CHAPTER 3

Wages and Human Capital: The Danish Evidence

Jens Jakob Christensen

&

Niels Westergård-Nielsen

Centre for Labour Market and Social Research,
University of Århus, Denmark
jjc@cls.dk nwn@cls.dk

1 Introduction to the research

The purpose of this introduction is partly to provide an introductory and formal presentation of the studies reviewed in this paper, and partly to outline the objective of each study. The studies reviewed are: Asplund et al. (1996a), Asplund et al. (1996b), Pedersen et al. (1990), Smith and Westergård-Nielsen (1988), and Bingley and Westergård-Nielsen (1997). The first two studies are part of a cross-country comparison of the Nordic countries[1], whereas the last three solely analyze the Danish labour market. The unit of observation for all studies is the individual, and the theoretical approaches are, in a broad sense, all based on various and augmented specifications of the standard human capital earnings function as proposed by Mincer (1974).[2] However, the objectives of the studies differ to some extent. Thus, where Asplund et al. (1996a) focus on the wage distribution (due to experience, education, occupation, etc.) across individuals in general, the target of Asplund et al. (1996b) along with Smith and Westergård-Nielsen (1988) is the wage differentials due to gender alone. Likewise, Pedersen et al. (1990) specifically focus on wage differentials between individuals employed in the private and public sectors. Finally, the objective of Bingley and Westergård-Nielsen (1997) is to estimate the size of demand induced firm wage determinants, while accounting for individual worker supply wage determinants. Primarily due to the fact that the results obtained in Asplund et al. (1996a), Asplund et al. (1996b), and Bingley and Westergård-Nielsen (1997) are based on the most recent data, there is reason to put emphasis on the empirical findings of these three studies.

2 Data

Table 1 provides a survey of the data sets used in the five studies. Common to the studies is partly that the estimations are based on

---

1 *The Nordic Labour Markets in the 1990's*, edited by E. Wadensjö (1996).

2 $\ln W = \beta_0 + \beta_1 \cdot S + \beta_2 \cdot EXP + \beta_3 \cdot EXP^2 + \varepsilon$. The specific definitions of the wage variable (W), the schooling variable (S), and the experience variable (EXP) emerge from Section 3.

data drawn from administrative registers (which ensures a high degree of accuracy and reliability), and partly that the samples are relatively large. Four out of the five studies are based on DLDB (*Danish Longitudinal DataBase*), which is a representative 1% sample of the population; i.e. of individuals aged 16 – 75.[3] The study by Bingley and Westergård-Nielsen (1997) is, however, based on a sample of IDA (*Integrated DataBase for Labour Market Research*), which contains information on *all* private sector establishments (app. 230,000) *and* the entire population of individuals in Denmark (app. 5,2 million).

Table 1. Data sets used

STUDY	DATA
Asplund et al. (1996a)	DLDB (*Danish Longitudinal DataBase*). Representative 1% sample of the population in the age group 16-75 covering the years 1976 to 1990 (around 30,000 – 40,000 observations each year). All information is drawn from administrative registers and is provided by Statistics Denmark. In this specific study, estimations are based on the 1990 observations of individuals in the age group 16-64 (around 22,000 observations).
Asplund et al. (1996b)	As in Asplund et al. (1996a).
Smith and Westergård-Nielsen (1988)	Sub-sample of DLDB (see above). Consists of 6,536 individuals observed, on average, over 6,16 years.
Pedersen, Schmidt-Sørensen, Smith, and Westergård-Nielsen (1990)	Sub-sample of DLDB (se above). Consists of 5,557 individuals observed, on average, over 7,95 years.
Bingley and Westergård-Nielsen (1997)	IDA (*Integrated DataBase for Labour Market Research*). Created by Statistics Denmark. IDA contains information on labour market conditions for the total population of individuals and establishments in Denmark over the years 1980-1991. The information originates from various administrative registers and is merged by Statistics Denmark. A representative sub-sample containing information on 1,400 private sector firms and all of their employees over 11 years is used in this specific study.

[3] Today, DLDB is officially called LLMR (*Longitudinal Labour Market Register*).

3 Variables

According to Table 2, which summarizes the variables included, both human capital variables as well as several other variables (in order to control for geographical factors, firm specific factors, worker specific factors, etc.) are used in the estimations of the five studies reviewed. As opposed to most human capital studies conducted in other countries, the variables *Age* and *Log working hours* are not included in any estimations of the wage function. *Age* is not included due to the access of rather accurate work experience data provided in the registers of the supplementary pension system (ATP), and *Log working hours* is not a relevant explanatory variable, since *Wage* (hourly) is calculated directly from the annual wage and the amount of hours worked in a year (also provided in the registers of ATP). In addition, it should be stressed that the dependent variable in all studies is *Log (gross) hourly wage*, i.e. the hourly wage rate *before* taxes. Due to the relatively small size of the Danish labour market, a dummy for *Province,* which takes the value of 1 when the wage earner lives outside the Greater Copenhagen area, is replacing the variable *Region*. The *Occupation* variable distinguishes between *Salaried employees* (upper, intermediate, and assistant), *Skilled workers*, *Unskilled workers*, and *Other workers*. The schooling variable is generally measured by the length (in years) of the highest attained vocational training and formal education beyond basic school (9 years), but Asplund et al. (1996a) also estimate the wage function using *levels* of education.[4]

As indicated above, the access to relatively accurate register data has allowed the use of *Actual experience* at the expense of *Potential experience / Mincer experience* (Age – S – school starting age). Consequently, *all* estimations are based on *Actual experience.* Finally, three out of five studies include variables to correct for selection bias (see notes in Table 2). The method used is Heckman's correction (Heckman, 1979).

---

[4] This approach can be used to evaluate whether the relationship between years of schooling and log wage is in fact linear (as in the Mincer approach).

Table 2. Applied research on return to education in Denmark: Variables included[a]

	Asplund et al. (1996a)[b]	Asplund et al. (1996b)[b]	Smith and Westergård-Nielsen (1988)	Pedersen et al. (1990)	Bingley and Westergård-Nielsen (1997)
Education (years)	x	x	x	x	x
Education (level)	x	-	-	-	-
Experience[h]	x	x	x	x	x
Experience squared	x	x	x	x	x
Tenure/seniority	x	-	-	-	x[g]
Occupation[c]	x	x	x	x	-
Sector (public/ private)	x	x	x	x	-
Firm size	-	-	-	-	x
Region	-	x	x	x	x
Sector (industry)	-	x	x	-	x
Other	-	x	x	x	x
Select. bias correc.	-	x[d]	x[e]	x[f]	-

Notes: [a] Not necessarily in the same estimation at the same time. All estimations use gross hourly wage.

[b] Part of a Nordic cross-country comparison (The Nordic Labour Markets in the 1990´s. Edited by E. Wadensjö, 1996).

[c] Occupation (Upper level sal. emp., Intermediate sal. emp., Assistant sal. emp., Skilled workers, Unskilled workers, and Other).

[d] Correction due to the exclusion of non-participants in the labour market.

[e] Correction for censoring due to confidentiality regarding wages higher than DKK 200,000 (1976-1980), DKK 220,000 (1981-1984).

[f] Correction due to individuals who work less than full time *and* correction for censoring due to confidentiality regarding wages higher than DKK 200,000 (only 1976-1980).

[g] Newcomers (Tenure proxy).

[h] Measured/actual experience.

4 Estimation techniques and central results

Even though all studies are, more or less, based on standard OLS estimations, there are a few exceptions depending on the specific

aim of each study.[5] The intention of this subsection is to briefly describe the estimation techniques used in the studies, and to report the central results (summarized in Tables 3, 4, 5, 6, and 7) along with comments on the most striking similarities and dissimilarities. First and foremost, we focus on the "core variables" of the Standard Mincer specification, i.e. *Schooling* (years), *Experience*, and *Experience squared*. In addition to these core variables, some comments will be attached to the empirical findings in terms of returns to *Levels of education* and addition of variables to control for firm and worker specific factors (4.2).

4.1 Returns to education (years) and experience

The overall (restricted) 1990 cross-section OLS estimates of returns to education and experience in Asplund et al. (1996a) are 0.045 and 0.017, respectively (Tables 3 and 4), and the return to experience is clearly bell-shaped (Table 5), i.e. the coefficient of experience squared is negative (-0.00023). However, for ease of exposition we have chosen only to report the linear experience term, i.e. the return to an individual at the time of entry into the labour market. The squared experience term of each estimation appears from Table 5.[6] An OLS estimation run separately for men and women (unrestricted) leads to rather different estimates, both in terms of returns to education and returns to experience. Thus, the returns to education and experience for men are 0.051 and 0.025, respectively, whereas the same coefficients for women are 0.034

---

[5] In order to avoid any likely correlation between schooling and the unobserved effects from ability and motivation, Pedersen et al. (1990) only report returns to schooling based on instrumental variable estimation. Note that when using OLS, it is implicitly assumed that the error term (ε) of the regression equation (see footnote 2) is independent and normally distributed with fixed variance σ^2.

[6] Due to the log specification, the coefficients (when multiplied by 100) approximately equal the percentage returns. Thus, $100(e^{(coefficient)} - 1)$ = percentage return. Furthermore, the correct calculation of returns to experience is taking the squared term into account. Thus, the marginal return to experience for a person with 10 years of experience (EXP=10) in Asplund et al. (1996a) is $0.017 - 2*0.00023*EXP = 0.012$, corresponding to a percentage return of $100(e^{0.012}-1) = 1.21\%$. Consequently, Table 4 gives the estimated return to experience for a person with no experience (EXP=0), i.e. the squared term has not been taken into account.

Table 3. Wage equations: Returns to education (years)

STUDY	YEAR	SECTOR	Coefficient[b]		
			Female	Male	All
Asplund, Barth, Le Grand, Mastekaasa, Westergård-Nielsen (1996)	1990	*Public* & *private*	0.0342	0.0508	0.0449
		Public	0.0356	0.0503	-
		Private	0.0387	0.0591	-
Asplund, Barth, Smith, Wadensjö (1996)[c]	1990	*Public* & *private*	0.0240	0.0360	-
Smith and Westergård-Nielsen (1988)	1976-1984	*Public* & *private*	-	-	0.0260
Pedersen, Schmidt-Sørensen, Smith, Westergård-Nielsen (1990)[a]	1976-1985	*Public*	0.0190	0.0595	-
		Private	[-0.0030]	0.0422	-
Bingley and Westergård-Nielsen (1997)[c]	1981-1991	*Private*	0.0238	0.0345	-

Notes: The numbers in brackets are not significant at any reasonable level. [a] Instrumental variable (IV) estimates. [b] See footnote 6. [c] Estimated returns from a model which includes several control variables.

Table 4. Wage equations: Experience (years)

STUDY	YEAR	SECTOR/ OCCUPATION	Coefficient[a]		
			Female	Male	All
Asplund, Barth, Le Grand, Mastekaasa, Westergård-Nielsen (1996)	1990	*Public* & *private*	0.0089	0.0247	0.0167
		Public	0.0003	0.0129	-
		Private	0.0173	0.0281	-
Asplund, Barth, Smith, Wadensjö (1996)	1990	*Public* & *private*	0.0110	0.0180	-
Smith and Westergård-Nielsen (1988)	1976-1984	*Salaried employee*	0.0030	0.0200	-
		Skilled	[-0.001]	0.0100	-
		Unskilled	-0.0100	[-0.001]	-
Pedersen, Schmidt-Sørensen, Smith, Westergård-Nielsen (1990)	1976-1985	*Public*	0.0029	0.0084	-
		Private	[0.0009]	0.0083	-
Bingley and Westergård-Nielsen (1997)	1981-1991	*Private*	0.0169	0.0205	-

Notes: The numbers in brackets are not significant at any reasonable level. [a] Instrumental variable (IV) estimates.

and 0.009, respectively. This apparent discrimination regarding returns to human capital is, as mentioned in the introduction, the main concern of Asplund et al. (1996b), where the conclusion is the same: The estimated returns to education and experience for men are 0.036 and 0.018 respectively, and for women 0.024 and 0.011, respectively (OLS estimations for 1990).

The gender specific returns to human capital variables have been analyzed in Smith and Westergård-Nielsen (1988) as well. Smith and Westergård-Nielsen (1988) do not estimate overall returns for males and females on average, but choose to estimate occupation specific returns (pooled cross-section OLS and fixed effects models), and the results are rather striking as concerns returns to experience (Table 4). Thus, the return to experience is generally (and significantly) lower than the equivalent estimates of the other studies. This is clearly illustrated by the extreme case of unskilled female workers whose return to experience is significantly negative.

In order to specifically investigate the wage differential between individuals in the public and private sectors, Pedersen et al. (1990) estimate gender and sector specific wage functions (pooled cross-section OLS and IV). The return to education (IV estimates) in the public sector is around 0.06 for men and 0.019 for women, which is more or less in accordance with the results obtained in other studies. However, according to Table 3, the estimate (IV) of the female return to education in the private sector is 0 (0.042 for men), which is quite remarkable. Likewise, the return to experience in Pedersen et al. (1990) is remarkably low, ranging from 0.001 to 0.008 (Table 4).

The estimated returns to both education and experience (pooled cross-section OLS & GLS, error-component model) in Bingley and Westergård-Nielsen (1997) also indicate some degree of discrimination, but not equivalently striking. The estimated male returns to education and experience are 0.035 and 0.021, respectively and for females 0.024 and 0.017, respectively (OLS estimates). Controlling for workplace and worker non-observables (GLS, error-component estimates) does not significantly alter the OLS estimated human capital coefficients, indicating that the specific choice of estimation technique is not critical to the basic findings concerning returns to education and experience.

Table 5. Wage equations: Experience² (years)

STUDY	YEAR	SECTOR/ OCCUPATION	Coefficient		
			Female	Male	All
Asplund, Barth, Le Grand, Mastekaasa, Westergård-Nielsen (1996)	1990	*Public* & *private*	-0.0001	-0.00045	-0.00023
		Public	0.00014	-0.00018	-
		Private	-0.00031	-0.0005	-
Asplund, Barth, Smith, Wadensjö (1996)	1990	*Public* & *private*	-0.0002	-0.00032	-
Smith and Westergård-Nielsen (1988)	1976-1984	*Salaried employee*	-0.00004	-0.00043	-
		Skilled	[0.00005]	-0.00028	-
		Unskilled	0.00020	[-0.00027]	-
Pedersen, Schmidt-Sørensen, Smith, Westergård-Nielsen (1990)	1976-1985	*Public*	0.0000049	-0.000049	-
		Private	0.000	-0.000091	-
Bingley and Westergård-Nielsen (1997)	1981-1991	*Private*	-0.00034	-0.00038	-

Note: The numbers in brackets are not significant at any reasonable level.

4.2 Returns to levels of education and addition of other variables

As outlined in Table 2, a variety of variables have been used in the estimation of the human capital wage function, but it is beyond the scope of this paper to comment on all of them. Instead, four topics have been picked for a brief elaboration; namely estimation based on *Levels of education* (4.2.1), controls for *Province* (4.2.2), returns to *Tenure* (4.2.3), and controls for *Occupation and Public sector employment* (4.2.4).

4.2.1 Levels of education[7]

According to Table 2 and Table 6, Asplund et al. (1996a) is the only study that reports returns to *Levels of education*. The four cate-

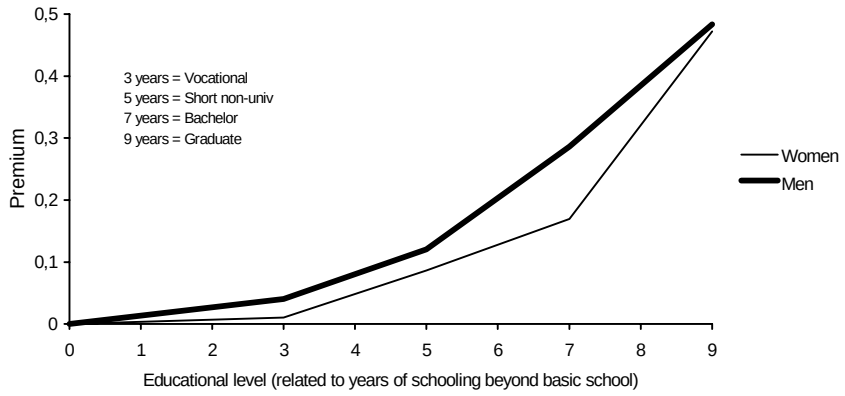
[7] The schooling variable in the regression equation (see footnote 2) is replaced by a dummy for each educational level (k in total) minus 1. Thus, $\ln W = \beta_0 + \beta_j \cdot Dummy_j + \varepsilon$, where $j = 1,...,k-1$. The omitted dummy (which can be chosen arbitrarily) is represented by the general intercept term of the regression equation (equivalent to including dummies for all educational levels and then run the regression without a general intercept term).

Table 6. Wage equations: Dummy variables for educational level (basic school omitted)

STUDY	YEAR	LEVEL	Coefficient[a]		
			Female	Male	All
Asplund, Barth, Le Grand, Mastekaasa, Westergård-Nielsen (1996)	1990	*Vocational*	0.0099	0.0402	0.0189
		Short non uni	0.0860	0.1200	0.1048
		Bachelor	0.1695	0.2863	0.2204
		Graduate	0.4725	0.4834	0.4758

Note: [a] Due to the log specification, the dummy coefficients (multiplied by 100) are approximately equal to the hourly wage rate %-premiums (referred to as returns) of each educational level compared to a basic school education (the omitted dummy). Proof: $\ln(w) = \beta_0 + \beta_j \cdot \text{dummy} \Rightarrow \beta_j = \Delta(\ln w) = \ln(1+\Delta w/w) = \ln(1+g) \cong g$, where g = rate of change. Regarding female bachelors for example, the real %-premium is thus $e^{(0.086)}-1 = 8.98$ %.

Figure 1. Returns to levels of education (premium compared to basic school = 9 years)



Note: Exact numbers are outlined in Table 6 above. The percentage premium equals $100(e^{(\text{premium})} - 1)$.

gories/dummies (basic school omitted) are, however, closely related to *years* of education (beyond basic school, 9 years). Thus, *Vocational* = 3 years, *Short non. uni.* = 5 years, *Bachelor* = 7 years, and *Graduate* = 9 years. When looking at Table 6 and Figure 1 (a graphical presentation of the returns in Table 6), it is obvious that returns are a positive *and* convex function of education (years & level). The convexity implies

that the incentive to move from one educational level to a higher one is present at all levels, and that the linear relationship of the human capital model might be inappropriate. Furthermore, it emerges from Figure 1 that male returns exceed female returns for each educational level – most significantly at the level *Bachelors* (7 years).

4.2.2 Province

Except for Asplund et al. (1996a), all the reviewed studies include a dummy for *Province* (1 if the individual lives outside the area of Greater Copenhagen), and the findings are rather similar; i.e., in all estimations (across time and study) the average disadvantage (discount) of living in the province in terms of wages is between 5% and 10% depending on gender.

4.2.3 Tenure

Though Bingley and Westergård-Nielsen (1997) use the variable *Newcomers* as a proxy, Asplund et al. (1996a) is the only study in which the wage effect of *Tenure* has been analyzed thoroughly. The returns are outlined in Table 7.[8] One main conclusion has been drawn by Asplund et al. (1996a): The return to *Tenure* is generally larger in the public sector than in the private sector – especially for men. This is partly explained by the fact that wages among public sector employees are regulated by relatively rigid pay scales and seniority based promotion patterns.

Table 7. Wage equations: Tenure

STUDY	YEAR	SECTOR	Coefficient[a]		
			Female	Male	All
Asplund, Barth, Le Grand, Mastekaasa, Westergård-Nielsen (1996)	1990	*All*	-	-	0.0034
		Private	0.0030	0.0041	-
		Public	0.0027	0.0052	-

Note: [a] See footnote 6.

[8] Since the reported returns to *Experience* (Table 4) and the reported returns to *Tenure* (Table 7) have been estimated separately, one should be careful to draw any conclusion regarding the relative effect of tenure and total experience on wages.

4.2.4 Controls for occupation and sector

According to the estimations carried out in Asplund et al. (1996a), there are two major effects of controlling for occupational status and public sector employment; the wage equation is significantly better explained, and the returns to schooling are, roughly speaking, halved (compare Table 8 with Table 3). On the other hand, returns to experience are apparently not sensitive to the addition of variables to control for occupation and sector. Furthermore, Table 8 reveals that public sector wages (on average) are lower than private sector wages, especially for men (around 11% on average).

Table 8. Wage equations: Returns to schooling, controls for occupation and public sector

STUDY	YEAR	VARIABLES	Coefficient[b]	
			Female	Male
Asplund, Barth, Le Grand, Mastekaasa, Westergård-Nielsen (1996)	1990	*Schooling*	0.0227	0.0294
		Experience	0.0106	0.0225
		Experience^2	–0.00016	–0.00043
		DUMMIES:[a]		
		High Salaried emp	0.2855	0.3262
		Medium Salaried emp	0.0544	0.1247
		Skilled worker	–0.0440	0.0136
		Unskilled worker	0.0084	0.0219
		Other	0.0360	0.0093
		Public	-0.0340	-0.1075

Notes: [a] Omitted occupational dummy is *Assistant salaried employees.*
[b] See note (a) of Table 6.

5 Conclusion

In accordance with the objective we have given a formal description of the Danish evidence in terms of returns to human capital variables (five studies in total). The five papers presented have been chosen for a review because of their comprehensive nature, and are thus not the only research which has been carried out

within the field of schooling and earnings. Furthermore the five papers share a common (and very attractive) feature: they are all based on large representative register based samples (DLDB (LLMR) & IDA).

Although the estimations use the same kind of data, the estimated returns differ quite significantly (due to different model specifications, addition of control variables, differences in terms of years covered, inclusion of variables to correct for selectivity bias, etc.). Nevertheless, reported female returns to schooling are found to be around 2 – 4%, and the male equivalent is around 5% (OLS). Based on the most recent findings, returns to schooling are higher in the private sector than in the public sector. As concerns returns to years of (actual) experience, the picture is more or less the same; male returns (around 2%) are higher than female returns (around 1%) and private sector returns exceed public sector returns. Throughout all estimations (roughly speaking) the earnings profile related to experience is found to be bell-shaped. Controlling for occupation and (less importantly) public sector employment significantly reduces returns to one additional year of schooling.

Basing the estimation on *levels of education* reveals a positive relationship between log wages and the level of education; i.e., moving from one educational level to a higher one is (on average) associated with higher hourly wage rates. In other words, there is a clear incentive to acquire formal skills in terms of the Danish labour market. The relationship between log wages and years of schooling is, however, not distinctively linear, but rather convex, implying that the linear specification might be inappropriate.

References

Asplund, R., Barth, E., le Grand, C., Mastekaasa, A. and Westergård-Nielsen, N. (1996a), Wage Distribution Across Individuals, in E. Wadensjö (ed.), *The Nordic Labour Markets in the 1990´s*. North-Holland, Amsterdam.

Asplund, R., Barth, E., Smith, N. and Wadensjö, E. (1996b), The Male-Female Wage Gap in the Nordic Countries, in E. Wadensjö (ed.), *The Nordic Labour Markets in the 1990´s*. North-Holland, Amsterdam.

Bingley, P. and Westergård-Nielsen, N. (1997), *Worker and establishment wages: Estimates from a multilevel model*. Centre for Labour Market and Social Research.

Heckman, J. (1979), Sample selection bias as a specification error, *Econometrica,* 47, pp. 153-161.

Mincer, J. (1974), *Schooling, Experience, and Earnings*. National Bureau of Economic Research, New York.

Pedersen, P.J., Schmidt-Sørensen, J.B., Smith, N. and Westergård-Nielsen, N. (1990), Wage differentials between the public and private sectors, *Journal of Public Economics,* 41, pp. 125-145.

Smith, N. and Westergård-Nielsen, N. (1988), Wage differentials due to gender, *Journal of Population Economics,* 1, pp. 115-130.

Wadensjö, E. (ed.) (1996), *The Nordic Labour Markets in the 1990´s*. North-Holland, Amsterdam.