

Wagner, Joachim; Lorenz, Wilhelm

Working Paper

An International Comparison of the Rates of Return to Human Capital: Evidence from Five Countries

LIS Working Paper Series, No. 23

Provided in Cooperation with:

Luxembourg Income Study (LIS)

Suggested Citation: Wagner, Joachim; Lorenz, Wilhelm (1988) : An International Comparison of the Rates of Return to Human Capital: Evidence from Five Countries, LIS Working Paper Series, No. 23, Luxembourg Income Study (LIS), Luxembourg

This Version is available at:

<https://hdl.handle.net/10419/160695>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

Luxembourg Income Study Working Paper Series

Working Paper No. 23

An International Comparison of the Rates of Return to
Human Capital: Evidence from Five Countries

Joachim Wagner and Wilhelm Lorenz

November 1988

(scanned copy)



An International Comparison of the Rates of Return to Human Capital: Evidence from Five Countries

by

Joachim Wagner and Wilhelm Lorenz, University of Hannover

(November, 1988)

Abstract: Age-earnings profiles and rates of return to schooling are compared for male full-time workers from five countries (Australia, Canada, Federal Republic of Germany, Israel, Netherlands). The analysis is based on identically specified human capital earnings functions of the Mincer Type, estimated from large sets of micro data which are part of the Luxembourg Income Study (LIS) data bank.

Acknowledgements: Parts of the computations were done while J. Wagner participated in the LIS Summer Workshop 1988, and he thanks the Hannoversche Hochschulgemeinschaft for financial support.

Authors' Address:

Dr. Joachim Wagner & Dr. Wilhelm Lorenz
Universität Hannover
Institut für Quantitative Wirtschaftsforschung
Wunstorfer Str. 14
D - 3000 Hannover 91

1. Introduction

It is a truism, that "(i)n all economies of which we have knowledge, people with more education earn on average higher incomes than people with less education, at least if the people being compared are of the same age." (Blaug 1970, 1) Human capital earnings functions of the type proposed by Mincer (1974) with the log of earnings as endogenous variable and years of schooling, years of experience, and years of experience squared as exogenous variables are a standard tool in econometric studies of the rates of return to schooling and experience. Willis (1986, 526) labeled this function "one of the great success stories of modern labor economics. It has been used in hundreds of studies using data from virtually every historical period and country for which suitable data exist".

Though earnings functions are very popular, there seem to be only a few attempts to compare the resulting estimates of rates of return across countries. Besides the authoritative surveys by Psacharopoulos (1973, 1975, 1981, 1985) the pioneering study by Carnoy (1967) for Chile, Colombia, and Mexico, and Venezuela, the collection of some results for the US, India, and Mexico in the textbook by Blaug (1970, 224), and the comparison of age-earnings profiles for Japan, Sweden, and the US by Klevmarken (1982) are to be mentioned. All these studies suffer from a number of short-comings because the comparisons are based on results collected from earnings functions with different specifications, using data for different years and from differently defined samples. To quote an expert: "International comparisons are notoriously known for non-comparability between classifications, definitions, number of years of schooling and the like." (Psacharopoulos 1975, 162)

The only study we are aware of that tries to overcome, at least partly, the shortcomings mentioned is Hagenaars (1986). She estimated earnings functions for men and women, based on surveys conducted in 1979 with nearly identical questionnaires in eight European countries. The focus of her study, however, is on poverty. Therefore, the dependent variable is defined as after-tax monetary income, including asset income, holiday allowances, bonuses, and other extra income, which is a concept not very well suited for an investigation of the returns to schooling in a human capital framework. Furthermore, the way the schooling variable is defined by transformation via a "normalization" procedure assuming normality of the distribution of education is rather unusual and leads to results which cannot be interpreted easily. The ways this schooling variable enters the earnings functions differs considerably between countries and, therefore, straightforward comparisons of the rates of return are impossible (cf. Hagenaars 1986, 195 for a few remarks).

In this paper we present a first attempt of an international comparison of the rates of return to human capital based on identically specified earnings functions for male full-time workers from five countries (Australia, Canada, Federal Republic of Germany, Israel, Netherlands). The model and the data are described in section 2, the results of the earnings functions estimated and tested are given in section 3. In section 4 and section 5 we compare age-earnings profiles and rates of return to schooling between countries, respectively. Section 6 summarizes our findings, points out some caveats, and hints at future research.

2. Model specification and data

Following Mincer (1974, 83 ff.) a human capital earnings function is usually specified as

$$\ln(y) = b_0 + b_1 \cdot s + b_2 \cdot e + b_3 \cdot e^2 \quad (1)$$

where $\ln(y)$ = log of earnings, s = years of schooling, and e = years of experience. In most cases the schooling variable is calculated by taking the years needed on average to get the degree of education reported in the questionnaire, and experience is calculated as age minus schooling minus six if the years of experience are not reported exactly. The model given in (1) is often augmented to control for, e.g., tenure, firm-size, and hometime (i.e. years not working).

The samples our estimations are based on are part of the Luxembourg Income Study (LIS) data bank (cf. Smeeding/Rainwater/Buhmann/Schmaus 1987 and Rainwater/Smeeding 1988), and, therefore, the model specification to be applied here is in part limited by the informations available therein. Earnings are (log of) gross annual wage and salary income, measured in the currency of the country an individual lives in. The schooling variable is coded as follows: a dummy variable for medium education (i.e. at least ten years of schooling and no academic education), and a dummy variable for academic education, using low education (i.e. one to nine years of schooling) as the reference group. This rather crude form of mapping 'schooling' was preferred to a 'cardinal' representation using the number of years in the way described above due to the huge differences of the systems of education between the countries included in our study. Using only the three categories mentioned we surely lose some information, but we hope that we gain something

as regards international comparability. Years of experience are not reported in the samples, the experience variable, therefore, is computed as potential experience, i.e. age minus schooling minus six, using nine years of schooling for low education, ten for medium education, and fifteen for academic. This calculation is in some way arbitrary, but experience shows that the results of estimations of earnings functions seem to be not very sensitive to slightly differing ways of computing years of potential experience.¹

Informations on tenure, firm-size and hometime are not available.² The earnings function used here, therefore, is specified as

$$\ln(y) = b_0 + b_1 \cdot \text{MEDEDUC} + b_2 \cdot \text{ACAEDUC} + b_3 \cdot \text{EXPPOT} + b_4 \cdot \text{EXPPOT}^2 \quad (2)$$

where $\ln(y)$ = log of gross annual wage and salary income, MEDEDUC is a dummy variable for 'at least ten years of schooling and not academic education' (medium education), ACAEDUC is a dummy variable for academic education, and EXPPOT means years of potential experience computed as stated above.

1 Those who doubt are reminded that the LIS data bank is open for any academic user - we invite replication!

2 Missing informations on tenure and hometime are one main reason why this study considers only men - the other reason is the problem of sample selection bias. The reader interested in an international comparison of earnings functions for women based on LIS data is referred to ongoing research by Shelly Phillips from Dalhousie University, Halifax, Nova Scotia, Canada.

3. Earnings functions for male full-time workers

The earnings function given in (2) was estimated by ordinary least squares (OLS) for full-time working men from the LIS samples for Australia, Canada, Germany, Israel, and the Netherlands.³

In an earlier study (cf. Wagner/Lorenz 1988) based on five samples from Germany it was tested whether the assumptions of the classical linear regression model are fulfilled for the wage equations estimated, i.e., whether the errors of the model are normally distributed and homoscedastic, and the functional form is specified correctly. The null hypotheses of normal distribution, homoscedasticity, and correct specification were nearly always rejected. To check whether these results are due to particularities of the German labor market (e.g. regulations or segmentation) or whether they can be found in other countries, too, the estimated models are submitted to a number of tests.⁴

The results of the OLS estimations for the earnings functions are given in Table 1, the means of the variables included are reported in Table 2.

All estimated coefficients show the theoretically expected signs which are statistically highly significant if tests are based on the t-values reported. The economic interpretation of the estimations is given in the next sections, here we will concentrate on the results of various model specification test:

3 The LIS data bank included microdata sets from ten countries in July 1988, but for only five of them the schooling variable was given in an appropriate form.

4 The rest of this section summarizes the findings reported in Wagner (1988).

Table 1: Earnings functions for Male Full-time Blue and White Collar Workers in five Countries
Endogenous Variable: log of annual gross wage and salary income

Country Year of Data	Australia (1982/82)	Canada (1981)	Federal Republic of Germany (1981)	Israel (1979)	Nether- lands (1983)
Medium Education (Dummy)	$\hat{\beta}$.152 $ t $ 11.79** ATV 11.90**	$\hat{\beta}$.164 $ t $ 11.09** ATV 10.72**	$\hat{\beta}$.324 $ t $ 15.08** ATV 15.44**	$\hat{\beta}$.370 $ t $ 11.87** ATV 11.79**	$\hat{\beta}$.311 $ t $ 19.55** ATV 19.53**
Academic Education (Dummy)	$\hat{\beta}$.471 $ t $ 22.32** ATV 19.84**	$\hat{\beta}$.472 $ t $ 21.93** ATV 20.00**	$\hat{\beta}$.426 $ t $ 4.11** ATV 5.76**	$\hat{\beta}$.721 $ t $ 18.68** ATV 19.46**	$\hat{\beta}$.687 $ t $ 24.18** ATV 21.84**
Potential Experience	$\hat{\beta}$.0446 $ t $ 21.92** ATV 16.77**	$\hat{\beta}$.0402 $ t $ 17.92** ATV 16.05**	$\hat{\beta}$.0440 $ t $ 8.83** ATV 7.48**	$\hat{\beta}$.0367 $ t $ 6.92** ATV 5.60**	$\hat{\beta}$.0453 $ t $ 13.14** ATV 12.63**
(Potential Experience) ²	$\hat{\beta}$ -.000767 $ t $ 19.04** ATV 14.10**	$\hat{\beta}$ -.000705 $ t $ 16.89** ATV 14.33**	$\hat{\beta}$ -.000792 $ t $ 8.48** ATV 6.98**	$\hat{\beta}$ -.000584 $ t $ 6.07** ATV 4.81**	$\hat{\beta}$ -.000692 $ t $ 10.43** ATV 9.74**
Constant	$\hat{\beta}$ 9.015 $ t $ 377.78** ATV 306.89**	$\hat{\beta}$ 9.354 $ t $ 317.77** ATV 301.51**	$\hat{\beta}$ 9.881 $ t $ 159.42** ATV 140.58**	$\hat{\beta}$ 9.339 $ t $ 132.84** ATV 113.99**	$\hat{\beta}$ 9.898 $ t $ 236.65** ATV 236.88**
R ² N of cases	.113 7577	.115 5588	.173 1464	.243 1143	.324 1892

Note: $\hat{\beta}$ = estimated regression coefficient
 $|t|$ = absolute t-value [(**) = significant for $\alpha = 0.05$ (0.01)]
 ATV = Heteroscedasticity-consistent t-value (White 1980)

Source: Own calculations using LIS data bank; for a description of variables and data see text.

Table 2: Means of Variables included in the Earnings Functions reported in Table 1

Variable \ Country Year of Data	Australia (1982/82)	Canada (1981)	Federal Republic of Germany (1981)	Israel (1979)	Nether- lands (1983)
Annual gross wage and salary income	17282.35	23425.39	39939.49	28599.16	47754.30
log of annual gross wage and salary income	9.650	9.954	10.519	10.135	10.698
Low education (Dummy)	.348	.334	.666	.307	.470
Medium education (Dummy)	.546	.527	.324	.473	.445
Academic education (Dummy)	.106	.139	.010	.220	.085
Years of potential experience	22.266	23.566	25.892	23.990	22.751
(Years of potential experience) ²	640.682	707.783	769.615	716.427	618.965

Note: For a definition of samples and variables see text.

Source: Own calculations using LIS data bank.

In checking these models we first tested the hypothesis of normality of errors using a test statistic derived by Jarque and Bera (1980).⁵ The results reported in Table 3 show that the null-hypothesis is rejected for all countries but Israel.

⁵ For details as regards the tests used see the original papers cited and the textbook by Krämer and Sonnberger (1986).

Table 3: Results of Tests for Earnings Functions for Male Full-time Blue and White Collar Workers in five Countries

Country Year of Data	Australia (1982/82)	Canada (1981)	Federal Republic of Germany (1981)	Israel (1979)	Nether- lands (1983)
TEST					
NORMALITY OF ERRORS Jarque-Bera Test	R	R	R		R
HOMOSCEDASTICITY OF ERRORS Breusch-Pagan-Test (studentized version) <u>Test Variables:</u> Medium Education Academic Education Years of potential Experience (Years of potential Experience) ² All four exogenous variables		[R]			
	[R]	R	[R]		R
		R	R		[R]
	R	R			
RESET <u>Test Variables:</u> Powers 3 and 4 of years of potential experience Powers 2 and 3 of fitted y-values					
	R	R	R	R	R
	[R]				R

Note: R [R] indicates that the test rejects the null-hypothesis for $\alpha = 0.01$ [0.05]

Source: Own calculations using LIS data bank,; for description of the models see Table 1, for tests see text.

A closer inspection of the residuals reveals that large standardized residuals are nearly exclusively found for cases belonging to either the highest one percent or the lowest two percent of the wage distribution. It was not possible to apply a robust estimation method (e.g. least absolute deviations) at LIS, but adding dummies

for 'highest 1%' and 'lowest 2%' did not change the results drastically, though the null hypothesis is rejected for the augmented models, too.

As the next step the hypothesis of homoscedasticity of errors was tested with the Breusch-Pagan-test (Breusch and Pagan 1979) using as test variables each exogenous variable and all of them, and applying a 'studentized' version of the test developed by Koenker (1981) because of the rejection of the hypothesis of normally distributed errors reported above. As can be seen from the results given in Table 2 only for Israel the null hypothesis of homoscedastic errors cannot be rejected on a five percent level of significance. Instead of estimating the unknown variances of errors and applying estimated generalized least squares we computed heteroscedasticity-consistent t-values (ATV) using the method of White (1980) to correct for the bias in the estimation of variances of the coefficients in the models estimated by OLS. A comparison of the t-values and the ATV reported in Table 1 does not reveal any difference large enough to come to a different conclusion as regards the statistical significance of the estimated coefficients. Therefore, heteroscedasticity of errors seems to be no sound reason to abandon the conclusions based on human capital earnings functions estimated by OLS.

The final step of diagnostic checking consists of testing the hypothesis of a correctly specified functional form.

Here the regression specification error test (RESET) by Ramsey (1969) is applied in a form suggested by Thursby and Schmidt (1977) using as test variables either powers three and four of years of potential experience or the second and third powers of the fitted endogenous variable. As can be seen from Table 2 all models are rejected by at least one version of RESET even at the one percent le-

vel of significance. Therefore, the specification used seems not to be a correct one. RESET, however, is not a constructive test in the sense that hints towards a correctly specified model are given.

The numerous rejections of the null hypotheses of the models based on data from Australia, Canada, Germany, and the Netherlands, raise the question whether earnings functions of the type used here (and, slightly modified in one way or another, in hundreds of studies all over the world) are based on solid econometric grounds. To repeat two of the caveats mentioned in our earlier study, each of the tests applied, however, may not be insensitive to the failure of assumptions different from the one it is designed for to test against. Furthermore, many questions regarding multiple testing of a model are still open today from a theoretical point of view, and, therefore, a prob value for the joint test conducted in applying different tests to each of the models cannot be given (cf. Krämer and Sonnberger (1986, 147 ff.)).

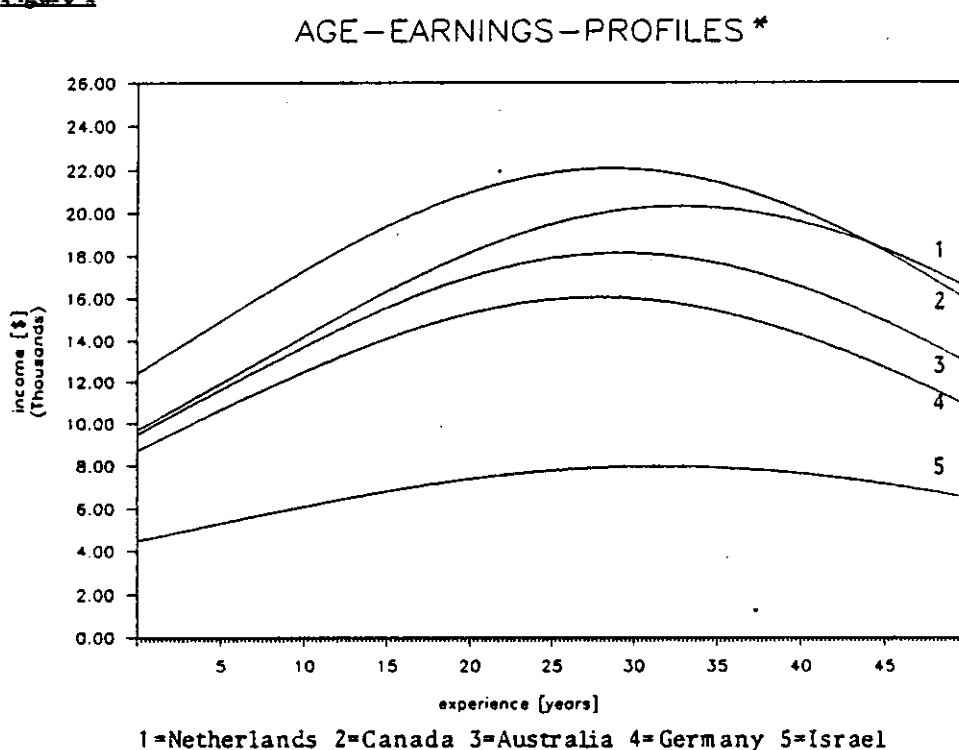
To sum up, the rejections of the null hypotheses stated when applying OLS to estimate an earnings function seem to be not due to particularities of the labor market in one or more countries. It is strongly suggested, therefore, to draw conclusions based on wage equations only carefully and in a tentative way.

4. Age-earnings-profiles for five countries

The standard argument to include an age- or experience variable in the earnings function is provided by human capital theory. During the working life individual's actual earnings - which have to be carefully distinguished from earnings capacity - are affected by two opposite effects. The first is a depreciation of the accumulated

human capital stock which may be due to technical progress and causes a reduction of actual earnings as well as earnings capacity, *ceteris paribus*. The second effect can be attributed to post schooling investments in human capital in the form of learning-by-doing or training on the job. While those investments increase the earnings capacity observable earnings are lowered relatively to the working time devoted to training (cf. Addison/Siebert 1979, 122-130).

Figure 1



* The calculations are based on the values given in Table 1 and Table 2. The US-Dollar equivalents of the earnings were calculated using purchasing power parities for private consumption reported in OECD National Accounts Main Aggregates 1960 - 1983 for Australia, Canada, Germany, and the Netherlands. For Israel an exchange rate given in United Nations Statistical Yearbook 1979/80 was used.

Postschool investments in human capital are highest at the beginning of the working career and diminish when people get older, because the amortization pe-

riod shortens and opportunity costs of investments in form of forgone earnings increase with the accumulated human capital. Together with the depreciation effect the timing of post school investments explains the typical inversely u-shaped age-earnings-profiles which are plotted for the five countries in Figure 1.

Beside human capital theory alternative interpretations of the observed correlation between experience and earnings may be found in the segmented labor market theory, in the theory of implicit contracts or in efficiency wage models. Eventually age - and thereby, at least in the case of male workers, experience - may simply be a proxy for such income relevant characteristics as health, labor market attachment, or the motivation to work. But whatever the correct theoretical explanation may be, empirically "three striking characteristics" have proved to be true:

- "1. All profiles, irrespective of the years of schooling or level of education attained, increase with age up to a maximum point somewhere after the age of forty and then level off, or in some cases even decline.
2. The higher the educational attainment, the steeper the rise in earnings throughout the early phases of working life and usually, although not invariably, the higher the starting salary.
3. The higher the educational attainment, the later the year at which maximum earnings are reached and the higher retirement earnings." (Blaug 1970, 27)

The first characteristic is substantiated by the profiles for all five countries in Figure 1 at a first glance. Moreover, all earnings maxima fall into the narrow range beginning with 28 years of experience for Germany and ending with 33 years for the Netherlands, i.e. highest earnings are realized at about an age of 45. On the other hand an assessment of the second and third characteristic on the basis of Figure 1

is not possible, because the distribution of educational levels within the samples is not clearly different between the five countries.

Following Hübler (1984, 5) we can employ a test on the equality of coefficients out of two regressions which are estimated from independent samples. The test statistic is given by

$$\frac{(\hat{\beta}_i - \hat{\beta}_j) / (\sigma_{\hat{\beta}_i}^2 + \sigma_{\hat{\beta}_j}^2)^{\frac{1}{2}}}{\hat{\beta}_i \hat{\beta}_j} \sim N(0,1) \quad (3)$$

In the upper triangle of Table 4 the computed statistics are shown for the coefficient of the experience variable. The critical value of this test statistic with an error level of 5% is 1.96. Therefore, the null hypothesis of equal coefficients could not be rejected in any of the ten possible comparisons between two of the five countries.

Table 4: Test for Homogeneity of Regression Coefficients

	E X P E R I E N C E				
	Australia	Canada	Fed. Rep. of Germany	Israel	Nether-lands
Australia	-	1.45	0.11	1.39	0.17
Canada	1.07	-	0.70	0.61	1.24
Fed. Rep. of Germany	0.25	0.85	-	1.00	0.21
Israel	1.75	1.15	1.55	-	1.36
Netherlands	0.97	0.16	0.87	0.92	-
(E X P E R I E N C E) ²					

Source: Own Calculations; see text for interpretation.

Since the same is also true for the coefficients of the quadratic experience variable (lower triangle of Table 4) we can conclude that in five economies for which we

estimated identically specified earnings functions age-earnings-profiles could not be shown to differ significantly: "Although investment in human capital is certainly not the only explanation for the shape of age-earnings-profiles, their relative stability indicates that this theory still gives a powerful explanation" (Klevmarken 1982, 551).

5. A comparison of the rates of return

As in the case of experience different theoretical explanations for the positive correlation between education and earnings can be found in the literature. The most popular is the Becker-Mincerian human capital theory (Becker, 1975; Mincer 1974) which postulates the chain relationship 'education - qualification - productivity - earnings'. Competing theories interpret the education system as a means of reproduction of social class structure (Bowles/Gintis 1976), or come from segmented labor market approaches (Thurow 1975), or drop the assumption of full information arguing that employers use formal schooling as a signal for workers' productivity in hiring decisions (Spence 1974). But which of these explanations may come closest to the truth, empirically "the positive association between education and earnings" belongs to "the few safe generalisations that one can make about labour markets" (Blaug 1974, 27).

In comparing the returns to education between the five countries our first step is again a pairwise test on the equality of regression coefficients. The results are presented in Table 5.

Table 5: Test for Homogeneity of Regression Coefficients

	M E D I U M E D U C A T I O N				
	Australia	Canada	Fed. Rep. of Germany	Israel	Netherlands
Australia	-	0.61	6.86	6.46	7.77
Canada	0.03	-	6.13	5.97	6.77
Fed. Rep. of Germany	0.43	0.43	-	1.22	0.48
Israel	5.68	5.63	2.67	-	1.69
Netherlands	6.10	6.03	2.43	0.71	-
A C A D E M I C E D U C A T I O N					

Source: Own Calculations; see text for interpretation.

Considering the coefficients of medium and academic level education together no significant differences can be found between Australia and Canada on the one hand and between Israel and the Netherlands on the other hand. Looking at Germany the coefficient of the academic education variable is not significantly different from those for Australia and Canada, while the coefficient of the medium education variable is similar to those of Israel and the Netherlands. In all, the educational variables seem to have a more differentiated influence on earnings between the countries than the experience variables.

Because education enters the earnings function (2) in dichotomous form, the estimated coefficients could not directly be interpreted as the percentage rise in earnings caused by medium or academic level education. Using the notation of formula (2) the percentage increase of academic compared to medium level education is given by (Halverson/Palmquist 1980)

$$r_{\text{academic, medium}} = 100 \cdot (\exp(b_2 - b_1) - 1) \quad (4)$$

The respective results for the five countries are presented in Table 6.

Table 6: Returns to Education

compared to	Percentage Rise in Earnings		
	medium low	academic low	academic medium education
Australia	16.4	60.2	37.6
Canada	17.8	60.3	36.1
Fed. Rep. of Germany	38.3	53.1	10.7
Israel	44.8	105.6	42.0
Netherlands	36.5	98.8	45.6

Source: Own Calculations; see text for interpretation.

The effects of education on income are varying widely between the countries. The percentage increase in income from medium and academic education is highest for Israel, and for this country about twice as high as for Australia and Canada. This is the only clear-cut result that can be drawn from Table 6. It is in accordance with the general pattern found by Psacharopoulos (1981, 326) that "returns to education in developing countries are higher relative to the corresponding returns in more advanced countries".⁶ On the other hand it is in contrast with a finding of Cohn (1979, 127) that "in Israel's egalitarian society high school graduates do not earn much more than primary school graduates".

That no further clear-cut results can be drawn from Table 6 may be a consequence of the rather crude specification of education by only three categories. But

⁶ In 1979 (year of the data set) per capita income in Israel amounted to 4150 US-dollar compared to 11 080 in Australia (1981/82), 11 400 in Canada (1981), 13 450 in the FRG (1981), and 9 850 in the Netherlands (1983); see World Bank, World Development Report, current issues.

this the price one has to pay for direct international comparability. The relatively low increase for academic education in the FRG may be a consequence of the underrepresentation of academic educated individuals in the German sample (see Table 2).

A comparison of the rates of return and human capital investments in diverse kinds of education within the countries is not possible on the basis of Table 6, because in general it requires more years from medium to academic educational level than from low to medium. For a calculation of the rate of return per year it is necessary to make assumptions about the average duration to reach an educational level.

In the following we assume these average duration to be 9 years for low, 12 years for medium, and 18 years for academic education. Because this is, of course, somewhat arbitrary we used respectively 7, 11, and 18 years to get an impression of the sensibility of the results on the assumptions. In the first case we calculated the return an investment per year of schooling for an individual at the age of 45, in the second case for an 37 year old individual. Since experience enters the earnings function in a nonlinear form specified as Age minus (6+ schooling) the relative increase g in earnings is not independent from experience. For academic compared to low education g is given by (Helberger 1988, 165)

$$\begin{aligned}
 1 + g &= \frac{\exp (b_0 + b_2 + b_3 E_a + b_4 E_a^2)}{\exp (b_0 + b_3 E_l + b_4 E_l^2)} \\
 &= \exp (b_2 + b_3 (E_a - E_l) + b_4 (E_a^2 - E_l^2))
 \end{aligned} \tag{5}$$

where E_a (E_l) denotes potential experience in the case of academic (low) education. In the example for a 45 year old individual E_a would be 21 ($= 45 - 18 - 6$), while for a low level educated individual of the same age potential experience E_l would be 30 ($45 - 9 - 6$).

The rate or return r per year of academic education (compared to low level education) is then found by

$$r = [\sqrt[n]{(1 + g)} - 1] \cdot 100 \quad (6)$$

where n is the difference in years required to achieve the educational levels, which are compared.

Table 7: Rates of Return to Education

	medium/ low	academic/ low	academic/ medium
Australia	7.55 (2.75)	7.24 (2.70)	7.08 (2.66)
Canada	7.87 (3.23)	7.18 (2.92)	6.84 (2.74)
Fed. Rep. of Germany	14.21 (7.45)	6.98 (2.43)	1.04 (-0.33)
Israel	14.73 (8.49)	9.50 (5.17)	6.97 (3.33)
Netherlands	12.59 (6.49)	9.10 (4.37)	7.39 (3.17)

Note: The rates are calculated for a 45 (37) year old individual; low education = 9 (7) years; medium education = 12 (11) years; academic education = 18 (18) years.

Source: Own Calculations; see text for interpretation.

As can be seen from Table 7 in each of the five countries the rate of return to medium education exceeds the rate to academic education. This may be due to the "law of diminishing returns", here in the form of "diminishing return to increments

in the quantity of schooling" (Blaug 1970, 231; see also Psacharopoulos 1973, 65). One can only speculate why the difference between the rates for medium and academic education is relatively low in Australia and Canada, while it is high in Israel, the FRG, and Canada.

6. Conclusions

The two main results of our study are, first, that age-earnings-profiles are of remarkable similar shape and, second, that there are diminishing returns to schooling in Australia, Canada, the FRG, Israel, and the Netherlands. We place more confidence in the first than in the second result for diverse reasons:

- Interested in homogeneous specifications for all countries we used a rather crude operationalisation of the education variable. But as a consequence of different education systems medium level education in Canada, for example, may be of a different quality than medium level education in Germany. On the other hand, problems of international comparability do not arise in the operationalization of the experience variable.
- Unobservable income relevant variables such as ability may be assumed to play a more crucial role in the estimation of returns to education than in the estimation of returns to experience.
- To find and test general patterns in the rate of return to investment between countries a data basis of only five countries is not sufficient.

Two general caveats for the interpretation of the estimated earnings functions have to be given. First, one may criticise the functional form, because none of the

five regressions passes the regression specification error test. Second, additional explanatory variables like tenure, firm size and industry or occupation are known to have an impact on earnings. Especially in the light of the today popular efficiency wage theory one may ask to take these variables into consideration.

The points just mentioned could be seen at the same time as hints for future research. The main difficulty in our opinion is to overcome the dilemma between equally specified regressions between the countries on the one hand and adequately specified regressions on the other hand.

References

- Addison, John T. and W. Stanley Siebert (1979), *The Market for Labor: An Analytical Treatment*, Santa Monica, California: Goodyear Publishing Company.
- Becker, Gary S. (1975), *Human Capital*, 2nd ed., Chicago, London: University of Chicago Press.
- Blaug, Mark (1970), *An Introduction to the Economics of Education*, Harmondsworth, Middlesex: Penguin.
- Blaug, Mark (1974), *Education and the Employment Problem in Developing Countries*, Geneva: International Labour Office.
- Breusch, T.S. and Adrian R. Pagan (1979), A Simple Test for Heteroscedasticity and Random Coefficient Variation, *Econometrica* 47, 1287-1294.
- Bowles, Samuel and Herbert Gintis (1976), *Schooling in Capitalist America*, New York: Basic Books.
- Carnoy, Martin (1967), Rates of Return to Schooling in Latin America, *Journal of Human Resources* II, 359-374.
- Hagenaars, Aldi J.M. (1986), *The Perception of Poverty*, Amsterdam etc.: North-Holland.
- Halverson, Robert and Raymond Palmquist (1980), The Interpretation of Dummy Variables in Semilogarithmic Equations, *American Economic Review* 70, 474-475.
- Helberger, Christof (1988), Eine Überprüfung der Linearitätsannahme der Humankapitaltheorie, Hans-Joachim Bodenhöfer (ed.), *Bildung, Beruf, Arbeitsmarkt*, Berlin: Duncker und Humblot, 151 - 170.

- Jarque, Carlos M. and Anil K. Bera (1980), Efficient Tests for Normality, Homoscedasticity and Serial Independence of Regression Residuals, *Economics Letters* 6, 255-259.
- Klevmarken, N. Anders (1982), On the Stability of the Age-Earnings Profiles. *Scandinavian Journal of Economics*, 84, 531-554.
- Koenker, Roger (1981), A Note on Studentizing a Test for Heteroscedasticity, *Journal of Econometrics* 17, 107-112.
- Krämer, Walter and Harald Sonnberger (1986), *The Linear Regression Model under Test*, Würzburg/Wien, Physica.
- Mincer, Jacob (1974), *Schooling, Experience, and Earnings*, New York, London: Columbia University Press.
- Psacharopoulos, George (1973), *Returns to Education. An International Comparison*, San Francisco/Washington: Elsevier.
- Psacharopoulos, George (1975), *Earnings and Education in OECD Countries*, Paris: OECD.
- Psacharopoulos, George (1981), Returns to Education: An Updated International Comparison, *Comparative Education* 17, 321-341.
- Psacharopoulos, George (1985), Returns to Education: A Further International Update and Implications, *Journal of Human Resources* XX, 583-604.
- Rainwater, Lee and Timothy M. Smeeding (1988), The Luxembourg Income Study: The Use of International Telecommunications in Comparative Social Research, *Annals of the American Academy of Political and Social Science* 495, 95-106.

- Smeeding, Timothy M. and Lee Rainwater, Brigitte Buhmann, Günther Schmaus (1987), Luxembourg Income Study (LIS): Information Guide, LIS-CEPS Working Paper No. 7.
- Spence, Michael (1974), Market Signalling, Cambridge: Harvard University Press.
- Thurow, Lester C. (1975), Generating Inequality, London, Basingstoke: Macmillan.
- Thursby, Jerry G. and Peter Schmidt (1977), Some Properties of Tests for Specification Error in a Linear Regression Model, *Journal of the American Statistical Association* 72, 635-641.
- Wagner, Joachim and Wilhelm Lorenz (1988), The Earnings Function under Test, *Economics Letters* 27, 95-99.
- Wagner, Joachim (1988), Earnings Functions under Test: Evidence from Five Countries, LIS-CEPS Working Paper No. 22.
- White, Halbert (1980), A Heteroscedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroscedasticity, *Econometrica* 48, 817-838.
- Willis, Robert J. (1986), Wage Determinants: A Survey and Reinterpretation of Human Capital Earnings Functions, in: O. Ashenfelter and R. Layard (ed.), *Handbook of Labor Economics*, Vol. I, Amsterdam etc.: North-Holland, 525-602.

Table 1: Earnings functions for Male Full-time Blue and White Collar Workers in five Countries
Endogenous Variable: log of annual gross wage and salary income

Country Year of Data	Australia (1982/82)	Canada (1981)	Federal Republic of Germany (1981)	Israel (1979)	Netherlands (1983)
Medium Education (Dummy)	$\hat{\beta}$.152 $ t $ 11.79** ATV 11.90**	$\hat{\beta}$.164 $ t $ 11.09** ATV 10.72**	$\hat{\beta}$.324 $ t $ 15.08** ATV 15.44**	$\hat{\beta}$.370 $ t $ 11.87** ATV 11.79**	$\hat{\beta}$.311 $ t $ 19.55** ATV 19.53**
Academic Education (Dummy)	$\hat{\beta}$.471 $ t $ 22.32** ATV 19.84**	$\hat{\beta}$.472 $ t $ 21.93** ATV 20.00**	$\hat{\beta}$.426 $ t $ 4.11** ATV 5.76**	$\hat{\beta}$.721 $ t $ 18.68** ATV 19.46**	$\hat{\beta}$.687 $ t $ 24.18** ATV 21.84**
Potential Experience	$\hat{\beta}$.0446 $ t $ 21.92** ATV 16.77**	$\hat{\beta}$.0402 $ t $ 17.92** ATV 16.05**	$\hat{\beta}$.0440 $ t $ 8.83** ATV 7.48**	$\hat{\beta}$.0367 $ t $ 6.92** ATV 5.60**	$\hat{\beta}$.0453 $ t $ 13.14** ATV 12.63**
(Potential Experience) ²	$\hat{\beta}$ -.000767 $ t $ 19.04** ATV 14.10**	$\hat{\beta}$ -.000705 $ t $ 16.89** ATV 14.33**	$\hat{\beta}$ -.000792 $ t $ 8.48** ATV 6.98**	$\hat{\beta}$ -.000584 $ t $ 6.07** ATV 4.81**	$\hat{\beta}$ -.000692 $ t $ 10.43** ATV 9.74**
Constant	$\hat{\beta}$ 9.015 $ t $ 377.78** ATV 306.89**	$\hat{\beta}$ 9.354 $ t $ 317.77** ATV 301.51**	$\hat{\beta}$ 9.881 $ t $ 159.42** ATV 140.58**	$\hat{\beta}$ 9.339 $ t $ 132.84** ATV 113.99**	$\hat{\beta}$ 9.898 $ t $ 236.65** ATV 236.88**
R ²	.113	.115	.173	.243	.324
N of cases	7577	5588	1464	1143	1892

Note: $\hat{\beta}$ = estimated regression coefficient
 $|t|$ = absolute t-value [*(**) = significant for $\alpha = 0.05$ (0.01)]
ATV = Heteroscedasticity-consistent t-value (White 1980)

Source: Own calculations using LIS data bank; for a description of variables and data see text.

Table 2: Means of Variables included in the Earnings Functions reported in Table 1

Variable \ Country Year of Data	Australia (1982/82)	Canada (1981)	Federal Republic of Germany (1981)	Israel (1979)	Nether- lands (1983)
Annual gross wage and salary income	17282.35	23425.39	39939.49	28599.16	47754.30
log of annual gross wage and salary income	9.650	9.954	10.519	10.135	10.698
Low education (Dummy)	.348	.334	.666	.307	.470
Medium education (Dummy)	.546	.527	.324	.473	.445
Academic education (Dummy)	.106	.139	.010	.220	.085
Years of potential experience	22.266	23.566	25.892	23.990	22.751
(Years of potential experience) ^a	640.682	707.783	769.615	716.427	618.965

Note: For a definition of samples and variables see text.

Source: Own calculations using LIS data bank.

Table 3: Results of Tests for Earnings Functions for Male Full-time Blue and White Collar Workers in five Countries

TEST \ Country Year of Data	Australia (1982/82)	Canada (1981)	Federal Republic of Germany (1981)	Israel (1979)	Nether- lands (1983)
NORMALITY OF ERRORS Jarque-Bera Test	R	R	R		R
HOMOSCEDASTICITY OF ERRORS Breusch-Pagan-Test (studentized version) <u>Test Variables:</u> Medium Education Academic Education Years of potential Experience (Years of potential Experience) ¹ All four exogenous variables	 [R] R	 [R] R R R	 [R] R	 	 R [R]
RESET <u>Test Variables:</u> Powers 3 and 4 of years of potential experience Powers 2 and 3 of fitted y-values	 R [R]	 R 	 R 	 R 	 R R

Note: R [R] indicates that the test rejects the null-hypothesis for $\alpha = 0.01$ [0.05]

Source: Own calculations using LIS data bank,; for description of the models see table 1, for tests see text.

Table 4: Test for Homogeneity of Regression Coefficients

	E X P E R I E N C E				
	Australia	Canada	Fed. Rep. of Germany	Israel	Nether- lands
Australia	-	1.45	0.11	1.39	0.17
Canada	1.07	-	0.70	0.61	1.24
Fed. Rep. of Germany	0.25	0.85	-	1.00	0.21
Israel	1.75	1.15	1.55	-	1.36
Netherlands	0.97	0.16	0.87	0.92	-
(E X P E R I E N C E) ²					

Source: Own Calculations; see text for interpretation.

Table 5: Test for Homogeneity of Regression Coefficients

	M E D I U M E D U C A T I O N				
	Australia	Canada	Fed. Rep. of Germany	Israel	Nether- lands
Australia	-	0.61	6.86	6.46	7.77
Canada	0.03	-	6.13	5.97	6.77
Fed. Rep. of Germany	0.43	0.43	-	1.22	0.48
Israel	5.68	5.63	2.67	-	1.69
Netherlands	6.10	6.03	2.43	0.71	-
A C A D E M I C E D U C A T I O N					

Source: Own Calculations; see text for interpretation.

Table 6: Returns to Education

compared to	Percentage Rise in Earnings		
	medium low	academic low	academic medium education
Australia	16.4	60.2	37.6
Canada	17.8	60.3	36.1
Fed. Rep. of Germany	38.3	53.1	10.7
Israel	44.8	105.6	42.0
Netherlands	36.5	98.8	45.6

Source: Own Calculations; see text for interpretation.

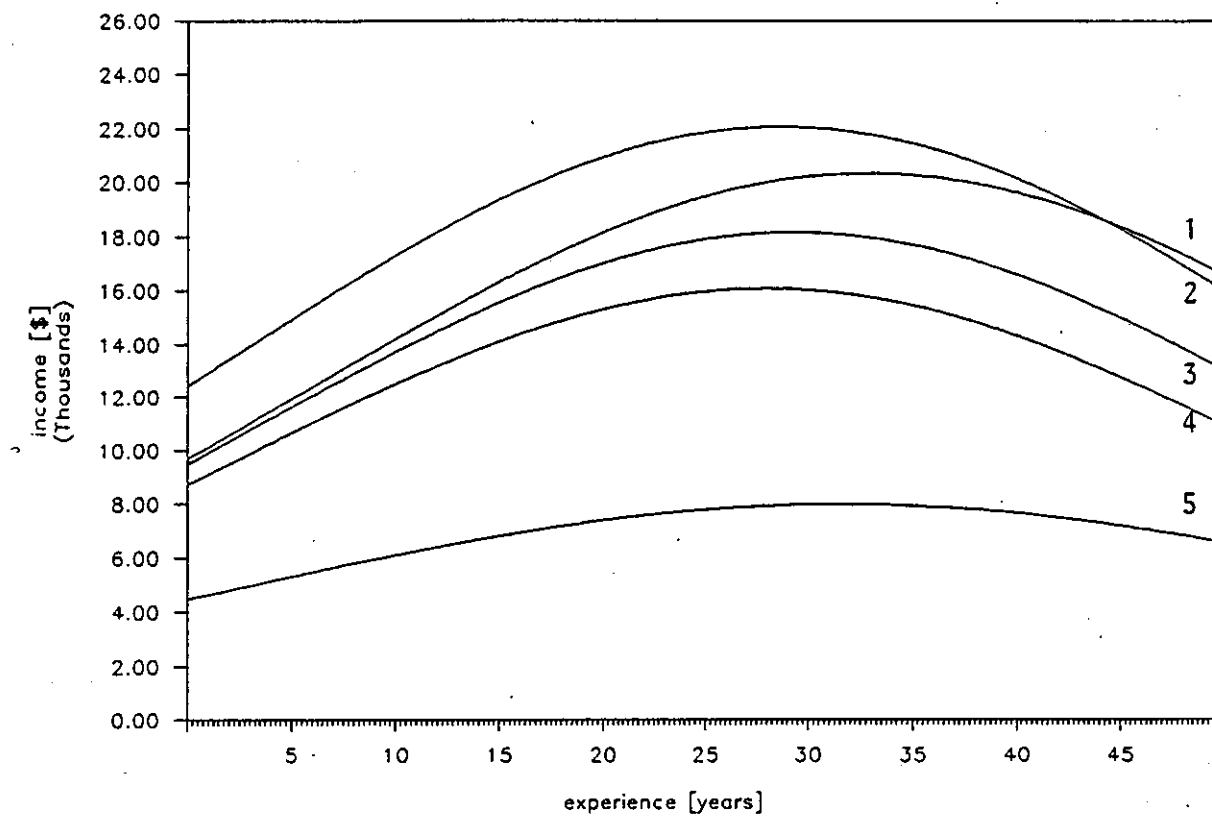
Table 7: Rates of Return to Education

	medium/ low	academic/ low	academic/ medium
Australia	7.55 (2.75)	7.24 (2.70)	7.08 (2.66)
Canada	7.87 (3.23)	7.18 (2.92)	6.84 (2.74)
Fed. Rep. of Germany	14.21 (7.45)	6.98 (2.43)	1.04 (-0.33)
Israel	14.73 (8.49)	9.50 (5.17)	6.97 (3.33)
Netherlands	12.59 (6.49)	9.10 (4.37)	7.39 (3.17)

Note: The rates are calculated for a 45 (37) year old individual; low education = 9 (7) years; medium education = 12 (11) years; academic education = 18 (18) years.

Source: Own Calculations; see text for interpretation.

AGE-EARNINGS-PROFILES*



1=Netherlands 2=Canada 3=Australia 4=Germany 5=Israel