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Changes in the rate of return to education in Sweden: 1968–1991[1]

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This paper estimates changes in the rate of return to education in Sweden between 1968 and 1991. Both the 'quantity' (years of schooling completed) and 'quality' (highest qualification obtained) dimensions of education are considered. Adopting a human capital approach, the rate of return is measured in terms of differences in wage rates associated with differences in education. Both quadratic wage and cubic spline wage functions are estimated. The data used are from the 1968, 1981 and 1991 *Swedish Level of Living Surveys.*

I. INTRODUCTION

Sweden provides a valuable context in which to examine issues relating to the rate of return to education. Both economic growth and the expansion of the education system have been rapid. However, policies pursued by the trade unions and government have likely had a considerable impact on the education investment decisions of individuals. More specifically, throughout the 1960s and 1970s, the highly centralized trade union movement campaigned vigorously for 'solidarity wage' policies, which were aimed at levelling wage rates across occupations among blue collar workers. The success of these policies led (in part) to a significant compression of the pre-tax distribution of earnings (see Hibbs, 1990a,b; Nilsson, 1992). In addition, throughout this period, the Swedish government pursued a policy of increasingly progressive income taxation. This, in turn, led to a compression of the post-tax distribution of earnings. In the 1980s, however, these trends toward pre- and post-tax equality established in the 1960s and 1970s, began to reverse themselves. More specifically, there was a breakdown in solidarity wage policies and central wage negotiating. Since 1983, union negotiations have occurred primarily at the industry level. This has increased the variation in wage settlements reached and has led to a widening of the pre-tax distribution of earnings (see Edin and Holmlund, 1995). We would expect these trends to have a substantial impact on the private rate of return to education.

During the past decades however the educational composition of the labour force has changed. The average education level of workers has increased considerably. Table 1 summarizes changes in the educational attainment of the Swedish labour force between 1968 and 1991 using data collected in three *Swedish Level of Living Surveys* (described below). As this table shows, the mean number of years of schooling increased for both men and women between 1968 and 1991. For men (women), the increase was from 8.7 (8.3) years in 1968 to 11.6 (11.4) years in 1991. The table also shows the distribution of the labour force by education level. These estimates show that the educational attainment (in terms of the highest qualification obtained) also increased in this period, despite the modest increase in the mean number of years of schooling completed. A major change was the reduction in the proportion of individuals who have only basic compulsory education (i.e. decreasing from 65.7% (72.6%) in 1968 to 27.3% (31.7%) in 1991 for men (women)). However, examination of the estimates presented in this table suggest that the increase in the overall level of education of the Swedish labour force has not been equally shared between men and women.

The purpose of this paper is to examine changes in the rate of return to education in Sweden in the period 1968 to

[1] A document containing information relating to the summary estimates presented in this paper is available from the authors upon request.

Table 1. *Educational composition of the Swedish labour force, 1968–1991 (individuals aged 20–64)*

	Males							Females						
Year	$\bar{S}$	$S1$	$S2$	$S3$	$S4$	$\bar{w}$	N	$\bar{S}$	$S1$	$S2$	$S3$	$S4$	$\bar{w}$	N
1968	8.7	65.7	25.9	4.5	3.9	75.8	1675	8.3	72.6	23.1	3.3	1.0	55.3	1808
1981	10.5	38.9	37.8	14.3	9.0	85.5	1520	9.9	49.4	34.9	11.7	4.0	69.5	1836
1991	11.6	27.3	42.9	18.8	11.0	89.5	1516	11.4	31.7	42.0	18.7	7.6	72.5	1623
Δ	2.9	− 38.4	17.0	14.3	7.1	13.7	–	3.1	− 40.9	18.9	15.4	6.6	17.2	–
%Δ	33.3	− 58.5	65.6	317.8	182.1	18.1	–	37.3	− 56.3	81.8	466.7	660.0	31.0	–

Notes: $\bar{S}$ = Mean years of schooling completed. $S1$ = Percentage with basic compulsory education. $S2$ = Percentage with vocational education for at least 1 year in addition to the basic compulsory education. $S3$ = Percentage with completed education from a gymnasium and/or vocational education in addition to gymnasium. $S4$ = Percentage with completed university education. $\bar{w}$ = Average hourly wage rate in real 1991 Swedish Crowns (adjusted by Consumer Price Index). N = Sample size.
Source: Own calculations from the 1968, 1981 and 1991 *Swedish Level of Living Surveys*.

1991. Adopting a human capital approach, the rate of return to education is measured in terms of the differences in hourly wage rates associated with differences in education. This paper extends previous research (e.g. Edin and Holmlund, 1995) in four directions. First, both the quantity and quality dimensions of education are considered. Second, particular attention is paid towards differences in the rate of return to education between men and women. Third, the potential problem of sample selection bias resulting from the nonrandomness of employment is addressed. The magnitude of this bias has likely changed over time given the changes in labour force participation rates (especially for women) that have occurred in this period. Fourth, the robustness of the estimates is considered by comparing them to estimates obtained from a more flexible cubic spline wage function. One issue that is not addressed in this paper is the potential endogeneity of education. However, given that we have no reason to believe that the magnitude of this endogeneity bias has changed over time, and given that we focus on *changes* in the rate of return to education, we do not consider it to be of fundamental importance. The remainder of this paper is organized as follows. Section II describes the data sources. Section III outlines the methodology used to estimate the rate of return to education. The estimates are presented in Section IV. Conclusion follows in Section V.

II. DATA

The data are drawn from the 1968, 1981 and 1991 *Swedish Level of Living Surveys* (see Eriksson and Åberg, 1987). These surveys were carried out by the Swedish Institute for Social Research at Stockholm University. These data are well suited to the issues raised in this paper because detailed information about wages, educational attainment and other socio-economic characteristics was collected for large samples of men and women using the same sampling method for each survey. The three samples used in this study are random samples of individuals living in Sweden of about 8000 individuals (approximately 0.1% of the Swedish population). In each survey, the nonresponse rate was about 15%. The samples used in the analysis are restricted to individuals between the ages of 20 and 64. Furthermore, farmers, the self-employed, students and the members of the military are excluded. We shall refer to this population as the 'labour force'. All estimates are weighted in order to reflect population totals. (Samples sizes are given in Table 1).

Two measures of education are considered. The first is the number of years of schooling completed (S). The second is highest educational qualification obtained. In our analysis, years of schooling is intended to capture the 'quantity' dimension of education. Highest qualification obtained is intended to capture the 'quality' dimension of education. For convenience, we shall refer to the first measure as 'schooling' and to the second measure as 'education level'. The latter measure has four categories, which represent distinct and major divisions in the Swedish educational system: (1) $S1$: *Basic compulsory* (e.g. folkskola, junior high school, realexamen, grundskola, högre folkskola, flickskola, folkhögskola), which is currently ten years of schooling; (2) $S2$: *Vocational education* for at least 1 year in addition to the basic compulsory education level $S1$; (3) $S3$: *Completed gymnasium* (c. high school) and/or *Vocational education in addition to high school*. Gymnasium is three years' schooling beyond basic compulsory education and is required for university entry; and (4) $S4$: *Completed university education*.

Wages are defined as gross hourly earnings before taxes and transfers from the government. Hourly wage rates are constructed by dividing self-reported monthly earnings from regular work by self-reported number of hours of work. The mean hourly wage rates for men and women in the three sample years are given in Table 1. The measure of work experience is obtained from a direct question of number of years worked up until the time of the survey. This measure is actual work experience, not potential work experience (i.e. age – age at leaving school – 6), which is usually used in most studies.

III. METHODOLOGY

There is considerable debate surrounding what is the most meaningful way to measure education when estimating the rate of return to education. Should one use years of schooling completed or education level obtained? In most empirical studies, years of schooling is used (see Lorenz and Wagner, 1990). The popularity of this specification stems directly from Jacob Mincer's influential theoretical work into the determinants of earnings (Mincer, 1974). However, in some countries, it has been shown that qualifications obtained are a more important statistical correlate of earnings than years of schooling completed (see Blinder, 1976).

As Blomquist (1979) points out, a useful way to conceptualize the relationship between schooling and education level is to view years of schooling as the 'input' to the education process and education level obtained as the 'output'. However, as mentioned above, years of schooling and education level can be thought to represent the quantity and quality dimensions of education. Given a certain education qualification, the number of years an individual requires to obtain this qualification, tells us something about his/her productivity. For example, an individual who obtains a basic university degree in a shorter period of time is likely more productive than an individual who takes longer to obtain the same degree. On the other hand, in the four education levels defined above, there is a certain amount of 'lumping together' of qualifications that take different amounts of time to obtain. For example, the university education category ($S4$) consists of all levels of university education, ranging from the basic undergraduate degree to a doctorate. Clearly, years of schooling will differ depending on what type (and perhaps subject) of degree is obtained. In this sense, therefore, years of schooling provides complementary information about the extent of investment in education.

Since years of schooling and education level potentially measure different aspects of education, we use both in our empirical investigation. Thus, three 'concepts' of the wage differential associated with education are considered: (1) The return to an additional year of formal schooling; (2) the return associated with possessing a given level of education; and (3) the return to an additional year of schooling within a given level of education.

There are two key methodological issues that arise when estimating wage differentials associated with differences in education. First, like most other studies, we have relatively small sample sizes when the data are broken down by gender and educational level. For example, our sample sizes are between 1000 and 2000 individuals (see Table 1). This means that if we consider formal schooling between 10 and 20 years, the average sample size will be between 100 and 200 for each group. These samples are very small which makes inference difficult, since sampling errors will be large. Second, as we can only observe wages for individuals that are employed, there is a potential problem of sample selection bias.

The most common way to handle the first problem is to control for differences in work experience by fitting a quadratic earnings function (see Mincer, 1974; Willis, 1986):

$$\ln W = \varphi + E\alpha + X\beta_1 + X^2\beta_2 + \varepsilon \tag{1}$$

where: $\ln W$ is the natural logarithm of the (observed) hourly wage rate; E is a vector of educational attainment characteristics; X is work experience; ε is a well-behaved error term (idd); and φ, α and β are parameters to be estimated. In this framework, the estimated αs provide information that can be used to calculate the wage differentials between individuals with different amounts of education, and represent the rate of return to education.

This quadratic wage function has been recently criticized for being overly restrictive. For example, Murphy and Welch (1990, p. 228) examine the bias of the quadratic approximation and conclude: 'While it seems clear that the quadratic must be scrapped for purposes of estimating career earning patterns, it is unclear whether the quadratic can still be used to effectively "control" for life-cycle wage effects when other factors affecting wages are of primary interest. On these matters we can provide no clear answers, only some words of caution'.

One way to address this problem is to use a more flexible functional form such as polynomial splines (see Poirier and Watts, 1973; Poirier, 1976; Murphy and Welsh, 1990). A polynomial spline of degree n is defined as a piecewise polynomial function made up of polynomials of degree at most n, such that both the spline and its derivatives up to and including $n - 1$ are continuous in all points. In statistical terms, it may be described as a polynomial of a certain degree, which is estimated separately for different segments under the restriction that it should be continuous in the points defining the segments, referred to as 'knots' in the spline function literature. Thus, in the univariate case, the researcher has to decide the degree of the polynomial, and the number and location of the 'knots'. It is also possible to estimate splines using more than one independent variable. In this case, in addition to estimating piece-wise polynomial functions for each independent variable, it is also possible to consider interactions between the variables.

In this study, polynomials of the third degree are used (i.e. cubic splines). Suits *et al.* (1978) have shown that these cubic spline functions can be easily estimated within a linear regression model framework. That is:

$$\ln W = S(E) + f_1(X - X_0) + g_1(X - X_0)^2 + h_1(X - X_0)^3 + \sum_{i=1}^{n} (h_{i+1} - h_i)(X - X_i)^3 D_i^* + \varepsilon \tag{2}$$

where: $S(E)$ is a general function of education; X_0 is the first 'knot', $X_1, \ldots, X_n$ are the remaining n knots; D_i^* is a dummy variable that takes the value one in the interval $X_{i+1} - X_i$ and zero otherwise; h are coefficients to be estimated and ε is a well behaved error term (idd). $S(E)$ may also be estimated as a spline function and it is straightforward to include interactions between E and X in this specification.

The second problem results from estimating behavioural equations with 'self-selected' samples, in the sense that the wage equations can only be estimated for individuals who are employed and hence have a positive wage. If those individuals who are employed are not a random sample of all individuals (both employed and unemployed), then the estimated rate of return to education derived from Equations 1 and 2 will be biased. This may be more of a problem for women compared to men, since the proportion of women employed is generally lower. However, Schultz (1990) finds large differences in the rates of return to schooling for both men and women in the United States depending on whether or not a correction for sample selection bias is carried out.

Various methods have been developed for correcting for sample selection bias of this type. The method used here is the popular two-step method proposed by Heckman (1979). In the first step, a probit regression equation of the probability that the individual is employed is estimated (i.e. on the probability of having a positive wage). The estimates of this equation are used to construct the 'inverse of the Mill's ratio':

$$\lambda_i = \phi(z_i)/[1 - \Phi(-z_i)] \qquad (3)$$

where: z_i is the deviate from the probit equation; and ϕ and Φ are the probability density and cumulative density functions, respectively. In the second step, this variable is entered into the wage equation (i.e. Equations 1 and 2) as an additional regressor.

This correction for sample selection bias requires the estimation of a probit equation of the probability that the individual is employed at the time of the survey. The variables (assumed exogenous) included in this equation are: age and its square; place of residence; marital status; number and age of children in the household; disability status; father's and mother's social class and educational qualifications; rural background; number of siblings; nonlabour income; and the local unemployment rate. For brevity the estimated first-stage probit equations are not reported here.

IV. RESULTS

Estimates from quadratic wage functions

The average wage differentials associated with the quadratic wage function are summarized in Table 2. The upper panel of this table are the rates of return to schooling. These were estimated by fitting Equation 1 with the only education variable being years of schooling completed. Therefore, the rate of return to schooling is simply the parameter associated with the years of schooling variable, multiplied by 100 in order to express it as a percentage. Turning first to estimates uncorrected for sample selection bias, the rate of return to schooling for both men and women declined considerably between 1968 and 1991. In 1968 for men, each additional year of schooling completed was associated with a 8.2% increase in wages, and by 1991 it had decreased to 4.0%. Likewise, for women in 1968, an additional year of schooling completed was associated with a 7.4% increase in wages, and by 1991 it had fallen to 3.9%.

The estimates corrected for sample selection bias also suggest that the rate of return to schooling is slightly lower for women compared to men. In 1968, the rate of return to schooling was 8.0% for men and 7.7% for women – a difference of about half a percentage point. Likewise, in 1991, the male rate of return was 3.8% compared to 3.4% for women – also a difference of half a percentage point. Overall the estimates suggest that there is little difference in the rate of return to schooling between Swedish men and women.

As a general remark, the estimates do not change much after the correction for sample selection bias is carried out. These 'corrected' estimates confirm that the rate of return to schooling for both men and women declined between 1968 and 1991. Furthermore, they suggest that there is little difference between men and women. Nevertheless, in terms of percentage declines, the decline in return to schooling has been 'larger' for women. As Table 2 shows, the corrected estimates suggest that the decline was 52.5% for men and 55.8% for women.

The average wage differentials associated with each of the four education levels are presented in lower panels of Table 2. These returns were calculated by first fitting Equation 1 with three binary variables representing the four different education levels. The excluded (reference) category is 'compulsory education only' ($S1$). (Years of schooling completed is not included in the equations.) The returns are the percentage increase (or decrease) in wages associated with each education level relative to compulsory education only.

Table 2 shows that in the three years that we consider, the return is higher (for both men and women) the higher the level of education attained. However, more importantly, the returns all declined considerably between 1968 and 1991. Again the estimates do not change much after the correction for sample selection bias is carried out. In percentage terms, the decline is largest for university education. The estimates corrected for sample selection bias suggest that for men in 1968, the rate of return associated with university education was 149.4%, and by 1991 it had declined to 47.3%. This represents a percentage decline of 68.3%. Likewise for women in 1968, the rate of return associated with university

Table 2. *The rate of return to education in Sweden, quadratic wage function (standard errors in parentheses)*

	Uncorrected for selection bias			Corrected for selection bias		
Year	Males	Females	Ratio	Males	Females	Ratio
Results from linear specification in years of schooling						
	(1)	(2)	(2)/(1)	(3)	(4)	(4)/(3)
1968	8.2	7.4	0.90	8.0	7.7	0.96
	(0.29)	(0.42)		(0.33)	(0.43)	
1981	4.2	3.5	0.83	4.0	3.3	0.82
	(0.22)	(0.22)		(0.23)	(0.23)	
1991	4.0	3.5	0.87	3.8	3.4	0.89
	(0.23)	(0.19)		(0.24)	(0.20)	
Δ	− 4.2	− 3.9	− 0.03	− 4.2	− 4.3	− 0.07
%Δ	− 51.2	− 47.3	− 3.3	− 52.5	− 55.8	− 7.3
Results from specification with dummy variables for different levels of education						
S2: *Vocational*						
1968	22.6	21.6	0.96	21.4	22.1	1.03
	(2.40)	(3.29)		(2.93)	(3.40)	
1981	12.4	11.4	0.92	11.3	8.9	0.79
	(1.86)	(1.61)		(1.89)	(2.42)	
1991	14.4	10.1	0.70	13.4	9.4	0.70
	(2.01)	(1.45)		(2.06)	(1.50)	
Δ	− 8.2	− 11.5	− 0.26	− 8.0	− 12.7	− 0.33
%Δ	− 36.2	− 53.2	− 27.1	− 37.4	− 57.5	− 32.0
S3: *Gymnasium/other*						
1968	83.2	81.0	0.97	86.4	81.9	0.95
	(7.62)	(10.64)		(9.84)	(10.73)	
1981	25.7	23.6	0.92	23.7	20.7	0.87
	(2.87)	(2.59)		(2.93)	(3.94)	
1991	33.5	21.7	0.65	31.3	20.9	0.67
	(2.94)	(2.00)		(3.03)	(2.05)	
Δ	− 49.7	− 59.3	− 0.32	− 55.1	− 61.0	− 0.30
%Δ	− 59.7	− 73.2	− 33.0	− 63.8	− 74.5	− 31.6
S4: *University*						
1968	157.4	160.0	1.02	149.4	161.0	1.07
	(11.05)	(25.63)		(13.02)	(25.70)	
1981	55.9	51.8	0.93	52.8	47.7	0.90
	(4.15)	(4.74)		(7.79)	(4.47)	
1991	49.5	45.6	0.92	47.3	43.8	0.93
	(3.75)	(3.11)		(3.83)	(3.25)	
Δ	− 107.9	− 114.4	− 0.10	− 102.1	− 117.2	− 0.14
%Δ	− 68.6	− 71.5	− 0.10	− 68.3	− 72.8	− 13.1

Notes: The difference associated with each education level is calculated by the following method: $\%\Delta W_j = [\exp(\alpha_j) - 1]*100$, where α_j is the parameter associated with each of the three education level variables (i.e. S_j where $j = 2, 3, 4$).
The standard errors are obtained through the Gauss approximation $\hat{\sigma}^2_{\%\Delta w_j} = \hat{\sigma}^2_{\alpha_j}\, 100 \exp(\hat{\alpha}_j)$ as they are a nonlinear function of the results from the regression equation.

education was 161.0% and by 1991 it had decreased to 43.8%. This is a decline of 72.8%.

It is clear from Table 2 that the decline in the rate of return to education (as measured by education level) was not equally shared between men and women. In short, the decline was much larger for women. More specifically, in 1968 the ratios of the returns for women relative to men (according to the corrected estimates) were very close to 1.0 (i.e. 1.03 for vocational education; 0.95 for gymnasium/other; and 1.07 for university education). By 1991, these ratios were all well below 1.0 (i.e. 0.70 for vocational education; 0.67 for gymnasium/other; and 0.93 for university education). This is confirmed by examining the percentage declines shown in the table. In all cases, the percentage declines are larger (i.e. more negative) for women compared to men.

Again it must be stressed that like what was found for the return to years of schooling completed, the largest decline occurred between 1968 and 1981. Between 1981 and 1991, there has been little change. In fact, as is shown in Table 2, for males with vocational qualifications or gymnasium, the rate of return actually increased slightly between 1981 and 1991.

Estimates from cubic spline wage functions

Figure 1 shows the predicted education–experience profiles for men in 1981 based on both the quadratic wage function and the cubic spline wage function. The 1981 estimates for men reveal the main differences between the quadratic and cubic spline wage functions. Therefore, the results for the other groups are not shown. A cubic spline for schooling, work experience and their (linear) interaction were included in the specification, with knots at 0, 15, 30 and 45 years of work experience and at 11 years of schooling. All calculations are carried out using the sample selection bias correction method described in the previous section.

This figure reveals some differences between the two specifications of the wage function. First, the cubic spline specification suggests a nonlinear relationship between years of schooling and wages, rather than the linear relationship imposed by the quadratic wage function. Second, compared to the cubic spline function, early career wage for individuals with few years of formal schooling are seriously underestimated by the quadratic wage function. Likewise, early career wages for the highly educated are overestimated and late career wages for the relatively highly educated are underestimated.

Figure 2 shows the predicted wage differentials associated with schooling for both men and women. Since the cubic spline wage function allows for an interaction between schooling and work experience, the returns to schooling for each level has been predicted as the average for each level of work experience. This was done for each year of schooling. The wage differentials are the percentage wage difference relative to the lowest level of education observed in the sample (i.e. 8 years). The figure also shows the predicted wage differentials based on the quadratic wage function. The quadratic wage function and the cubic spline wage function give very similar results for both men and women 1981 and 1991, apart from the nonlinearity in the relation between years of schooling and hourly wage rate implied by the spline. However, for 1968 the results are quite different, with the difference being very large for women.

To examine this difference further, Figure 3 shows the predicted education–experience profiles for women in 1968 based on both the quadratic wage function and the cubic spline wage function. The figure shows that there is a strong interaction between wages and work experience that is not picked up by the quadratic wage function. The quadratic specification implies decreasing late career wage, while the spline specification implies decreasing late career wages for women with low education. On the other hand, for highly educated women, the spline function implies increasing wages as work experience increases. This suggests that the quadratic earnings function (compared to the spline wage function), underestimates the decrease in the returns to education between 1968 and 1981 for both males and females in the high education groups. The reason being that the magnitude of the interaction between education and work experience has decreased between 1968 and 1981. In addition, it is important to note that in 1981 and 1991, the profiles diverge after 17 years of schooling. Unlike the quadratic wage function, the cubic spline wage function allows for this outcome.

Cubic spline wage functions were also estimated for each education level separately, in order to measure the between group wage differentials. For the groups 'Basic compulsory'

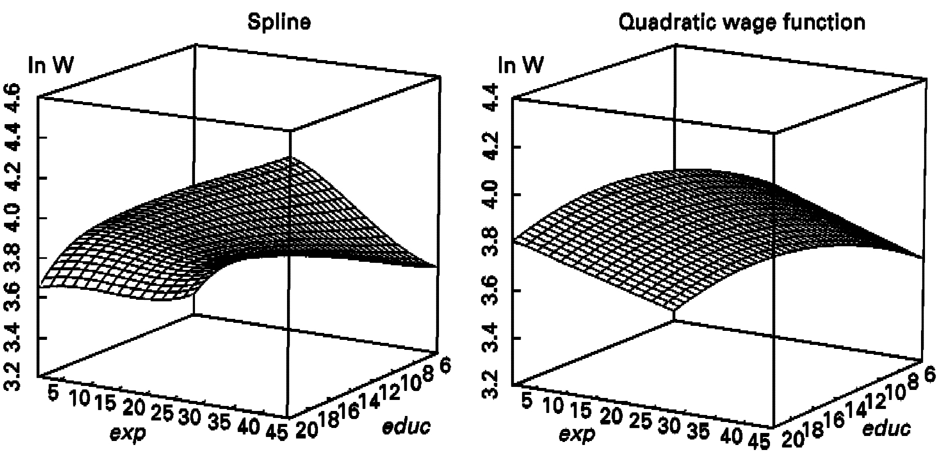

Fig. 1. *Plotted predictions from a quadratic wage-equation with years of formal schooling and a cubic spline function. Males 1981*

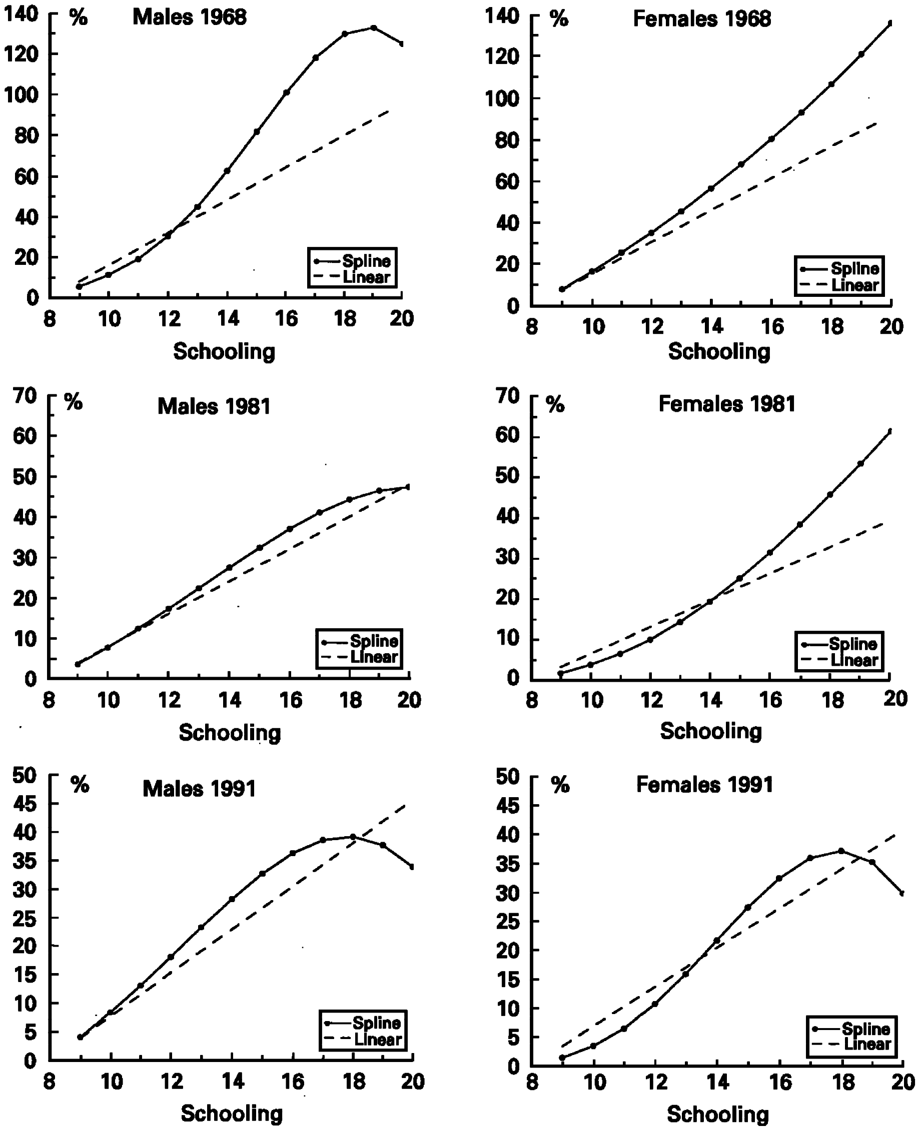

Fig. 2. *Wage differentials related to differences in formal schooling. Comparison between linear specification and splines*

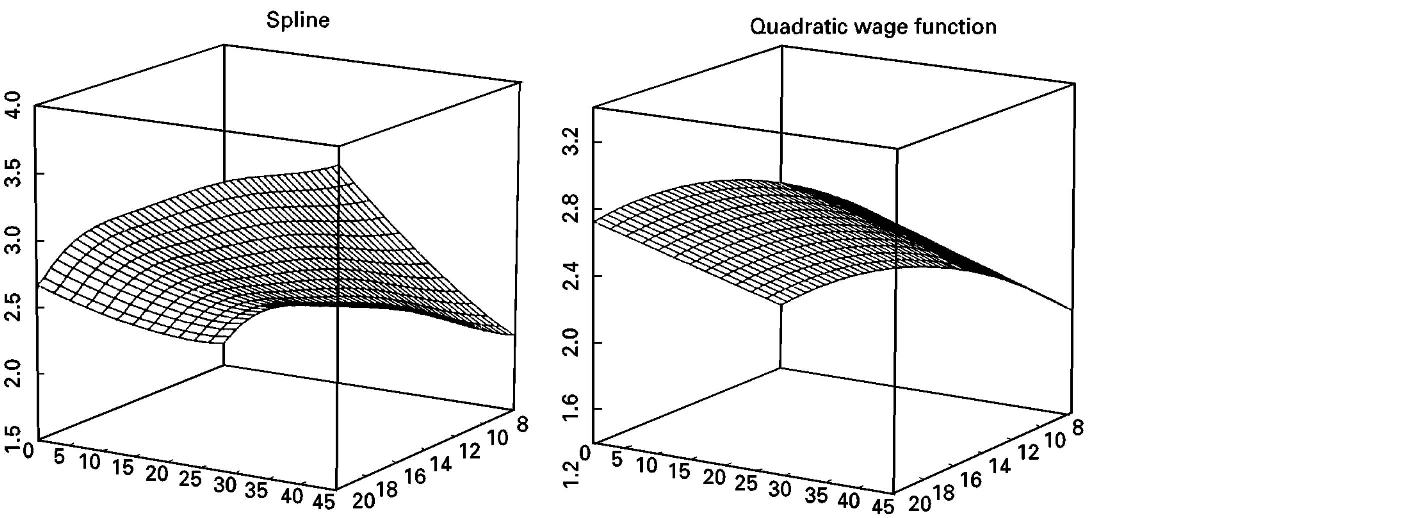

Fig. 3. *Plotted predictions from a quadratic wage-equation with years of formal schooling and a cubic spline function. Females 1968*

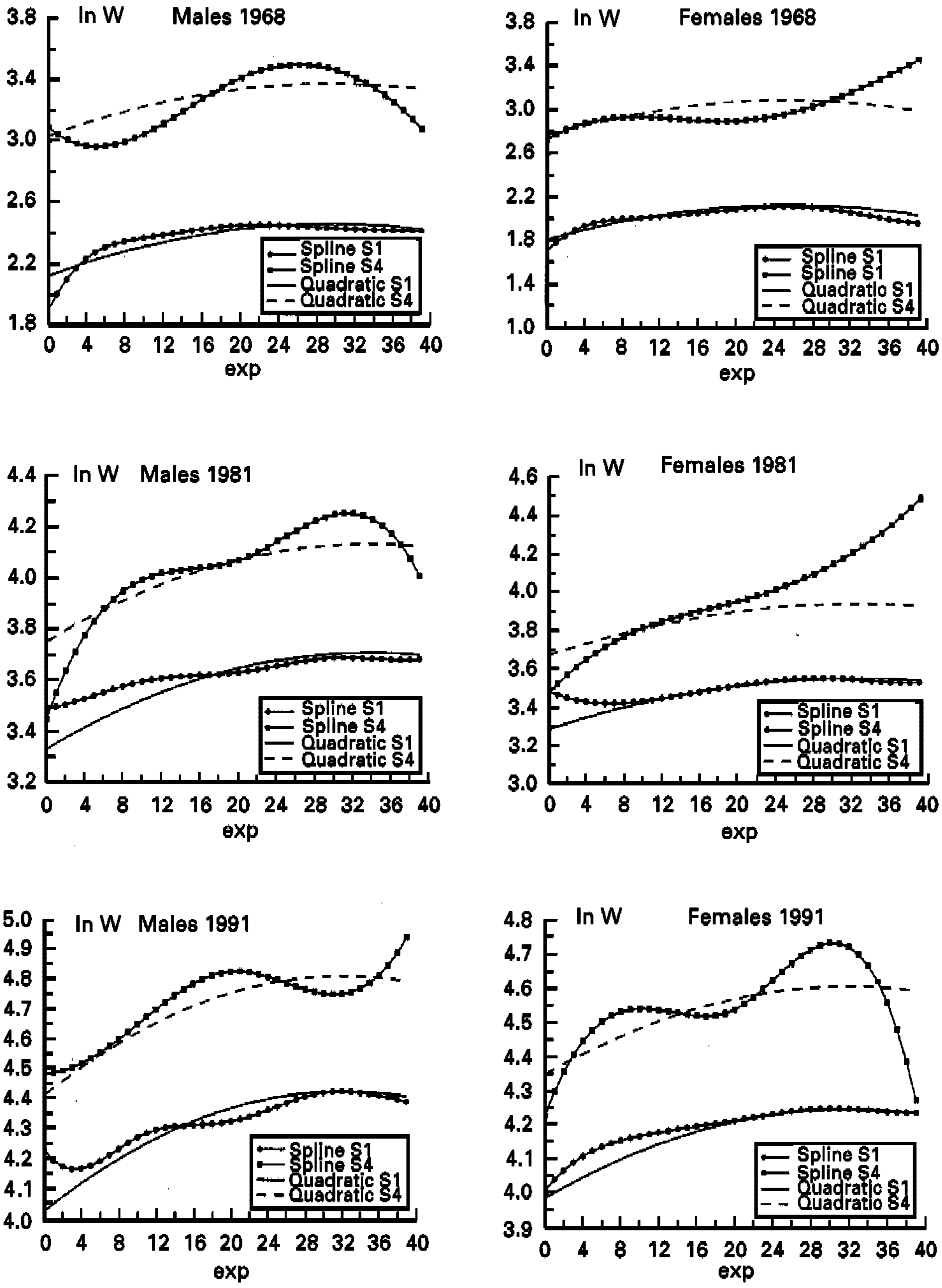

Fig. 4. *Plotted predictions from a quadratic wage-equation and cubic spline for group S1 and S4*

(*S*1) and 'Vocational education' (*S*2) , the 'knots' have been placed at 0, 10, 20, 30, 40 and 50 years of experience. For the groups 'Completed gymnasium' (*S*3) and 'Completed university' (*S*4) , the 'knots' were placed at 0, 20 and 40 years of work experience, as the sample sizes did not allow for a more detailed breakdown. Figure 4 shows the predicted experience profiles for education levels *S*1 and *S*4. The profiles for education levels *S*2 and *S*3 are very similar to education levels *S*1 and *S*4 respectively, and therefore are not reported. The figure shows that the quadratic wage function underestimates early career wages (and consequently overestimates late career wages) in all cross-sections except for very early career wages for both men and women in 1968. The figure also shows that for the *S*4 education level, the spline estimates are much more unstable, because of smaller sizes.

Table 3 shows the predicted average wage differentials between different educational levels based on a within-group cubic spline wage function. The estimates are very similar to those obtained using the quadratic wage function

Table 3. *The rate of return to education in Sweden cubic spline wage function*

Year	Males (1)	Females (2)	Ratio (2)/(1)
*S*2: Vocational			
1968	17.7	35.6	2.01
1981	6.4	5.54	1.03
1991	12.2	6.4	0.53
Δ	− 5.5	− 29.2	5.31
%Δ	− 31.4	− 82.0	2.61
*S*3: Gymnasium/other			
1968	96.6	109.3	1.13
1981	28.6	8.5	0.30
1991	39.2	22.2	0.57
Δ	− 57.4	− 87.1	1.52
%Δ	− 59.4	− 79.7	1.34
*S*4: University			
1968	128.4	162.2	1.26
1981	43.8	55.7	1.27
1991	43.9	37.5	0.85
Δ	− 84.5	− 124.7	1.48
%Δ	− 65.8	− 76.9	1.17

(see Table 2). Thus, the specification with the education level dummies and the corresponding spline function gives a more similar prediction of mean wage differentials compared to the specification with years of schooling. The explanation for this is that this specification is not restricted to be linear in years of schooling and thus makes better predictions of the mean wages when there is an interaction between education and work experience.

Estimates of rate of return to schooling within education levels

Finally, the rates of return to an additional year of schooling within a given education level are shown in Table 4. These returns were estimated by fitting Equation 1 separately for each education level and including years of schooling completed in each of these equations. Therefore, the rate of return to schooling within each education level is the parameter of the years of schooling variable multiplied by 100.

Four points about this table are worth making. First, the estimates are qualitatively unchanged after the correction for sample selection bias is carried out. Second, with the exception of university education in 1991, the rates of return to schooling are all positive. That is, except for university education, each additional year of schooling completed is associated with an increase in wages. This is the case for men and women. Third, with the exception of 'gymnasium/other' education amongst men, the returns to schooling have all declined between 1968 and 1991, with the decline being concentrated in the 1968 to 1981 period. And finally, again with the exception of university education, the percentage declines are larger for women compared to men.

V. CONCLUSION

In this paper, changes in the rate of return to education in Sweden were estimated. Five main conclusions emerge from the analysis. (1) The rate of return to education declined considerably between 1968 and 1991, with most of the decline occurring in the 1968 to 1981 period. (2) The magnitude of the decline was not the same across all levels of education, with the decline being particularly pronounced for university education. (3) The decline was not equally shared between men and women, with the decline (in percentage terms) being larger for women. (4) Sample selection bias is not a serious problem, since the estimated rates of return do not change much after they are corrected using Heckman's two step method. (5) The quadratic wage function and the cubic spline wage function, give approximately the same results, except when an interaction between schooling and work experience is included in the specification.

In closing, it is important to point out that the quadratic wage function with a linear specification of the years of schooling and the cubic spline wage function gave very different results for the 1968 sample. Therefore, the decrease in returns to education between 1968 and 1991 was underestimated using the quadratic wage function compared to the cubic spline wage function. The within group splines and the quadratic wage function with dummy variables for education levels yielded approximately the same estimates of mean wage differentials. However, the estimates of the relationship between wages and work experience differed. This is of importance if one believes that the individual decision of investment in education is influenced by the cross-section wage distribution and the individual discounts future expected earnings. Results from the quadratic specification could therefore be very misleading.

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Table 4. *The rate of return to schooling by educational level (standard errors in parentheses)*

Year	Uncorrected for selection bias			Corrected for selection bias		
	Males (1)	Females (2)	Ratio (2)/(1)	Males (3)	Females (4)	Ratio (4)/(3)
*S*1: Basic compulsory						
1968	8.3	5.4	0.65	7.3	5.9	0.81
	(0.85)	(0.85)		(0.85)	(0.87)	
1981	5.2	1.8	0.34	4.7	0.9	0.19
	(1.01)	(0.66)		(1.00)	(0.70)	
1991	3.5	1.5	0.43	3.5	1.2	0.34
	(0.80)	(0.55)		(0.85)	(0.58)	
Δ	− 4.8	− 3.9	− 0.22	− 3.8	− 4.7	− 0.47
%Δ	− 57.8	− 72.2	− 33.8	− 52.1	− 79.7	− 58.0
*S*2: Vocational						
1968	5.0	7.7	1.54	5.0	7.7	1.54
	(0.79)	(1.14)		(0.80)	(1.15)	
1981	3.2	2.3	0.72	3.0	2.3	0.76
	(0.59)	(0.46)		(0.59)	(0.47)	
1991	2.6	2.7	1.04	2.5	2.7	1.08
	(0.55)	(0.40)		(0.55)	(0.41)	
Δ	− 2.4	− 5.0	− 0.50	− 2.5	− 5.0	− 0.46
%Δ	− 48.0	− 64.9	− 32.5	− 50.0	− 64.9	− 29.9
*S*3: Gymnasium/other						
1968	1.6	10.5	6.56	1.4	10.7	7.64
	(2.14)	(3.11)		(2.11)	(3.22)	
1981	1.3	2.3	1.77	1.2	2.3	1.92
	(1.02)	(0.85)		(1.04)	(0.87)	
1991	2.0	1.3	0.65	2.0	1.3	0.65
	(0.88)	(0.73)		(0.87)	(0.73)	
Δ	0.4	− 9.2	− 5.91	0.6	− 9.4	− 6.99
%Δ	25.0	− 87.6	− 90.1	42.9	− 87.9	− 91.5
*S*4: University						
1968	0.6	9.0	15.00	0.8	8.7	10.88
	(2.21)	(5.02)		(2.15)	(5.66)	
1981	1.1	5.3	4.82	1.1	5.4	4.91
	(0.95)	(1.76)		(0.96)	(1.77)	
1991	− 1.8	− 0.5	0.28	− 1.8	− 0.6	0.33
	(1.24)	(1.30)		(1.21)	(1.30)	
Δ	− 2.4	− 9.5	− 14.7	− 2.6	− 9.3	− 10.55
%Δ	− 400.0	− 105.6	− 98.1	− 325.0	106.9	− 96.97

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