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GHAZALA NAZ, ØIVIND ANTI NILSEN
AND STEINAR VAGSTAD

EDUCATION AND COMPLETED FERTILITY IN NORWAY

Department of Economics

UNIVERSITY OF BERGEN

Education and completed fertility in Norway

by*

Ghazala Naz, Øivind Anti Nilsen** and Steinar Vagstad

Department of Economics, University of Bergen

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Abstract

Using Norwegian data we find that married women's education is positively associated with completed fertility, but this relationship becomes insignificant after controlling for husbands' characteristics. Husbands' education has a positive effect on women's fertility. These findings suggest that the effect of education on married women's fertility goes through assortative mating. For unmarried women, in contrast, we find that the relationship between education and fertility is negative. This latter result is consistent with a hypothesis suggesting that unmarried women suffer a more detrimental impact of motherhood on their careers than do married women.

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** Corresponding author. Address: Fosswinckelsgate 6, N-5007 Bergen, Norway.
Email: oivind.nilsen@econ.uib.no

1. Introduction

Increased education levels and decreased overall fertility seems to be an empirical regularity in most OECD countries (Council of Europe 2001; OECD 2001a). Micro-based studies in various other countries as well also report a negative relationship between women's education and fertility (see for instance, Gardner 1973; Rindfuss, Bumpass, and John 1980; Schultz 1993; and Weinberger, Lloyd and Blanc 1989). One explanation for the negative correlation between education and fertility is the time-use and opportunity costs. Economic theory acknowledges the importance of parental time, especially the mother's time in the upbringing of children (see for instance, Becker 1965; Schultz 1973, Gronau 1973). The trade-off between fertility and labour market work is an important and widely accepted economic explanation of the observed negative association between women's education and total fertility. An increase in the education increases the wages and employment opportunities of a woman, inducing substitution out of time intensive activities such as children (see Becker 1991; Schultz 1993; Brisdall 1988). Economists have estimated strong negative effects of women's wages on fertility (see for instance, Heckman and Walker 1990b; Merrigan and Pierre 1998).

The Scandinavia countries have not experienced the same dramatic drop in total fertility over the last decades as compared to most other OECD countries. At the same time, female labour force participation and average education levels are high in Scandinavia. Some recent empirical studies using Scandinavian data suggest a positive association between education and third birth of married women, given that they already have got two children (see Hoem and Hoem 1989; Kravdal 1992; Rønsen 1998; Naz 2000). However, the positive association between education and third birth does not imply that females' education increases completed fertility as there is evidence that the percentages of childless women and women with only a single child are higher for those who have the longest schooling (see for instance, Lappegård 1999). A higher proportion of childless women and women with only a single child may offset the positive association between education and third birth observed in previous studies. Therefore, to evaluate the relationship between females' education and total fertility, it is important to look at childlessness together with the total number of children given that one gets children at all.

The first objective of this paper is to investigate the association between completed fertility and education of married women in Norway. Empirical evidence suggests that women with high education tend to marry men with even higher education (see, for instance, Winch 1958; Vandenberg 1972). This is referred to as positive assortative mating in the marriage market (see Becker 1991). Assortative mating implies that the education of the husbands ought to be taken into account when measuring the association between women's education and fertility. Due to assortative mating two kinds of indirect effects of females' education can take place. First, marrying a man with higher education and correspondingly higher income works as an income effect (similar to the effect of a labour-free income), which may affect fertility positively. Empirical studies verify the positive association between husbands' income and fertility (see for instance; Heckman and Walker 1990a, 1990b; Merrigan and Pierre 1998). Second, assortative mating may also affect fertility through specialisation. The literature on household economics suggests that a large part of gains from marriage stems from specialisation between husband and wife: the husband specialises in the labour market while the wife is specialising in household production.[1] There is ample evidence for specialisation within the household. Married men work longer hours in the market and have substantially higher wages than unmarried men. Moreover, married women have lower wages and work more at home than unmarried women (see Gronau 1986; Daniel 1992; Korenman and Neumark 1992). We expect that increased husband's education may imply more specialisation within the family, leading to a reduction of the opportunity cost of bearing children for women. We first estimate the gross effect of females' education on fertility. Thereafter, we decompose this effect into a "husband effect" and a "net effect".

In Western countries child bearing is not confined to marriage, but rates of fertility within marriage is higher than those outside the marriage. The opportunity cost of children may be different for married and unmarried women. Thus, the second objective of this paper is to analyse and discuss the difference in completed fertility for married and unmarried women. The fact that married women get more children than unmarried ones needs no further explanation. We find that education is positively correlated with fertility for married women but negatively for unmarried ones, and this is perhaps more of a puzzle. We will argue that in Scandinavia both married and

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[1] Some degree of specialisation according to comparative advantages is predicted by practically any kind of model of intra-family decision-making, (see for instance Becker 1973, 1985; Weiss 1997).

unmarried women are to a large extent insured against what can be called direct costs of giving birth, while they are not insured against more indirect losses, for instance against foregone career opportunities. Unmarried women may be expected to suffer a larger career loss from childbirths as compared with married women, for several reasons. First, it is sometimes argued that Scandinavian women have what is called “supportive husbands,” implying that career and family is compatible. Moreover, it is often argued that by marrying, a woman signals little interest in career opportunities, and then she has little to loose by getting children. Finally, the career loss may differ across parity levels: it is reasonable to believe that loss of career is largest for the first child, for instance due to fixed time-costs of having children. Since the marginal fertility decision of the average unmarried woman is whether or not to have the first child, while the marginal decision of the average married woman is whether to have a third child, this is another explanation of the difference between married and unmarried women’s fertility response to education.

The Norwegian dataset used, based on census data from public registers, is unique along several dimensions. First, since the data are based on census, we do not have only a small number of observations as in surveys. Our final sample includes more than 8,000 individuals. By using the Norwegian data we are able to meet some of the critique of existing literature; limited samples, the omitted information about spouse characteristics and the incidence of childlessness. These shortcomings may have plagued former studies, giving imprecise or erroneous results.

The rest of the paper is organised as follows. In the next section we give a brief description of some institutional features of Norwegian women’s fertility, educational level and labour force participation together with a description of the fertility patterns in Norway over the last decades. Section 3 presents the data and some summary statistics. In Section 4 we discuss the theoretical differences in fertility between married and unmarried women. The empirical specification is discussed in Section 5. In section 6, we present and discuss our empirical results. Section 7 concludes our findings.

2. Institutional background[2]

The relative high fertility accompanied with a high educational level in the Scandinavian countries may be due to institutional settings in these countries. First, Norway and Sweden have labour markets characterised by strongly compressed wage distributions, especially for women (see for instance OECD (1993), and Kahn (1998)). This means that female wages and thereby the direct costs of bearing children are not much affected by education, and that any measured effect of education therefore might have a less direct cause. Second, the Scandinavian countries have quite generous arrangements for maternal leaves – arrangements that to a large extent insure a woman from an income loss due to childbirths (see OECD 2001b).[3] Also the level of governmental transfers to parents has increased over time. However, this insurance against short-term income losses from childbirths does not eliminate the importance of more indirect costs attached to loss of career. We will return to this point below.

(Figure 1: "Total fertility" about here)

Figure 1 illustrates the total fertility for Norway. The figure indicates that the fertility from 1983 has somewhat increased. Note however, that this pattern covers the fact that women seem to postpone their childbirths. As Figure 2 illustrates, women today get their children later in their lifecycles as compared with earlier generations. In addition, we find that completed fertility of younger generations seems to be small relative to older generations.

(Figure 2: "Cohort fertility" about here)

The educational level in Norway is increasing, similar to most other countries. This pattern is especially evident for females. For instance, in 1952 only 15 percent of the students in graduate schools and universities were females, while this share was 55

[2] Most of the information in this section stems from NOU (1996:13).

[3] For instance, the current Norwegian maternity leave system gives the women the choice between a maternity leave compensation of 100% of work income for 42 weeks, or 80% for 52 weeks. This compensation requires a minimum of 6 months' paid work previous to giving birth for eligibility, and comes in addition to the universal child benefit. Consequently, for the "normal" family the cost of children does not vary much across income and educational groups.

percent in 1994. Only at the PhD level the female share of students is still lower than for males. When we look at the median age at first birth by educational length for various cohorts (shown in Figure 3), we see that the age of first birth is higher for the more educated groups and that the age of first birth has increased for all educational groups over time.

(Figure 3: "Median age at first birth by educational groups" about here)

The labour force participation rates of females are relatively high in Norway as compared with other countries, especially among younger cohorts. However, many women choose to work only part-time. For instance, the proportion of working women who chose to work part-time was 46% in 1994.

3. Data

Data sources

The data in this study is extracted from the Norwegian Database of Generations. This database provides information from public and administrative registers and includes all individuals born in every fifth year in the period from 1950 to 1995. For all the cohorts there is information about family characteristics, education and variables describing the labour market attachment of the individuals. The time of sampling of the different variables varies. For instance, family status, the length and type of education, and variables describing the labour market attachment is given every tenth year, while childbearing is recorded annually.

Primarily due to missing birth data we have restricted attention to women born in 1955 (Data for the 1950 cohort is hampered by severe under-registration of births for the years 1968-71, while cohorts from 1960 onwards have not completed their fertile period at the end of registration period (1995)). By concentrating on the 1955 cohort of women, we are able to follow the individuals through most of their fertile age. Missing variables cut our data to 86% of the entire Norwegian 1955 female cohort. There are 4,341 unmarried and 20,201 married women in the remaining data. The unmarried ones in our final sample have never been married, while the married ones have been married to the same husband all the time. That means that divorced, widowed or remarried women are excluded from our sample. This exclusion is done to get as homogeneous sample as possible. However, note that there will be substantial variation in our sub-sample of unmarried women, as this group encompasses cohabitating women as well as single women.[4]

In order to get information about husbands' characteristics we include only those married women in our sample whose husbands are found in the data (3,873 observations). As the Database of Generations provides information for only the individuals who are born in every fifth year in the period from 1950 to 1995, we include only women with husbands born in one of the years 1950, 1955, 1960 or 1965. One might worry that this sub sample may not be representative of all the married women as it selects only the women whose husbands are of the same age, 5 years younger, or 5 or 10 years older. Note however, that we will test whether the sub sample of women with husbands included in the database are similar as those women with husbands not found in the database.

Variables

The dependent variable is number of children ever born to the women when they are 40 years old. Our educational variable is the number of years of schooling for the respondent.

As already discussed, education may affect fertility in several ways. First, women's education may be used as a proxy for earnings potentials. In addition, it may work as a proxy of time costs of raising children. Another proxy for the income potential would be a measure of actual income (for instance income in a single year or an average over several years). However, one obvious problem with including income in a fertility study is that such a variable is endogenous since women's available time to income-work is limited with more children. To avoid the described endogeneity problem, we exclude income variables in our study knowing that this might introduce problems due to omitted relevant variables.

As discussed in the introduction, assortative mating may give rise to indirect effects of education on fertility. To get a more complete picture of the effect of women's education on their complete fertility, it therefore is important to also control for spouse characteristics. In this study we include spouse education, measured as

[4] According to aggregate statistics, almost 37 percent of unmarried Norwegian women of age 40-44 were living as cohabitants in year 1995 (Source: Statistics Norway).

number of years of schooling. Spouse income is excluded. This exclusion is based on the same arguments as for the exclusion of women's own income.

We have also included the age difference between husband and wife, defined as husband's age minus woman's age. Another variable included is the age at marriage. Women who get married early have a longer period where the likelihood of an additional child is greater. An additional reason for including age at marriage is that this variable might partly control for a woman's "social status," since high income and highly educated individuals are likely to get married late. Other fertility studies, such as Kiernan (1989) and Santos Silva and Covas (2000) find a negative effect of a late marriage on the probability of having children.

Since the average educational level varies across regions, it is important to control for place of residence. We have included seven regional dummies, using Oslo as the base case. If we had ignored the geographical aspect, the educational variable might just have picked up regional differences. The regional dummies might also control for regional differences in the costs of raising children, together with regional differences in the income potential for both women and husbands.

Descriptive statistics

Some descriptive statistics are given in Table 1.

(Table 1: "Descriptive statistics" about here)

There is a marked difference between unmarried and married women: close to 80% of the unmarried women get no or one child, while more than 80% of those who marry get two or more children. The numbers reported in Table 1 reveal that the mean of the number of years of schooling is higher for unmarried as compared with married. Furthermore, highly educated women are over-represented among those who never marry. This is probably also one of the explanation for the higher income among unmarried compared to the married ones. However, hours worked are likely higher among single women, leading to higher income. In Table 1 we also present summary statistics for married women who have been married to the same husband all the time but whose husband are not found in the database. The broad picture reveals only minor differences between the two groups. We therefore base our regressions on married women for whom we have information about husbands' characteristics.

(Table 2: "Years of schooling of women and husbands" about here)

Table 2 shows the years of schooling for women and husbands. The educational attainment is positively correlated, clearly illustrating the positive assortative mating discussed above: the frequencies are highest close to the diagonal.

(Table 3: "Number of children by parents' years of schooling" about here)

Table 3 illustrates the correlation between couples' education and number of children. We see that the number of children is positively correlated with fathers' education, while the correlation with mothers' education is not clear.

4. Fertility and Marital Status

The opportunity cost of children may differ for married and unmarried women. Furthermore, the cost of having an additional child may vary with the parity levels. To refine our discussion of career losses and costs associated with costs of children, we look at the difference dependent on the marital status.

We start by noting that the expected number of children, denoted y, can be written as:

$$E(y) = P(y > 0) \times E(y | y > 0) \tag{1}$$

Differentiation with respect to female education, denoted *edu*, yields the following expression for the marginal effect of education on fertility:

$$\frac{\partial E(y)}{\partial edu} = \left[\frac{\partial P(y > 0)}{\partial edu} \times E(y | y > 0) \right] + \left[P(y > 0) \times \frac{\partial E(y | y > 0)}{\partial edu} \right] \tag{2}$$

Equation (2) shows that the effect of education on fertility can be decomposed into the effect on the probability of getting at least one child (the first term on the right hand side) and the effect on the expected number of children, given that a woman already has got at least one child (the second term on the right hand side).[5]

Additional education opens new career opportunities, and therefore increases the opportunity costs of having children. Norwegian women are to some extent insured against income losses stemming directly from childcare, while "losses of career" remain. As discussed in the introduction, unmarried women may suffer a larger career loss from childbirths compared to married women. Since unmarried women often do not have a partner in the household to share the time-consuming activity of caring for and raising children, they may suffer a larger career loss from childbirths as compared with married women. If it is true that singles experience a tougher career-drop than married, we may expect to find $\frac{\partial P^{married}(y>0)}{\partial edu} > \frac{\partial P^{unmarried}(y>0)}{\partial edu}$. For similar reasons, we may expect that $\frac{\partial E^{married}(y|y>0)}{\partial edu} > \frac{\partial E^{unmarried}(y|y>0)}{\partial edu}$.

5. Empirical Specification

To see the effect of a set of background variables and characteristics on women's completed fertility, we use a count data model.[6] A first choice would be a Poisson model. The Poisson model assumes the equality between mean and variance for the dependent variable. However, when the assumption of equidispersion is violated the estimated parameters from a Poisson model are consistent but not efficient. We see in Table 1 that there are both over-dispersion (when variance is greater than mean) and under-dispersion (when variance is smaller than mean) in the number of children, depending on what (sub-) sample we are looking at. For the case where we have over-dispersion we could use a negative binomial model. The negative binomial model, however, does not account for under-dispersion. Instead, we adopt a strategy where we use a restricted generalised Poisson regression model (RGPR). This model has the

[5] For a variety of reasons, married women get more children than their unmarried sisters: $p^{married}(y>0) > p^{unmarried}(y>0)$ and $E^{married}(y|y>0) > E^{unmarried}(y|y>0)$.

[6] See Cameron and Trivedi (1998) for a comprehensive review of count data models.

convenient feature that it allows for both over- and under-dispersion.[7] The RGPR model has previously been used by Wang and Famoye (1997) to analyse completed fertility.

In the RGPR model the probability function for the response variable Y_i (here; the number of children) is given by:

$$f_i(y_i \mid m_i, a) = \left(\frac{m_i}{1 + a m_i}\right)^{y_i} \frac{(1 + a y_i)^{y_i - 1}}{y_i!} \exp\left(-\frac{m_i (1 + a y_i)}{(1 + a m_i)}\right) \tag{3}$$

where y_i = 0, 1, 2,.., and μ_i = exp($\mathbf{x}_i ß$). The $\mathbf{x}_i$-vector includes the covariates and an intercept, while *ß* is a vector of regression parameters. The inclusion of the a -parameter is an extension of the standard Poisson model, such that when $a = 0$, the probability function in eq. (3) reduces to the Poisson model. Note that if $a < 0$, there is under-dispersion, if $a = 0$, there is equidispersion, and finally, if $a > 0$, there is over-dispersion in the data.

The log-likelihood function for the RGPR model is given by:

$$LogL(a, b) = \sum_{i=1}^{N} \left\{ y_i \log\left(\frac{m_i}{1 + a m_i}\right) + (y_i - 1)\log(1 + a y_i) - \frac{m_i (1 + a y_i)}{(1 + a m_i)} - \log(y_i!) \right\} \tag{4}$$

where $a > min(-\frac{1}{max(m_i)}, -\frac{1}{max(y_i)})$. We report the marginal effects and the corresponding z-values.[8] The marginal effect of covariate *j* is calculated as:

$$\frac{\partial E(y \mid \mathbf{x})}{\partial x_j} = \frac{1}{N} \sum_{i=1}^{N} b_j \hat{m}_i \tag{5}$$

where $\hat{m}_i = \exp(\mathbf{x}_i \hat{b})$. Let $c(\hat{b})$ denote the vector of all the marginal effects. Using the delta method we may estimate the covariance matrix of the marginal effects as:

[7] For more details, see for instance Famoye (1993).
[8] The corresponding coefficients are available from the authors on request.

$$V\left(c(\hat{b})\right)=\left(\frac{\partial E(c(\hat{b}))}{\partial \hat{b}}\right)' Var\left(\hat{b}\right)\left(\frac{\partial E(c(\hat{b}))}{\partial \hat{b}}\right) \qquad (6)$$

The reported z-values of the marginal effects are based on this latter expression.

6. Results and Discussion

To study the effect of females' education on completed fertility we split our sample into married and unmarried women and run regressions using the RGPR model. The results are given in Table 4.

(Table 4: "Restricted Generalised Poisson Regression Results" about here)

The results presented in Column 1 are the results for married women without controlling for any husband characteristics. We find that females' education is positively associated with completed fertility at age 40. One year of additional education is associated with 0.027 more children. The positive association between females' education and fertility is in contrast to empirical findings in various other countries. The findings give no support to the theories focusing on the costs of time, saying that higher education leads to higher wages and thereby higher opportunity costs of having children.

However, the positive and significant effect of education might be due to the combination of assortative mating and omitted husband's characteristics. If we do not control for husbands' education, the covariate *women's education* would not only pick up the effect of women's own education, but also the effect of their husbands' education. We decompose the "gross effect" of married women's own education on fertility into a "husband effect" and a "net effect". To find the "net effect" of women's own education, we include also their husbands' educational length together with the age difference between husband and wife. These results are given in Column 2 of Table 4. We see that when we control for husbands' characteristics the positive effect of females' education becomes smaller and insignificant. The effect of husband's education is positive and significant. One year of additional education of a husband is associated with 0.033 more children. One interpretation of this result is as follows: Norwegian females' education does not affect fertility directly, only through assortative mating. Women with high education tend to marry men with even higher education and this assortative mating provides an income effect that affects fertility positively. The results suggest that it is the income potential for husbands and not women's own income potential (reservation wage) that is important for women's complete fertility.

Concerning the age difference, we see that women married to older men tend to get fewer children. However, with the relative large age differences in our sample (5, 0, -5, and -10 years) care should be taken when interpreting this result. Still, based on the reported marginal effect in Column 2, an increase of one year in the *age difference* between the husband and the wife will lead to 0.020 less children.

The marginal effect of *Age at marriage* is negative but small. This tells us that women who get married earlier are likely to get more children. An obvious reason is that an early marriage also leads to a longer period of marriage, and thus, a longer period where the likelihood of an additional child is greater. Another potential explanation is that the age at marriage is a proxy for the somewhat imprecise definition "social status". Women with lower social status tend to get married earlier, and also get more children. Based on the reported marginal effect, decreasing age at marriage with one year leads to 0.06 more children. Given that women with lower social status take less education, the total difference between women with various social backgrounds may be significant. Finally, we see that the fertility pattern varies by regions, and that most of the regional dummies are statistically significant.

As already pointed out, our sample of married women includes only women whose husbands are born in 1950, 1955, 1960 or 1965. We have tested whether there are any substantial differences between the sub-sample of married women for which the husbands are in the sample and the sub-sample for which the husbands are not in the sample. We merge the two sub-samples, and run a RGPR model where we include a sample dummy (1 if husband in sample, 0 otherwise) separately, in addition to interaction terms between the explanatory variables (as used in Column 1, Table 4) and the sample dummy. None of the interaction variables are individually significant, except for age at marriage.[9] The marginal effect is small, but still it is an open

[9] These results are not reported for sake of brevity.

question to us why this coefficient is statistically significant (t-value = 2.00). The summary statistics do not reveal any differences between the two sub-samples. Furthermore, a chi-square test of joint-significance of all the interaction variables in the RGPR model strongly rejects the hypothesis that there are any differences between the two sub-samples ($c^2_{df=8} = 9.11$).

The last columns of Table 4 illustrate the association between education and fertility of unmarried women at age 40. We see that education of unmarried women is negatively related to fertility. One year of additional education is associated with 0.033 less children. This is significantly different from what we found for married women.[10] As already mentioned, our sample of unmarried women is rather heterogeneous with cohabitating as well as single women. Thus, when we find the effect of education to be significantly negative even with measurement errors for unmarried women, we expect the true negative effect of education on single women's fertility to be even stronger.[11] From the summary statistics we also know that married women tend to have more children than unmarried women. The discussion in Section 4 encompassed the ideas about fertility and marital status. The numerical values of all the expressions in equation (2) are given in Table 5. Numerical values for $\frac{\partial E(y)}{\partial edu}$ are taken from the results reported in Table 4. To calculate numerical values for $\frac{\partial P(y>0)}{\partial edu}$ we run probit regressions, reported in Table A1 in the Appendix.[12] Finally, the numerical values for $E(y \mid y>0)$ and $P(y>0)$ and are calculated from the reported numbers in Table 1. Given these numbers, we get an expression for $\frac{\partial E(y \mid y>0)}{\partial edu}$ by rearranging equation (2).

(Table 5: "Fertility and Education by Marital Status" about here)

[10] This test is done by merging the two sub-samples using interaction variables, and then testing the significance of the interaction coefficients.

[11] Underlying this latter expectation is an assumption that cohabitating women behave as married women, and thus, the effect of education on fertility for cohabitating women would be positive.

[12] Note that only 5.3 percent of married women are childless. This skewness, in favour of women with at least one child, may give unreliable results in a standard binary choice model. Thus, the probit results for married women should be interpreted with great care.

Looking at the results in Table 5, the first thing we note is that the differences in the characteristics for the two groups are as expected. For instance we find that one additional year of education is associated with 2.2 % decrease in the probability of having at least one child of unmarried women, while increased educational level does not affect the probability of childlessness for married women. We also see that there is a substantial difference between married and unmarried women in the expected number of children given that the woman has at least one child, $E(y \mid y > 0)$. Note however, that this difference is not driven by education since $\frac{\partial E(y \mid y > 0)}{\partial edu}$ is small and more or less the same for married and unmarried women (0.008 and 0.006, married and unmarried women respectively). Thus, the significant difference in the importance of education for the completed fertility may be caused by the effect of education on childlessness. This is consistent with the hypothesis that that unmarried women experience a tougher career drop as a consequence of having children than married women do.

In contrast to married women, we find the regional dummies of South and West to be negative for unmarried women. This is as expected since these two regions comprise the "Bible-belt" in Norway.

In Table 4, we also report the estimated a -s. For none of the (sub-) samples, a is equal to zero. These estimates confirm what we already saw in the descriptive statistics; for the sub-samples of married there is under-dispersion, while there is over-dispersion for the sub-sample of unmarried. With the assumption of equidispersion violated, a standard Poisson model would give inefficient estimates.

(Figure 4: "Number of children; Sample and predictions," about here)

To see the prediction properties of the RGPR model, we show relative frequencies for the number of children in Figure 4. The actual frequencies (denoted *sample*) and the predicted frequencies (denoted *Generalised Poisson*) are given. The predictions are based on the estimates given in Table 4, Column 2 and Column 3 (*Married*, and *Unmarried*, respectively). The fit for *Unmarried* is rather good. However, for the *Married* sample there is an underprediction of the mode and overprediction of the tails of the distribution. Similar findings are also reported by Santos Silva and Covas (2000).

7. Conclusion

The main objective of this paper is to investigate the relationship between completed fertility and education for women in Norway. We find that the effect of married women's education on fertility is positive. The effect of education becomes much smaller and insignificant when we control for husbands' education. At the same time we find that husbands' education affects women's fertility positively. These findings suggest that married women's education does not directly affect fertility but goes through assortative mating in the marriage market. Given this pattern, one may ask why is it so important to distinguish the effects working via the husband from other effects? Consider two different thought experiments. In the first we "give" a random woman one extra year of education. This will affect her fertility directly, and also make her marry a man with somewhat higher education, which also affects fertility. Next consider giving one extra year of education to *all* women. For each of them we can compute the direct effect, but when every woman acquires more education, the average woman cannot possibly expect to marry some man with higher education, leaving them with only the direct effect.

In contrast to our findings for married women we find that there is a negative relationship between education and the completed fertility of unmarried women. The career losses attached to childbirths may explain this difference between married and unmarried women. We find that the association of women's education with the expected number of children, given that they have at least one child, is almost the same for married and unmarried women. However, education increases the probability of remaining childless for unmarried women but has no effect for married women. In Norway, as in rest of Scandinavia, there has been consensus of that it should be possible to combine motherhood and career. If our findings really are caused by women' concern about career losses attached to having children, this indicates that the Scandinavian welfare state has not fully succeeded. Nevertheless, the effect of education on completed fertility is small, which might be an indication that the policy of encouraging high fertility and high labour force participation among women has been successful.

From aggregate statistics we know that an increased level of education leads to a higher incidence of living single. When we see a pattern in most OECD countries with more and more individuals taking higher education while the overall fertility decreases, this might be due to the decision of marriage or cohabitation, and not an effect of education on the fertility *per se*. Thus, to get a better understanding of the overall effect of increased education on the total fertility one needs to analyse family formation and fertility decisions jointly. This will be at the core of our future research.

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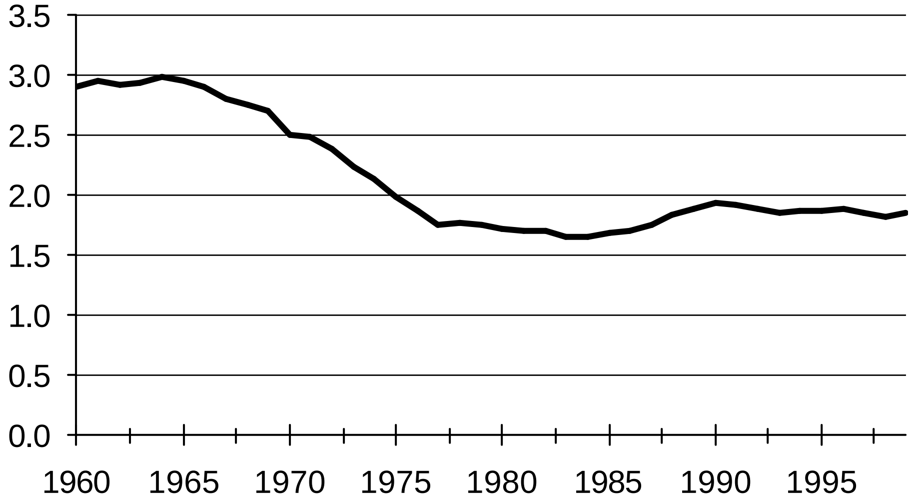
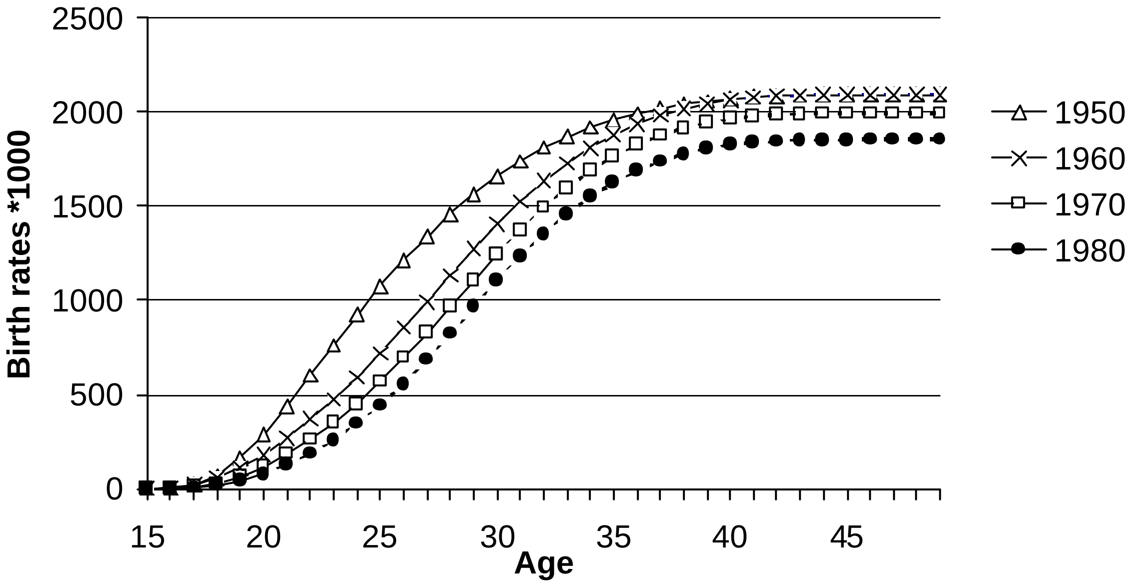
Figure 1: Total fertility



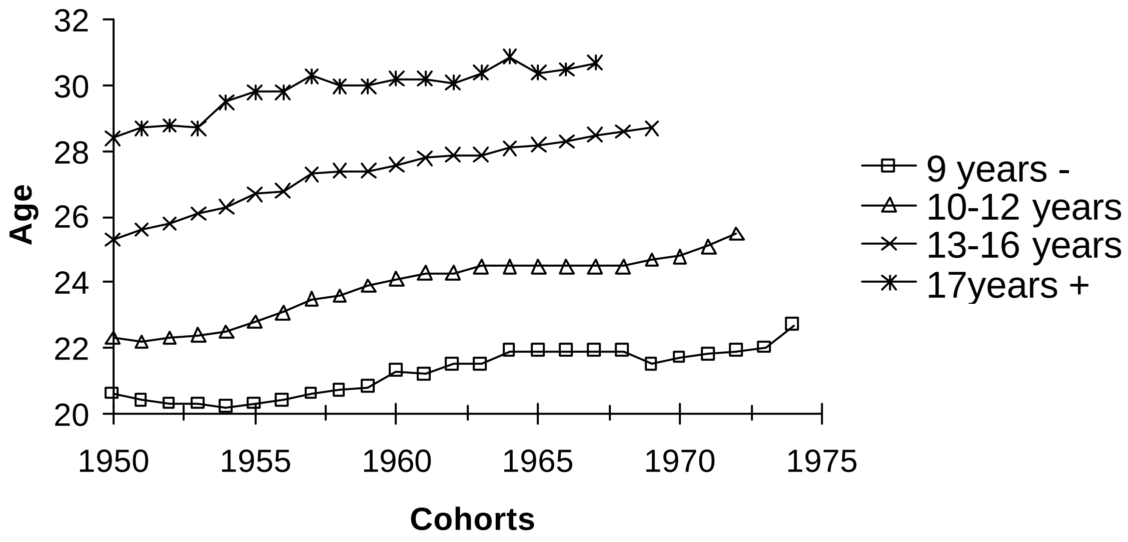
Source: Statistics Norway

Figure 2: Cohort fertility; accumulated birth rates *1000 (the last years are extrapolated)



Source: Statistics Norway

Figure 3: Median age at first birth, by educational groups



Source: Statistics Norway

Table 1: Descriptive statistics

	Married (husband in sample)	Married (husband not in sample)	Unmarried
Number of children			
Mean	2.27	2.23	0.77
Variance	1.03	1.09	0.94
Distribution (%)			
0	5.3	6.6	52.5
1	10.7	11.1	25.2
2	46.3	46.0	16.7
3 +	37.7	36.3	5.6
Age at first birth			
(conditional on having at least one child)	24.5	24.3	27.1
Age at marriage	23.7	23.6	
Years of schooling			
Mean	11.7	11.6	12.0
Distribution (%)			
- 11	52.9	55.5	47.3
12 - 15	33.6	32.4	34.7
16 +	13.4	12.1	18.0
Age difference (husband - wife)			
Distribution (%)			
-10 years	0.4		
-5 years	3.9		
0 years	56.7		
5 years	39.0		
Mean income (1989, 1992, and 1995)			
(1995 prices, 1000 NOK)	123.3	122.6	143.0
Regions (counties)			
Distribution (%)			
Oslo (*Oslo, Akershus*)	12.8	16.6	16.7
East (north) (*Hedmark, Oppland*)	7.2	8.8	9.0
East (south) (*Østfold, Vestfold, Buskerud*)	28.6	17.7	18.0
South (*Telemark, Vest-Agder, Aust-Agder*)	6.5	10.5	9.8
West (*Rogaland, Hordaland, Sogn- og Fjordane*)	15.6	22.2	21.7
Mid (*Møre- og Romsdal, Sør-Trønderlag, Nord-Trønderlag*)	13.6	14.6	15.0
North (*Nordland, Troms, Finnmark*)	15.8	9.7	9.9
Number of observations	3873	16328	4341

Table 2: Years of schooling of women and husbands. Number of couples.

Women	Husbands -9	10-11	12-13	14-15	16-17	18+	Total
-9	163	176	183	26	18	5	571
10-11	288	388	541	155	67	41	1480
12-13	69	131	265	114	57	57	693
14-15	27	48	157	137	100	139	608
16-17	17	29	88	78	109	79	400
18+	1	2	5	11	14	88	121
Total	565	774	1293	521	365	409	3873

Table 3: Number of children by parents' years of schooling

Women	Husbands -9	10-11	12-13	14-15	16-17	18+	Mean
-9	2.31	2.24	2.19	2.50	2.44	2.20	2.26
10-11	2.27	2.30	2.30	2.36	2.24	2.37	2.30
12-13	2.07	2.20	2.18	2.26	2.47	2.56	2.24
14-15	2.11	2.10	2.42	2.31	2.45	2.50	2.38
16-17	1.82	2.10	2.28	2.19	2.10	2.24	2.18
18+	1.00	1.50	1.60	1.91	1.43	2.22	2.05
Mean	2.23	2.25	2.27	2.30	2.27	2.38	2.27

Table 4. Restricted Generalised Poisson Regression Results

	Married		Married		Unmarried	
	Marg.eff.	z-value	Marg.eff.	z-value	Marg.eff.	z-value
Woman's education	0,027	3,000	0,008	0,871	-0,033	-9,988
East (north)	0,056	0,674	0,076	0,907	0,105	1,153
East (south)	0,009	0,127	0,003	0,041	-0,257	-5,324
South	0,205	2,561	0,203	2,558	-0,167	-2,363
West	0,353	4,927	0,355	5,042	-0,095	-1,787
Mid	0,259	3,457	0,258	3,469	0,120	1,991
North	0,299	3,597	0,310	3,756	0,342	4,787
Age at marriage	-0,056	-12,803	-0,060	-13,606		
Age difference			-0,020	-2,974		
Husband's education			0,033	4,333		
a (coefficient)	-0,097	-96,370	-0,097	-98,157	0,097	5,618
Log likelihood	-5568,8		-5555,8		-5061,0	
Number of obs.	3873		3873		4341	
Number of children						
μ (predicted)						
mean	2,27		2,27		0,77	
max	2,96		3,06		1,34	
y (actual)						
mean	2,27		2,27		0,77	
max	10		10		6	

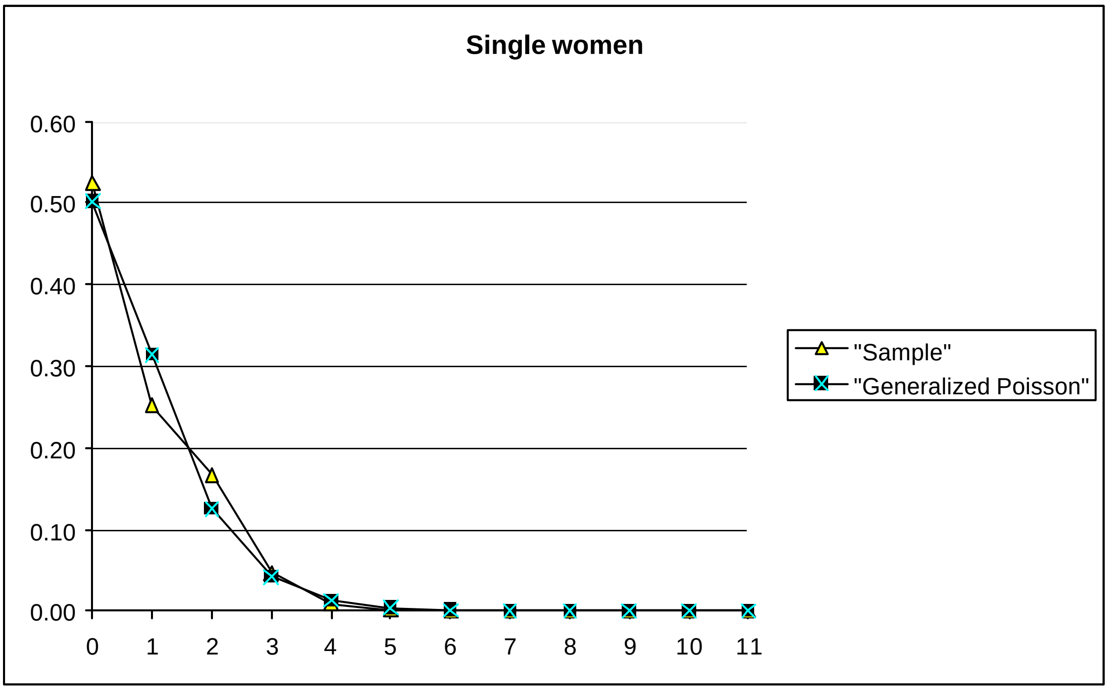
Notes: The reference category is women living in the Oslo region.
An a=0 indicates that the RGPR reduces to Poisson model.
The marginal effects of the regional dummies are measuring the discrete change of dummy variable from 0 to 1

Table 5: Fertility and Education by Martial Status

	$\frac{\partial P(y>0)}{\partial edu}$	$E(y\|y>0)$	$P(y>0)$	$\frac{\partial E(y)}{\partial edu}$	$\frac{\partial E(y\|y>0)}{\partial edu}$
Married	0.000	2.40	0.934	0.008	0.008
Unmarried	-0.022	1.62	0.475	-0.033	0.006

Notes: The results for ¶*P(y>0)/*¶*edu* are based on the logit regression results reported in Table A1. *E(y|y>0)* and *P(y>0)* are calculated from Table 1 while Table 4 gives the numerical values for ¶*E(y)/*¶*edu* . Figures for ¶*E(y|y>0)/*¶*edu* are based on the reported numbers together with a rearrangement of equation (2) in the main text.

Figure 4: Number of children; Sample and predictions



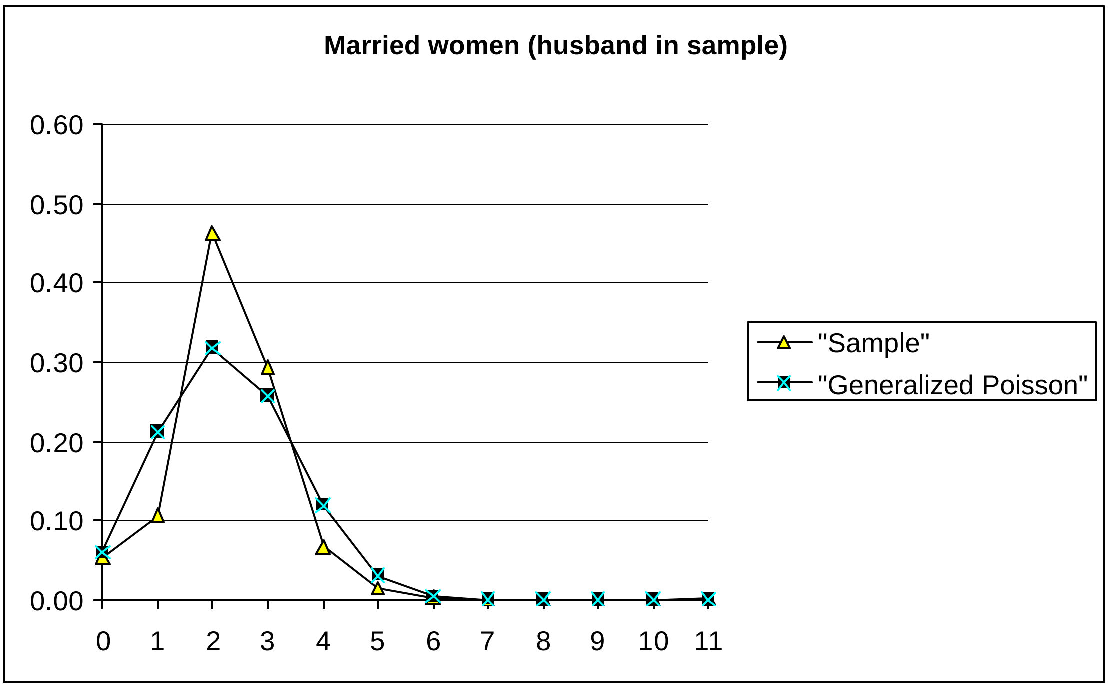


Table A1. Regression results, Probit model

	Married		Married		Unmarried	
	Marg. eff.	z-value	Marg. eff.	z-value	Marg. eff.	z-value
Woman's education	0.001	0.882	0.000	0.338	-0.022	-7.321
East (north)	0.000	0.006	0.000	0.009	0.039	1.109
East (south)	-0.013	-1.127	-0.014	-1.159	-0.128	-5.099
South	-0.011	-0.719	-0.011	-0.741	-0.103	-2.909
West	-0.006	-0.526	-0.006	-0.571	-0.073	-2.563
Mid	0.001	0.060	0.001	0.073	0.048	1.597
North	0.007	0.619	0.008	0.661	0.192	6.885
Age at marriage	-0.006	-10.541	-0.006	-10.699		
Age difference			-0.002	-1.298		
Husband's education			0.001	0.812		
Log likelihood	-751.6		-750.1		-2862.1	
Pseudo-R^2	0.063		0.065		0.047	
Number of obs.	3873		3873		4341	

Notes: The reference category is women living in the Oslo region.
The dependent variable is equal to one if a woman has one or several children, and zero otherwise.
The marginal effects of the regional dummies are measuring the discrete change of a dummy variable from 0 to 1