.143/0.140	0.086/0.087	0.770/0.773
Category 5	0.167/0.160	0.106/0.106	0.727/0.734	0.153/0.146	0.061/0.061	0.786/0.793
Category 6	0.082/0.068	0.017/0.015	0.901/0.918	0.099/0.088	0.015/0.014	0.886/0.899

Notes: The elements in each row are the proportions of the respondents in each of the three educational categories. Each row represents a different category of father's education and hence the row entries sum to unity. Category 1 = None, Categoty 2 = Vocational. Category 3 = Gymnasium. Category 4 = Short Tertiary. Category 5 = Intermediate Tertiary. Category 6 = University.

TABLE 4
Proportions of Males Aged 23 Who had Started University

In 1985 and 2005 by Mother's level of Education

		Males		**Females**
Mother's Education	1985	2005	1985	2005
Category 1	0.046	0.071	0.032	0.086
Category 2	0.118	0.127	0.077	0.155
Category 3	0.278	0.237	0.236	0.259
Category 4	0.233	0.239	0.202	0.331
Category 5	0.254	0.302	0.197	0.337
Category 6	0.492	0.550	0.442	0.597
All	0.085	0.167	0.063	0.191

Mother's Educational Categories: Category 1 = None. Category 2 = Vocational. Category 3 = Gymnasium. Category 4 = Short Tertiary. Category 5 = Intermediate Tertiary. Category 6 = University.

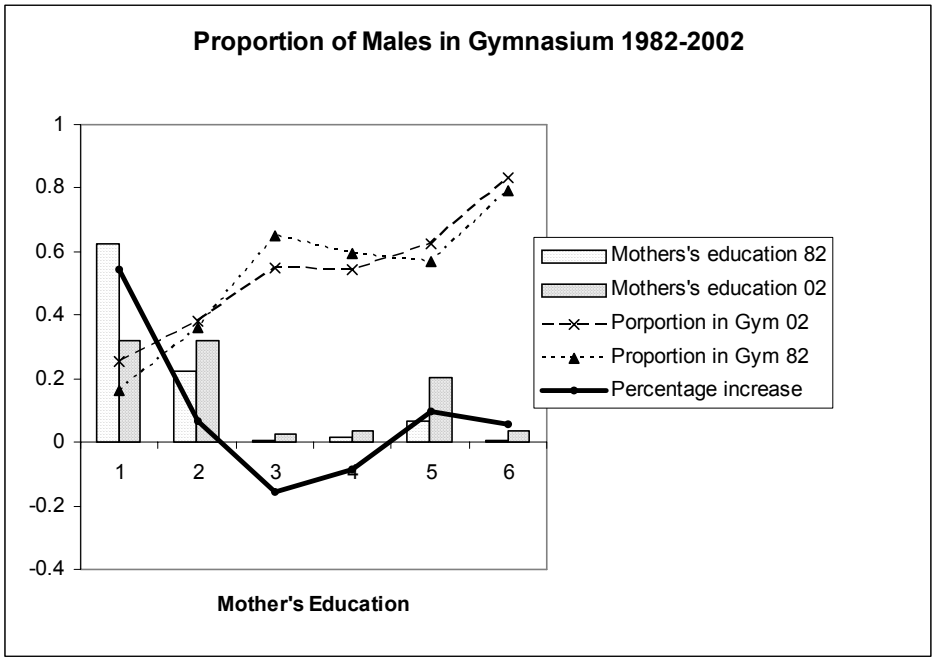

Figure 1:

Mother's Educational Categories: Category 1 = None, Category 2 = Vocational. Category 3 = Gymnasium. Category 4 = Short Tertiary. Category 5 = Intermediate Tertiary. Category 6 = University.

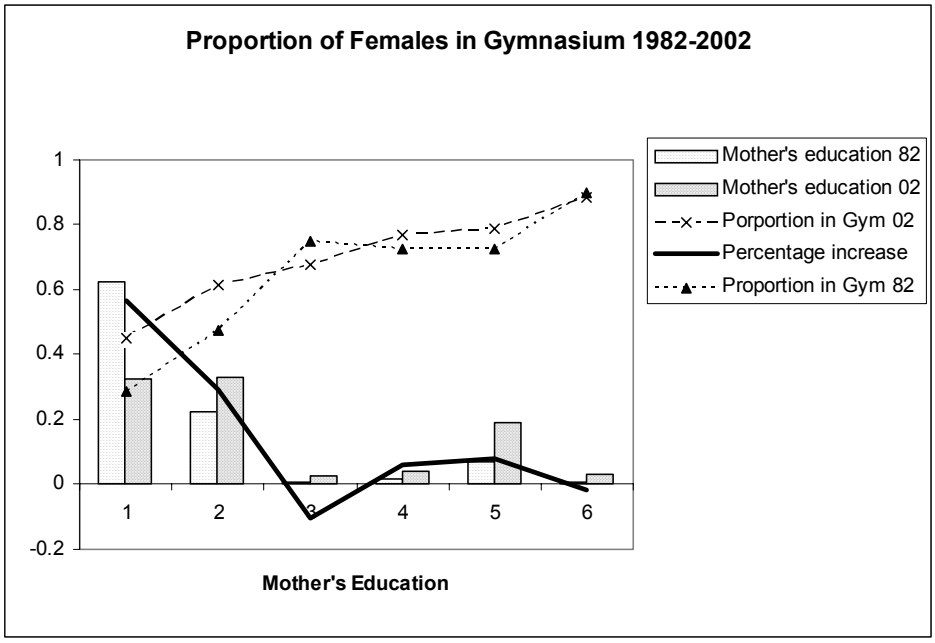

Figure 2:

Mother's Educational Categories: Category 1 = None. Category 2 = Vocational. Category 3 = Gymnasium. Category 4 = Short Tertiary. Category 5 = Intermediate Tertiary. Category 6 = University.