CENTRE FOR ECONOMIC RESEARCH

WORKING PAPER SERIES

2001

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WP01/16

August 2001

DEPARTMENT OF ECONOMICS

UNIVERSITY COLLEGE DUBLIN

BELFIELD DUBLIN 4

Dispersion in the Economic Return to Schooling*

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20th August 2001

JEL Classification: J31, J24, C31

Abstract: In this paper we extend the standard human capital earnings function to include dispersion in the rate of return to schooling by treating the return as a random coefficient. One motivation is that if the increase in supply of skilled workers has been brought about by dipping further into the ability distribution. Alternatively if the expansion in post-compulsory education comes about through relaxed credit constraints then we might expect this to increase average ability in the pool of educated workers. Either event might lead to a rise in the variance in returns. Based on a sample of data from the United Kingdom our estimates suggest that neither the mean nor the dispersion in returns to schooling has altered significantly over time. This is consistent with educational expansion not leading to a disproportionate inflow of low ability individuals into the system.

* We are grateful to Yu Zhu for research support. Valuable comments were received from seminar participants at NUI Maynooth and from Gavan Conlon, Kevin Denny, Donal O'Neill and Olive Sweetman. Financial support which facilitated this research is acknowledged from the UK Department for Education and Skills (Walker), the EU Commission for the award of a Marie Curie Fellowship at the University of Warwick (Hogan) and to the Nuffield Foundation for the award of a New Career Development Scholarship in the Social Sciences at UCL (Harmon). The usual disclaimer applies.

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1. Introduction and Context

In estimating the standard model of human capital accumulation it is usual for the econometrician to assume that the return to schooling is constant across individuals. However, investments in human capital are inherently risky for two reasons: first, education is usually discrete and the wages associated with each finite unit are not observed by the individual prior to committing to that unit; and, secondly, the individual does not know, in advance, whether he will "succeed" in that unit. If the returns to education depend, at least in part, on the credentials that the individual attains then the possibility of failing to achieve the standard required to attain a credential implies some risk (Park, 1996).

While existing research has estimated the mean return to education over time to investigate if expansion in the supply of skilled workers has resulted in the returns to skill falling, the weight of evidence suggests that the there has been little tendency for the mean return to fall.[1] However, if the increase in the supply of skilled workers has been brought about by dipping further into the ability distribution, and if the returns to education arise from signalling innate ability, then we should observe a rise in the variance in returns as more and more low ability individuals acquire the signal. The same would also be true if innate ability and human capital were complementary. In this paper we extend the standard human capital earnings function (Mincer, 1974) to include dispersion in the rate of return to schooling. We allow the return to education estimated on a sample of UK data to vary across individuals by treating the return to schooling as a random coefficient. Thus we estimate both the mean return and the variance around this mean.

[1] In the US see, in particular, Card and Lemieux (2001). In the UK see Dearden *et al.* (2000). Despite the large expansion in post-compulsory education that has occurred in both countries, and many others, there seem to be little evidence of a statistically significant decline in returns. See Denny, Harmon and Lydon (2001) and Trostel, Walker and Woolley (2001) for an analysis of comparable data across 28 countries.

2. Specification

We specify the basic Mincer-type earnings function as

$$\ln Y_i = (b + u_i)S_i + gX_i + n_i \qquad (1)$$

where Y is the log wage, **X** is a vector of explanatory variables, including a constant term and a quadratic in age to proxy for experience, S is years of schooling and ν is the usual residual. We explicitly allow the individual specific coefficient on schooling to be a random parameter so that $\hat{a}$ is the mean return. This is equivalent to

$$\ln Y_i = a + bS_i + gX_i + e_i$$

where $e_i = u_i S_i + n_i$, and

$$\Sigma_i = E(e_i^2) = s^2 + q^2 S_i^2 \qquad (2)$$

Thus, equation (1) is a specific example of general heteroscedastic model and therefore the likelihood function is given by (3)[2]

$$\ln L_i = -0.5\ln(2p) - 0.5\ln(\Sigma_i) - 0.5\left(\frac{e_i^2}{\Sigma_i}\right) \qquad (3)$$

At this juncture it is worth clarifying that the parameter θ is the standard deviation of the distribution of returns. However this is different from the sampling error associated with the estimate of β, which is itself the estimate of the mean of the distribution of returns. We can see this difference clearly from equation (3) where the parameters q and b enter into the likelihood function, whereas the sampling error of b will be calculated from the estimated information matrix associated with (3). In order to avoid confusion in what follows, we refer

[2] See Greene (1993), page 402

to q as "dispersion" and we refer to the sampling error of b as being the "standard error" of b.[3]

3. Data and Results

We use the UK Labour Force Survey from 1993-2000 to estimate the model outlined in Section 2. The LFS is close in design to the US CPS data. It is a large sample survey with a 5-quarter rotating panel design which has contained earnings information since 1993. Full details on the data and descriptive statistics are available on request or can be obtained on-line from the UK Data Archive.[4] We select employees aged 25 to 59 with positive recorded hours and earnings and define the wage a hourly earnings. Table 1 presents results from OLS and random coefficients (RC) models for men and women in the pooled data. We control for years of schooling, a quadratic in age as a proxy for experience, birth cohort through a cubic function of the year of birth (we can discriminate between birth cohort and age because the data is pooled over eight successive years), marital status (married or cohabiting versus divorced, widowed, separated and never married), ethnic background (white versus non-white), and union membership (member versus non-member). In addition to the direct control for year of schooling in this specification we also include interactions of schooling with the other covariates to allow the return to schooling to vary by observable characteristics.

The return to schooling from OLS is about 4% for men and 7% for women for the default individual but varies significantly with observable characteristics. If we average across all individuals then the estimated (mean) return is 6.8% for men and 7.3% for women. These

[3] Our analysis also presumes that schooling is exogenous. While there is some evidence for the US, UK and elsewhere that using instrumental variables results in larger estimates than OLS our concern here is with the dispersion of returns - see the studies reviewed in Card (1999) or Ashenfelter, Harmon and Oosterbeek (1999). Moreover the issue of estimation by IV methods is in itself controversial – see Heckman *et al.* (2001).

[4] dawww.essex.ac.uk.

results change little when we use RC to estimate the return - the returns for women rise only slightly. Our estimate of the dispersion in the return to schooling is about 4% for men and 3.3% for women. That is 95% of men have returns in the +/- 8% interval around the mean, while the dispersion for women is lower with 95% of women within +/- 6.6% of the estimated mean. Thus the dispersion is large, even though we have allowed for differences by observable characteristics.

Table 1 includes year fixed effects but the year dummies are not interacted with schooling. Estimates of specifications that include this interaction allow us to see how the mean return and its dispersion varies across time. These estimates, available on request from the authors, differ little from those in Table 1. We plot the estimated mean return and its dispersion in Figures 1 and 2. In each case the top half of the graph plots the OLS and RC return to schooling while in the bottom half of the graph the dispersion parameter is plotted together with the 95% confidence interval for this parameter.

For men the OLS and RC returns to schooling differ by about 1% over the range of years with a slight, insignificant, upward trend in the return. The corresponding dispersion figure behaves quite erratically but varies only between 3% and 5% over the period. For women the returns behave quite differently with a downturn in the return to schooling, albeit insignificant, in the later period in both the OLS and RC return. In contrast the dispersion parameter is relatively stable over time between 4% and 3%.

Table 1 OLS and Random Coefficient Models (Pooled Annual Cross Sections)

	MEN				WOMEN			
	OLS		RC		OLS		RC	
	Coeff.	*Std. Error*	Coeff.	*Std. Error*	Coeff.	*Std. Error*	Coeff.	*Std. Error*
Constant	2.05	*0.01*	2.03	*0.02*	1.91	*0.01*	1.86	*0.03*
Years of schooling	4.03	*0.23*	4.13	*0.45*	7.43	*0.24*	8.62	*0.62*
AGE /100	0.66	*0.19*	0.36	*0.33*	1.09	*0.18*	0.67	*0.32*
$AGE^2/10^4$	-5.88	*0.75*	-6.25	*1.32*	0.80	*0.76*	1.07	*1.31*
COHORT /100	0.06	*0.20*	-0.34	*0.36*	0.84	*0.19*	0.34	*0.34*
$COHORT^2/10^4$	1.46	*0.70*	2.07	*1.24*	0.33	*0.71*	0.33	*1.21*
$COHORT^3/10^5$	1.74	*0.29*	1.95	*0.52*	1.95	*0.28*	1.86	*0.51*
MARRIED	0.13	*0.01*	0.11	*0.01*	-0.05	*0.01*	-0.04	*0.01*
COHABITATING	0.08	*0.01*	0.09	*0.02*	0.02	*0.01*	0.03	*0.02*
NONWHITE	-0.18	*0.02*	-0.15	*0.03*	0.02	*0.02*	0.01	*0.03*
HEALTH	-0.14	*0.01*	-0.15	*0.02*	-0.11	*0.01*	-0.09	*0.02*
UNION	0.14	*0.00*	0.13	*0.01*	0.21	*0.00*	0.20	*0.02*
Yrs of Schooling*AGE /100	0.22	*0.03*	0.22	*0.07*	-0.01	*0.04*	0.04	*0.07*
Yrs of Schooling *$AGE^2/10^2$	-0.43	*0.19*	-0.27	*0.39*	-0.96	*0.20*	-1.45	*0.37*
Yrs of Schooling *COHORT/100	0.19	*0.04*	0.17	*0.08*	0.03	*0.04*	0.08	*0.08*
Yrs of Schooling *$COHORT^2/10^3$	-0.15	*0.17*	-0.46	*0.37*	-0.08	*0.19*	0.29	*0.34*
Yrs of Schooling *$COHORT^3/10^4$	-0.48	*0.07*	-0.32	*0.15*	-0.76	*0.08*	-0.68	*0.15*
Yrs of Schooling *MARRIED/100	0.53	*0.16*	1.24	*0.39*	0.50	*0.16*	0.37	*0.30*
Yrs of Schooling *COHAB/100	0.02	*0.24*	-0.09	*0.48*	-0.04	*0.25*	-0.16	*0.43*
Yrs of Schooling *NONWHITE/100	-2.45	*0.27*	-3.82	*0.59*	-3.88	*0.30*	-4.07	*0.66*
Yrs of Schooling *HEALTH/100	-0.31	*0.26*	0.31	*0.54*	-0.32	*0.27*	-0.86	*0.52*
Yrs of Schooling *UNION/100	1.90	*0.11*	1.95	*0.22*	1.01	*0.12*	0.58	*0.37*
Dispersion - θ	-		4.22	*0.42*	-		3.37	*0.34*
Sample Size	76,722		76,722		81,508		81,508	
R^2	0.22				0.27			

Note: regressions also include controls for region and year of sample.

Figure 1: Year-on-Year Estimates of the Return to Schooling for Men: OLS and RC

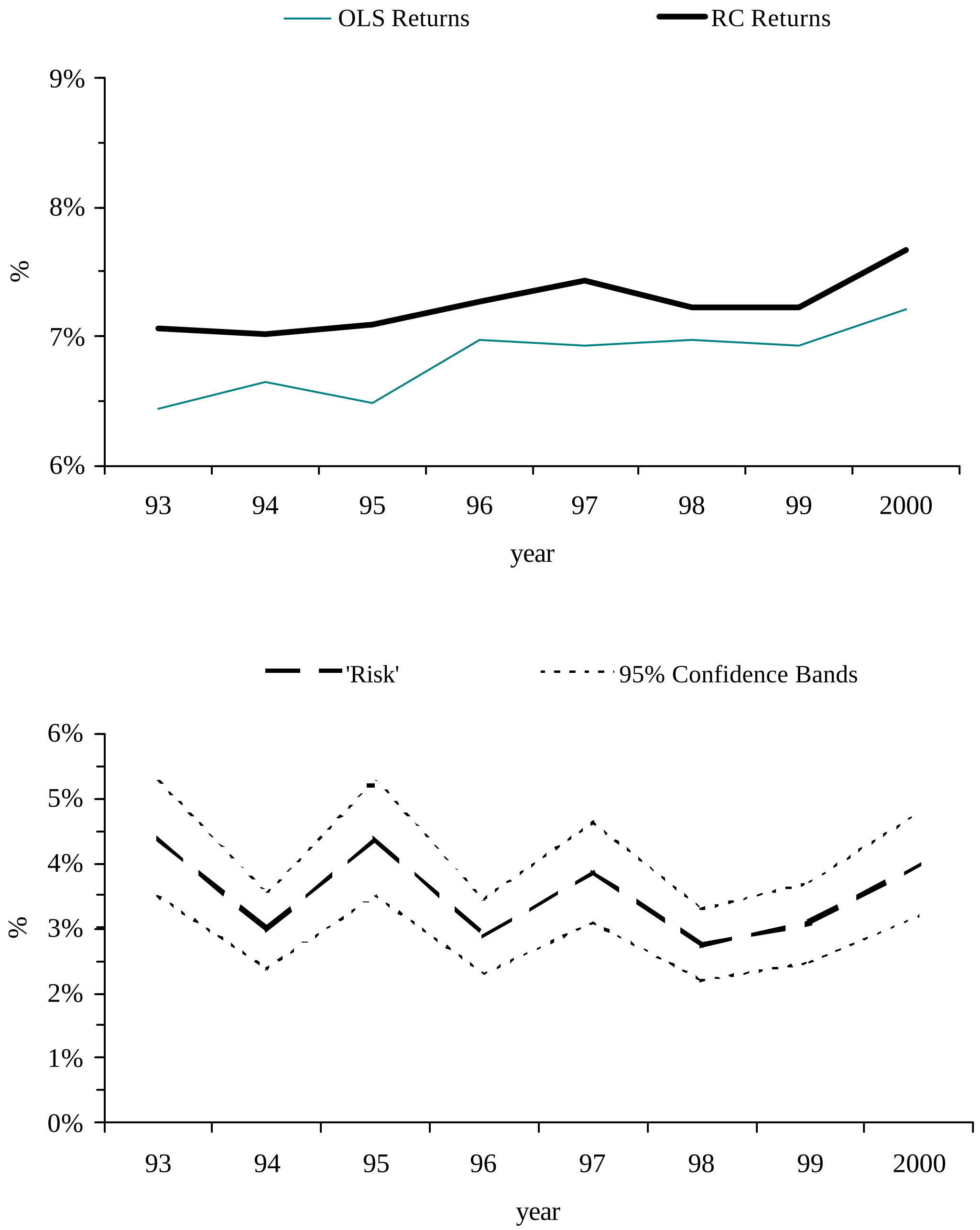
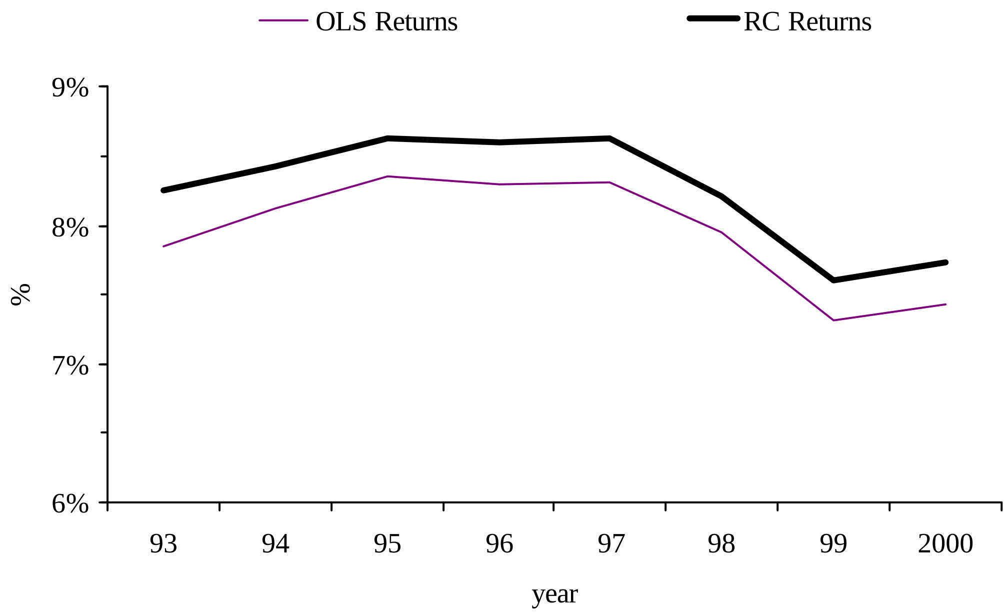
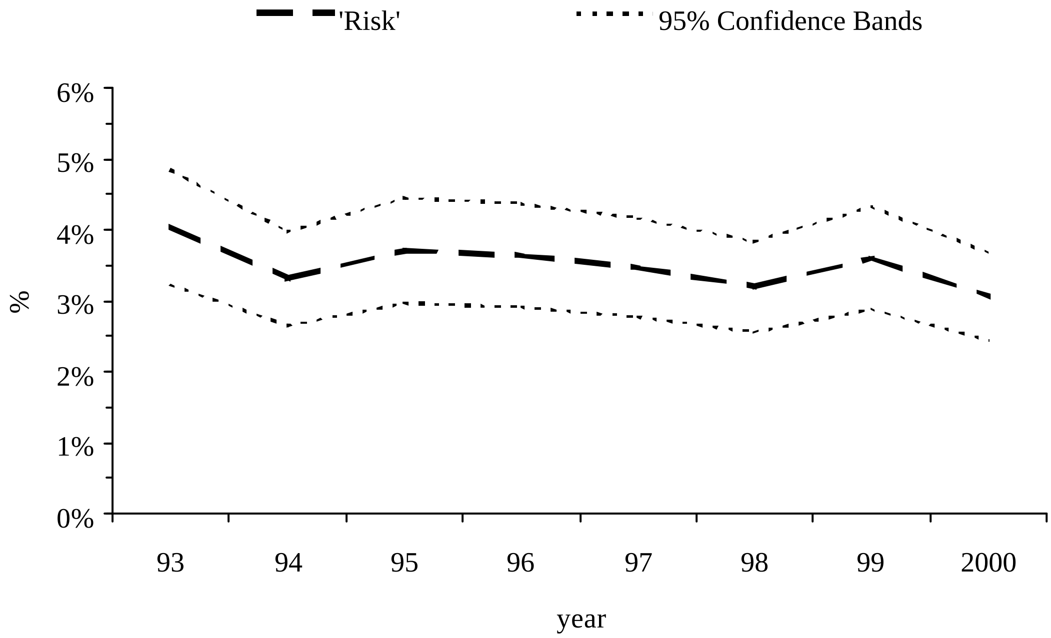


Figure 2: Year-on-Year Estimates of the Return to Schooling for Women: OLS and RC





4. Conclusion

This paper is motivated by the concern that examination of the mean return to schooling may overlook important information about the nature of the returns. For example, expansion of participation in post-compulsory schooling might result not just in a reduction in the mean return to schooling but it may also lead to a longer tail of low return individuals.

Alternatively if the expansion in post-compulsory education comes about through relaxed credit constraints then we might expect this to increase average ability in the pool of educated workers.

We use a sample of data from the United Kingdom whose educational system has undergone a prolonged period of expansion beginning in the mid-to-late 1960's.[5] Our estimates suggest that neither the mean nor the dispersion in returns to schooling has altered significantly over time. This is consistent with the expansion not leading to a disproportionate inflow of low ability individuals into the educational system.

[5] For details on the educational reforms in the UK see Harmon and Walker (1999) and the detailed analysis in Office of National Statistics (2001).

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