Nontechnical summary

This paper analyses the extent to which gender differences in human capital contribute to explaining the observable wage differential in favour of men and its reduction since the mid-eighties among West German full-time employees in the private sector. A first descriptive overview showed that if women still have on average a lower level of education than men, educational expansion was stronger among women and there seems to be a convergence across genders in the qualification structure of the employees. At the same time, wage increases were stronger for women than for men, so that the overall gender wage gap has narrowed somewhat. The hypothesis that educational expansion - or that of human capital overall - has been stronger for women than for men and is therefore responsible for the diminution of the gender wage gap is examined here.

The analysis shows that investing in further education yields a positive return in terms of wages, and it appears that, at an equivalent education level, the wage outcome is higher for men than for women. At the same time, the return to labour market experience is higher for women than for men. Previous unemployment and non-employment have a negative impact on wages, somewhat stronger for women. Moreover, there is evidence for some occupational segregation of women into lower paid jobs which also explains the lower female wage level.

Based on a simple analytical framework, it is shown that if a large part of the gender wage gap can be attributed to the fact that women have a lower endowment in human capital than men, an equally large part stems from the fact that female human capital is less valued in terms of wages. Wage increases since the mid-eighties mainly reflect changes in the valuation of human capital rather than changes in human capital itself. The reduction in the gender wage gap stems mainly from a reduction in gender inequality with respect to the returns to human capital in terms of wage which favours women. Nevertheless, women improved their relative position regarding human capital endowment, but the overall lower valuation of human capital by the labour market reduces the benefit of this relative improvement.

The roles of the educational attainment, labour market experience and occupational factors were analysed specifically. The level of educational attainment explains a large part of the gender wage gap, mainly because women have a lower educational attainment than men but also because similar qualification levels yield lower returns for women. Taken alone, the developments related to education would have increased the gender wage gap significantly. This is because, if women did catch up in terms of educational attainment, the effect of this educational expansion was more than compensated by the fact that the returns to education dropped particularly markedly for women. Thus, the gender inequality in the returns to education has increased in favour of men. Changes related to labour market experience have a neutral influence on the gender wage gap. Women improved their relative position concerning their work experience, and this catch-up alone would explain some 60% of the reduction in the gender wage gap. At the same time, however, women have lost their relative advantage in the valuation of their work experience by the labour market. Part of the gender wage gap is attributable to occupational segregation of women into lower paid occupations. This wage disadvantage is strengthened by the fact that women working in typically female jobs have a stronger wage penalty than men who do so. The extent of occupational segregation has remained fairly stable, but the wage penalty for working in typically female jobs has increased over time. As a result, developments related to occupational segregation contribute to widening the gender wage gap.

Gender Wage Gap in West Germany: How Far Do Gender Differences in Human Capital Matter?

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Abstract: This paper analyses the extent to which gender differences in human capital contribute to explaining the observable wage differential in favour of men and its reduction since the mid-eighties among West German full-time employees in the private sector. Based on a simple analytical framework, the analysis shows that if a large part of the gender wage gap can be attributed to women's relative deficit with respect to human capital endowment, an equally large part stems from the fact that female human capital is less valued in terms of wages. The gender wage gap narrowing stems mainly from a reduction in gender inequality with respect to the returns to human capital in terms of wage which favours women. Nevertheless, women improved their relative position regarding human capital endowment, but the overall lower valuation of human capital by the labour market reduces the benefit of this relative improvement. The roles of the educational attainment, labour market experience and occupational factors were analysed specifically. The level of educational attainment explains a large part of the gender wage gap, mainly because women have a lower educational attainment than men but also because similar qualification levels yield lower returns for women. Taken alone, the developments related to education would have increased the gender wage gap significantly. This is because, if women did catch up in terms of educational attainment, the effect of this educational expansion was more than compensated by the fact that the returns to education dropped particularly markedly for women. Changes related to labour market experience have a neutral influence on the gender wage gap. Women improved their relative position concerning their work experience, but lose their advantage in the returns to work experience. Part of the gender wage gap is attributable to occupational segregation, i.e. female crowding into lower paid occupations. The extent of occupational segregation has remained fairly stable, but the wage penalty for working in typically female jobs has increased over time.

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1 Introduction

Like in most other industrialised countries, female workers earn, on average, substantially lower wages than male workers in West Germany. Moreover, the gender wage gap has only decreased at a very low path in the past decades in Germany. Although gender wage differentials have been the subject of a large volume of research internationally (e.g. Oaxaca 1973, Oaxaca and Ransom 1994, Sorenson 1989, Blau and Kahn 1996,1997), very few studies concentrate on the German case. Moreover, no clear evidence emerges from the research on the gender wage gap for Germany, since the few studies available differ basically with respect to the period of observation, to the method of analysis or to the sample chosen and lead thus to very different, hardly comparable results (see Gerlach 1987, Licht and Steiner 1991, Prey 1999, Lauer and Steiner 1999).

There may be several explanations to the gender wage gap. First, part of the gender wage gap may be due to the fact women do not possess to the same extent as men the skills desired and rewarded by employers. Hence, women may have lower wages because they have on average a lower educational attainment and a different type of education, or because they accumulate less human capital after leaving school if, for instance, they only work part-time or interrupt their working career to devote to family duties. On the other hand, the wage differential between men and women may result from the fact that even identical skills are not rewarded in the same way by employers. Both aspects can be attributed to different factors, like differing abilities and preferences, or discrimination. Indeed, women may decide to invest less in their human capital because they have lower abilities, which renders the investment more costly. Alternatively, they may have a preference for qualifications which are not well rewarded by the labour market (e.g. subject of studies). They may also invest less than men in their human capital because they anticipate a lower return in terms of wages or employment (e.g. because of discrimination, of tax incentives), or because they have other life priorities (time for children etc.). Similarly, there are many reasons why the reward of identical skills may differ for men and for women. Again, this may be the result of differing abilities (e.g. a lower commitment to their job), or of preferences which induce female-specific job choices (e.g. non-pecuniary compensations like flexible working time, or choice of the region), or caused by discrimination, i.e. an unjustified difference of treatment between men and women on the part of the employers. The latter could be reflected by the existence of some entry barriers for women to certain - higher - occupational positions or by wage discrimination at equivalent positions. This difference of treatment might signalise some sexist behaviour on the part of employers, but this may also be a reaction to the greater risk associated with female employees since these are more likely to quit their job for maternity reasons.

This paper focuses on the following question. To what extent is the average gender wage gap observable in West Germany among full-time employees in the private sector attributable to gender differences in human capital? In particular, is the slight reduction in the gender wage gap, which has taken place between the mid-1980s and the mid-1990s, attributable to the fact that women catch up with respect to their human capital? As a matter of facts, a common belief is that educational expansion has been stronger for women and is therefore responsible for the diminution of the gender wage gap. The veracity of this hypothesis will be examined here. Note that this paper does not have the ambition to disentangle the sources of gender wage inequality in terms of abilities, preferences or discrimination. Indeed, such an analysis would require precise information on choice motivations, preferences and abilities which are not available. Therefore, I rather concentrate on the disentangling of price from quantity effects. The paper proceeds as follows. The first part establishes the basic relationship between wages and human capital (section 2), based on

a brief descriptive overview and on the interpretation of some extension of Mincer's wage equations. The second part analyses the contribution of human capital variables to explaining the gender wage gap in the mid-1980s and in the mid-1990s, to explaining wages increases for both genders and finally to explaining the slight reduction in the gender wage gap between both periods (section 3).

2 Human capital as a determinant of wages

This empirical analysis is based on data from the German Socio-Economic Panel (GSOEP). This panel is a longitudinal household survey conducted on an annual basis since 1984. At the time of the study, 14 waves were available, from 1984 to 1997. The GSOEP contains micro-information on certain essential socio-economic characteristics such as earnings, working time, educational achievement, household structure and other variables relevant for individual labour market behaviour.

The sample observed here is restricted to native West German citizens because changes in the East German wage distribution after unification differ radically from the West German wage developments (see Franz and Steiner 1999) and because including foreigners educated abroad would introduce some bias due to differences in the educational systems. The self-employed have been excluded from the sample owing to the lack of consistent wage data, as well as people working in the public sector, in which wage determination is very specific (see Lauer and Steiner 2000). The study concentrates on active labour force aged between 20 and 60, military personnel and students or trainees being left aside. It concentrates on full-time employees, since the wage structure of part-timers differs from that of full-time workers, in particular with respect to the returns to education (see Lauer and Steiner 2000). Moreover, the quasi-absence of part-time workers among men renders any gender comparison difficult.

2.1 Descriptive overview

An essential component of the stock of human capital is the educational background. Table 1 shows the average qualification structure of the retained sample of West-German employees in two periods: 1984-87 and, ten years later, 1994-97[1].

Table 1: Qualification structure 1984-87 and 1994-97 (shares active labour force in %) – Full-time employees, private sector

	1984-87			1994-97		
	Men	Women	Men/women	Men	Women	Men/Women
No degree	0.5	0.4	1.3	0.7	0.7	1.1
Low or interm. school	11.1	24.5	0.5	9.0	16.0	0.6
Apprenticeship	65.9	61.0	1.1	58.2	63.6	0.9
Master	9.0	3.5	2.6	10.8	5.2	2.1
High school	0.3	1.1	0.3	1.0	1.0	0.9
High school+appr./master	3.7	5.6	0.7	5.8	6.5	0.9
Higher tech. college	5.0	1.3	4.0	6.5	2.5	2.7
University	4.6	2.6	1.8	8.0	4.5	1.8

Source: GSOEP 1984-97, own calculations.

The proportion of employees with no degree at all is close to zero. The great majority (about 70%) of full-time West-German employees holds a low or intermediate school degree (*Hauptschul-* or *Realschulabschluß*) assorted with an apprenticeship or a master craftsman degree or equivalent (*Meister*, *Fachschule*, *Beamtenausbildung*, *Gesundheitsausbildung*).

[1] See the figure describing the German education system in Annex 1.

Conversely, very few have a high school degree alone (*Abitur* or *Fachhochschulreife*). The bulk of high school leavers pursue their studies by completing an apprenticeship (particularly women) or higher education (particularly men). At the tertiary level, the majority of full-time employees has completed university or equivalent institutions rather than the more practically oriented and short-track higher technical colleges (*Fachhochschulen*), especially in the latest period. The proportion of tertiary level graduates has increased from about 8% to some 12.5% between 1984 and 1997[2]. Similarly, the proportion of high school graduates, especially those holding an additional vocational degree, as well as the share of master craftsmen has increased significantly, whereas lower qualified employees have become comparatively fewer. This points out a general shift of the qualification structure upwards over the period.

Gender differences in the qualification structure are illustrated by the relationship of the proportion of men holding a certain degree to that of women with the same degree. On the whole, women are less educated than men. More women have no vocational degree at all, and women are clearly underrepresented at the tertiary level. Interestingly, more women than men have a high school degree without tertiary level degree. However, the proportion of women with no vocational degree has decreased strongly in the ten years separating 1984-87 from 1994-97, above all in favour of vocational degrees, but also for tertiary level studies (particularly higher technical college). However, women largely remain underrepresented among tertiary level graduates as well as among master craftsmen. Overall, there seems to be a convergence in the qualification structure across genders: in the second period, the relationship of the male to the female proportion has become closer to 1 at all education levels. Thus, if there is a positive correlation between the level of qualification and wages, these developments in the qualification structure suggest that wages should also have converged during this period, all other things equal.

In Figure 1, the employees have been grouped into three broad educational categories:

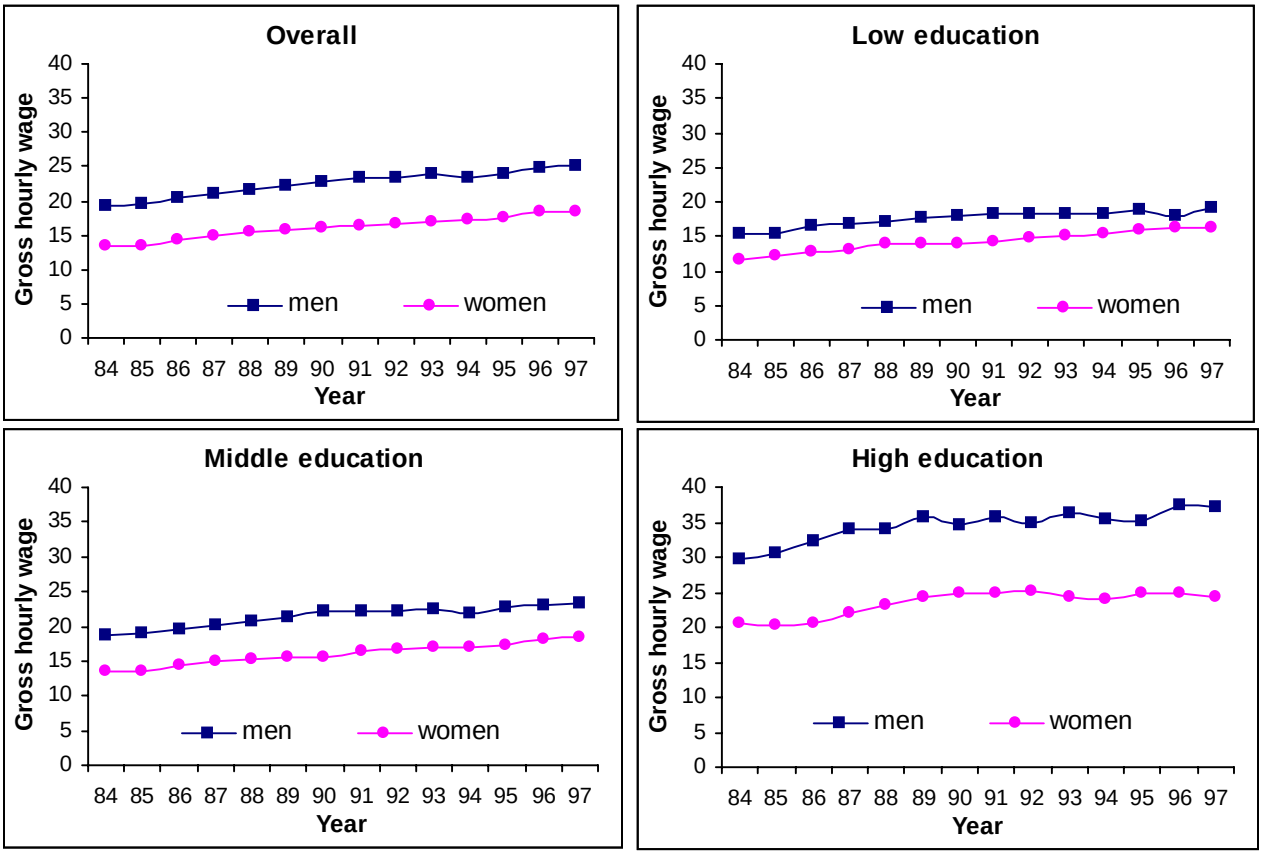
- Low education level ("low"): no degree or only a low or intermediate school degree.
- Intermediate education level ("middle"): apprenticehip, master, high school with or without apprenticeship/master.
- High education level ("high"): higher technical college or university.

The real gross hourly wage is obtained by dividing the monthly nominal gross wage in the month preceding the date of interview by the number of hours worked, and deflated by the consumer price index. As can be seen from Figure 1, the higher the education level is, the higher is the wage level. At all education levels, men have higher wages than women. The gender wage gap is larger at higher qualification levels, both in absolute and in relative terms, as shown in Table 2[3]. Hence, male tertiary graduates earn some 50% more than their female counterparts, while low educated men earn "only" around 17% more than women in the latest period. As is apparent from Figure 1, real gross hourly wages have developed in a quite parallel pattern for men and for women over the period. Table 2 shows that this corresponds to a somewhat stronger wage increase for women at all qualification levels, but particularly at lower qualification levels. The wage increase was stronger for the lower qualified, especially for women. As a result, the gender wage differential seems to have shrunk, especially at lower qualification levels.

[2] Since we observe full-time employees aged between 20 and 60 whereas the completion of a tertiary level degree takes place after 20 years of age, the lower diplomas are somewhat overrepresented in the sample. This should not be a real problem since the study focuses on changes over time and because the core analysis consists in the multivariate analysis, where age is controlled for.

[3] The pattern is different if employees from the public sector or part-time workers are also included (see Lauer and Steiner 2000).

Figure 1: Average real gross hourly wage by education level (DM) – Full-time employees, private sector



Source: GSOEP 1984-97, own calculations.

Table 2: Increase in real gross hourly wage and gender wage gap[1)] by education level 1984-87 and 1994-97 (%) – Full-time employees, private sector

		Low education	Middle education	High education	Overall
Wage increase (%)	Men	16.6	17.9	14.0	20.9
	Women	28.6	25.5	16.6	27.3
Gender wage gap (%)	1984-87	28.9	37.0	52.0	43.4
	1994-97	16.8	28.7	48.6	36.3

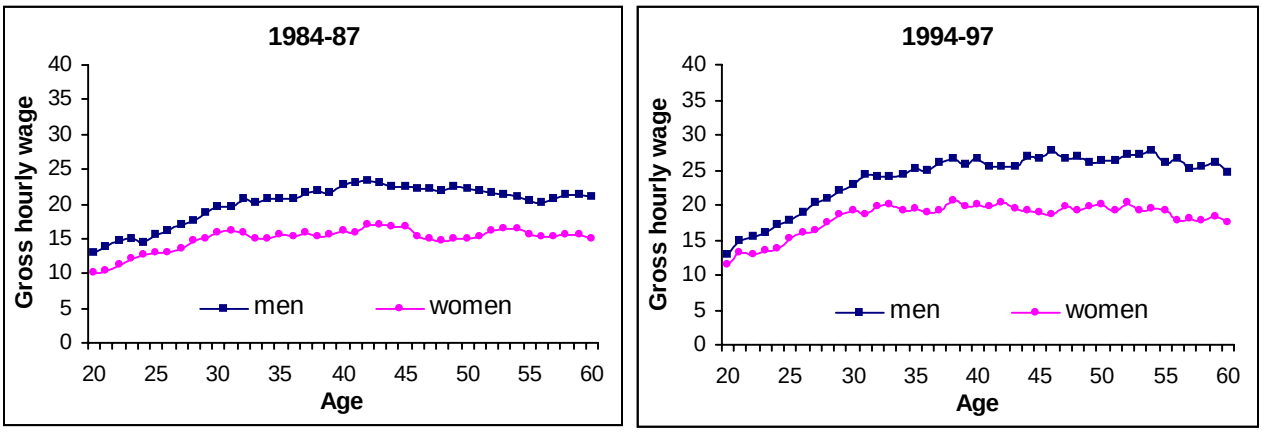
Source: GSOEP 1984-97, own calculations.
Note: 1) Difference between male and female wages as a percentage of female wages.

These figures tend to corroborate the view that education, especially higher education, is positively correlated to wages, i.e. yields a positive return in terms of wages. Hence, the changes in the relative distributions of human capital among male and female employees might have been at the origin of the reduction in the gender wage gap. However, the educational background is not the only factor influencing labour productivity and, hence, wages. For instance, older workers are expected to have higher wages, for a given education level, than younger workers, because they have more work experience. Figure 2 shows the pattern of wages over the life-cycle. A sort of concave shape can be observed: in a first stage, wages increase faster, then more slowly[4]. The turning point is earlier for women (around age

[4] The concavity of the curve is strengthened by the fact that at young ages, the more educated have not yet arrived on the labour market. When they start working, typically in their mid-twenties, the average wage level increases accordingly.

30 compared to age 40 for men). This is probably due to the fact that women traditionally interrupt their working career owing to family duties and have thus a slower advancement path. This implies that the wage premium for men becomes larger along with age. The pattern of life-cycle wages is similar in both periods, except that the initial wage increase seems to have become steeper in the most recent period. Furthermore, the gender wage gap at the end of the life-cycle is somewhat larger than in the first period.

Figure 2: Age-wage profiles by gender – Full-time employees, private sector



Source: GSOEP 1984-97, own calculations.

Of course, age only gives an imprecise idea of the amount of work experience, and some other factors than schooling or age are likely to affect the level of wages. The next section moves on to a more detailed analysis of the relationship between education and wages, which also controls for the influence of other possible determinants of wages. The aim is to analyse, in a further step (section 3), whether the changes in human capital or in the way it is valued by the labour market may explain the reduction in the gender wage gap.

2.2 Wage equations

The standard approach to estimate the nature of the relationship between education and wages dates back to Becker (1964) and Mincer (1974) and has its roots in the neoclassical theory. The basic assumption is that an individual's earnings reflect its labour productivity and that investment in human capital in the form of foregone earnings in the past pays off in terms of higher wages in the future (see Card (1999) for an extensive discussion of the human capital theory and its empirical implementation). Starting from this, Mincer developed a theoretical model from which he derived a wage equation, where wages (in logarithmic form) are explained by years of schooling and labour market experience (and its square). While the schooling variable proxies human capital acquired through formal education, labour market experience is a proxy for human capital acquired on-the-job. The estimated parameters can be interpreted as the returns to schooling and experience in terms of wages. Here, the basic Mincer's human capital model is extended and the wage equations are specified as follows:

$$\begin{aligned} \ln Y_m^t &= \beta_m^t X_m^t + \varepsilon_m^t \\ \ln Y_f^t &= \beta_f^t X_f^t + \varepsilon_f^t \end{aligned} \qquad (1)$$

with

Y = gross hourly wage
X = set of explanatory variables
β = parameters to estimate
ε = stochastic error term
m = males
f = females
t = time index

2.2.1 Definition of the variables

The dependent variable is real gross hourly wage. Several possibilities offered themselves with respect to the construction of this variable. First, annual labour earnings of the previous year could have been the reference for calculating hourly wages. This would have had the advantage that special payments like a 13th month's salary or bonus payments, which are part of one's labour income, could have been incorporated. However, if the GSOEP does provide retrospective information about the number of months the person was employed in the previous year as well as about the average monthly wage perceived in that year, there is no data about the number of hours worked in the previous year, but only for the current position. Therefore, it would have been necessary to reduce the sample to those persons who have not changed jobs since the previous year. Such an a priori restriction would have reduced dramatically the size of the sample and, on top of that, introduced a bias since the sample of individuals not having changed jobs is unlikely to be representative of all employees. Hence, I preferred to base the calculation of hourly wages on the monthly wage obtained in the month preceding the date of the interview and divide it by the number of hours worked in that month. Since data was available about regular working time and overtime hours last month, it would have been possible to include overtime hours in this measure, in so far as the latter are paid. However, a series of factors argue against this approach. First, it is not clear what to do with individuals claiming that overtime is partly paid, partly compensated for in terms of leisure. Second, overtime hours worked in one month are not necessarily paid in the same month. Third, the data on paid overtime is missing for a certain number of years. Since a main point of interest are the developments over time, it seems preferable to have a consistent definition of working hours over time. Finally, this paper is interested in the valuation of human capital attributes by the labour market in terms of wages, and since working contracts are generally based on regular working time, it makes sense to take the latter into account and not to count overtime.

The typical Mincer wage function was somewhat extended, since not only the basic human capital variables – schooling and labour market experience – have been used. Years of schooling are quite a rough measure of educational achievement. Estimating the return to years of schooling in the wage equation implicitly suggests that one additional year of schooling, whatever the current level of education is, yields the same return. This may not be the case if, for instance, completed degrees rather than years of schooling as such are valued in the labour market. Here, a more qualitative measure of educational attainment is preferred and, instead of using years of schooling as an explanatory variable, a set of mutually exclusive dummy variables is included, which describes the highest completed educational or vocational degree. The same categories as in the descriptive overview are used. The reference group consists of individuals without any degree or with only a low or intermediate school degree (*Hauptschul-* or *Realschulabschluß*). Holders of high school degree, with or without an additional vocational degree, have been grouped together. Hence, six educational dummies were constructed, and five of them are included in the wage equation, the last one being the reference group relative to which the coefficients are to be interpreted.

As previously mentioned, the accumulation of human capital on the labour market is also expected to affect individuals' wages. In order to account for this, the vector of explanatory variables includes a certain number of variables related to labour market experience. Traditionally, potential experience, measured as age minus years of schooling minus school starting age (6 years), as well as its squared, is used and gives a sort of maximum measure for work experience given the education level. The number of years of schooling can be computed by attaching a typical number of years to several standardised educational levels. However, the potential work experience may deviate from the actual one if

the working career is interrupted, whatever the reason[5]. Therefore, additional variables were included in the wage equation to complement the description of labour market experience. First, the acquisition of human capital through work experience may be less intensive than suggested by the measure of potential experience because part of the previous work experience was only part-time. Therefore, a variable for previous part-time experience (in years) was added. Second, the interruptions of the working career are captured by the inclusion of two variables for previous unemployment duration and other non-employment periods accumulated during the working career. The latter variable is dominated by the military service period for men and by periods of housekeeping for women. Those additional variables were constructed on the basis of the retrospective data of the GSOEP, containing the employment status of the individuals from the age of 15. Furthermore, a variable for years of tenure by the current employer was included, which is due to capture the specific knowledge acquired within a firm. Whether the person works in the area she has been trained for also matters, and a corresponding dummy variable was included.

The GSOEP provides information on workers' occupational position, which may affect the relative wage levels of men and women. In particular, part of the gender wage gap may be due to some gender-specific occupational streaming rather than to wage differences for given occupations. The problem is that since the occupational position is highly correlated with the level of education, it seems preferable not to include it in the regression. Following Brown, Moon and Zoloth (1980), a possible approach consists in first estimating, in a multinomial logit model, the probabilities of occupying certain positions for each gender and then accounting for these differing probabilities while estimating wage equations separately for each occupation. This approach has two main drawbacks. First, the number of observations is not large enough to build a sufficient number of occupations and estimate the wage equations separately, and second, it requires the availability of instruments which explain occupational choices while having no direct effect on wages. Preliminary tests show that the same variables explain the occupation and the wages. Thus, we don't have valid instruments at our disposal and human capital seems to determine simultaneously occupations and wages. The wage equation without occupational variables can be seen as a reduced form. Nevertheless, the approach of Sorenson (1989) is adopted. The idea is to capture to some extent the effect of gender-specific occupational patterns by including a variable containing the degree of feminisation of the occupation[6] in the wage equation. Indeed, if the coefficient of this variable turns out to be significant, it means that the gender-specific occupational choices affect wages significantly (Sorensen 1989). Finally, the wage equations entail some further control variables for marital status, number of children, firm size, industry branch, region and years.

2.2.2 Estimation method

Several sources of bias may limit the validity of the estimation of wage functions (Griliches 1977, Card 1999):

- *Unobserved individual heterogeneity*

A bias may occur when omitting to control for unobserved individual heterogeneity. Indeed, if such individual effects exist and are correlated with the observed control variables, then, the effects of this heterogeneity may be wrongly attributed to the latter, leading to biased coefficient estimates. In our specific case, for instance, the coefficient of one type of educational degree may be significantly positive because the unobserved ability of the holders of this degree is higher than average rather than because the completion of this degree increases one's productivity and is therefore more rewarded by employers. The problem is

[5] See Lauer and Steiner (2000) for a discussion of the use of various experience variables in earnings functions.
[6] Proportion (in percent) of women in an occupation, defined by some aggregation of ISCO 2-digit codes.

that no information about ability is available. A usual practice to circumvent this is to prefer panel estimation to OLS. Since it is reasonable to allow the individual effects to be correlated with the explanatory variables in the wage function, a fixed-effects model is generally preferred. One problem with this approach is that conditioning variables which do not vary over time disappear from the regression: the individual effects are treated as nuisance parameters and eliminated by taking deviations from individual means. The basic human capital variables, for instance, would disappear from the regression. Indeed, the educational variables are in most cases constant, and potential experience is incremented each year by one. Furthermore, panel estimates place more weight on short-run effects, since they focus on changes in variables rather than on their levels to identify coefficients. Thus, fixed-effect panel estimation does not seem to be the most appropriate way to analyse the basic relationship between human capital and wages. I will therefore prefer the traditional OLS estimator to panel estimation and try to reduce unobserved individual heterogeneity by adding a quite large number of control variables.

- *Sample selectiviy*

A second kind of bias may arise if the sample used is not representative of the population we are interested in and only individuals with some specific characteristics enter the sample. In the present context, individuals' decision to work determines whether wages are observed or not in the data. This decision is particularly worth being analysed for women, which are traditionally more likely to decide not to work or to work part-time. If the factors determining this decision were random and uncorrelated with the factors affecting individual wages, we could simply ignore the fact that not all wages are observed. However, such an independence assumption is unlikely to hold in practice. Hence, full-time employed persons are likely to be a self-selected group whose wages may not be representative of all individuals with given observed characteristics. This could bias the estimates. In order to test for sample selectivity bias, the traditional Heckman procedure (Heckman 1979) may be applied: a selectivity correction term, the inverse Mill's ratio, is computed from a reduced-form probit equation of labour force participation (selection equation) and included as an additional regressor in the wage function to be estimated (outcome equation). If this correction term proves significant and alters the other coefficients, this indicates that omitting to correct for selectivity would bias the estimates. This procedure requires the availability of some credible instruments, i.e. variables which determines of the propensity to work but do not have a significant direct effect on wages. In practice, such exclusion restrictions are difficult to find and collinearity problems are likely to prevail. If this is the case, it is better to do without selectivity correction. Several tests were conducted in Lauer and Steiner (2000), using marital status, number of children below the age of 16 years, whether the mother was employed during the individual's childhood, other household income and the amount of monthly mortgage payments as such instruments. Different combinations of these instruments were tested. The inverse Mill's ratio proves mostly significant (negative) in the wage equation for both men and women, but it does not alter the other coefficients in a significant way[7]. Moreover, the size and the significance of the correction-term turns out to be quite sensitive to the choice of the exclusion restrictions. Therefore, for this study, the estimation will be done without correction for selectivity bias (see the critique of the Heckman procedure in Puhani 2000).

- *Endogeneity*

Estimation by OLS assumes that the explanatory variables are all exogenous. If this is not be the case, the estimates may be biased. One traditional way to correct for this bias is to apply a two-stage instrumental variables (IV) procedure, where the endogenous variable is first regressed on a set of explanatory variables and then instrumented by its predicted value

[7] Results available on request.

in the second-stage wage function. Again, this procedure requires the availability of variables which affect the endogenous variables without directly affecting wages. Given the number of potentially endogenous variables, correcting for endogeneity would unnecessarily complicate the model. Moreover, the lack of credible instruments renders the results very sensitive to the choice of the variables and casts some doubts on the usefulness of such an approach (see Lauer and Steiner 2000). Therefore, no correction for endogeneity will be undertaken.

Generally speaking, the importance of these potential biases has to be relativized. Since the main point of interest here are changes over time, the biases will cancel out if they influence the estimates in a similar way over the different periods. Moreover, it seems preferable to have the same bias for both periods rather than to correct for them with a very sensitive correction procedure, which, moreover, tends to introduce new sorts of biases.

2.2.3 Time scope

The estimations were run separately for each of the four-year sub-periods defined, giving a kind of average for 1984-97 (period 1) and, 10 years later, 1994-97 (period 2). F-tests were conducted to test for the appropriateness of choosing such sub-periods. The stability of the regression coefficients *within* each of the sub-periods and *between* them was tested. Within each period, estimations were run including dummy variables for years as well as interaction terms between the explanatory variables and the year dummies. If the interaction terms turn out to be jointly insignificant, one can conclude that there are no statistically significant differences in the coefficients over years. In that case, it is legitimate to pool the sample over years and run the estimations on the pooled sample. The same procedure was applied – with a period dummy and interaction terms between the period dummy and the other variables - to check for the significance of the differences between the periods.

Table 3: F-tests of stability of regression coefficients over time

		Men		**Women**	
		F-stat.	Prob>F	F-stat.	Prob>F
Differences within periods:	1984-87	0.65	0.99	0.46	1.00
	1994-97	0.64	0.99	0.44	1.00
Differences between periods:		2.50	0.00	2.53	0.00

Source: GSOEP, own calculations.

As appears from Table 3, the interaction terms prove statistically insignificant within the periods. In other words, there is no statistical difference in the coefficients over years within each period. However, the differences between both periods are statistically significant, since the null hypothesis of insignificance of the interaction terms with the period dummy are jointly rejected at a 1% level. Hence, the further analyses will concentrate on the changes between period 1 and period 2, each period being homogenous.

2.2.4 Estimation results

A simple F-test applied on the sample pooled across genders shows that gender differences are jointly statistically significant in both periods (F-statistic=5.89 in period 1, F-statistic=4.58 in period 2). The chosen variables enable to explain 45-50% of the variance in labour earnings. Annex 2 provides descriptive statistics for the human capital variables included in the wage equation.

Table 4: Wage equations. Dependent Variable: log gross hourly wage – Full-time employees, private sector

	1984-87		1994-97	
	Men	Women	Men	Women
Low/interm. school+apprenticeship	0.124	0.120	0.109	0.085
	(9.589)	(6.638)	(7.565)	(4.195)
Low/interm. school+master	0.286	0.202	0.253	0.147
	(16.012)	(5.172)	(13.653)	(4.119)
High school+/apprenticeship/master	0.360	0.274	0.274	0.218
	(15.499)	(8.827)	(12.942)	(6.891)
Higher technical college	0.526	0.415	0.544	0.354
	(23.800)	(7.295)	(24.921)	(7.492)
University	0.699	0.611	0.623	0.434
	(30.669)	(14.308)	(29.809)	(11.123)
Potential experience	0.032	0.039	0.033	0.037
	(18.102)	(15.541)	(16.559)	(12.233)
Potential experience^2 / 100	-0.059	-0.070	-0.059	-0.060
	(-15.833)	(-12.091)	(-14.582)	(-9.429)
Previous part-time experience	-0.006	-0.000	-0.016	-0.010
	(-1.848)	(-0.013)	(-4.036)	(-3.811)
Previous unemployment	-0.045	-0.050	-0.032	-0.052
	(-6.995)	(-3.901)	(-7.575)	(-5.216)
Previous non-employment	0.002	-0.009	-0.005	-0.009
	(1.094)	(-5.972)	(-2.262)	(-4.918)
Tenure	0.002	0.003	0.002	0.000
	(3.467)	(2.355)	(3.274)	(0.016)
Occupation in area trained for	0.031	0.053	0.051	0.133
	(3.603)	(3.415)	(5.540)	(8.558)
Feminisation of occupation/100	-0.006	-0.085	-0.054	-0.142
	(-0.350)	(-2.941)	(-2.931)	(-4.509)
Observations	4,663	1,767	3,775	1,464
R^2	0.45	0.44	0.50	0.44

Source: GSOEP, own calculations.

Note: All regressions include dummies for firm size, industry, region, marital status, number of children and years as additional control variables. T-statistics in parentheses.

People with no or only a low/intermediate educational degree build the reference group. Thus, the estimated education coefficients represent the wage premium associated with the considered educational degrees compared to the reference group. For instance, a men with a university degree earns on average 69.9 ln-%, i.e. 101% (=[exp(0.699)-1]×100) more than a men with no or only a low/intermediate school degree in the first period. This wage differential is lower for women: a women who holds a university degree earns on average 84% (=[exp(0.621)-1]×100) more than a women in the reference category. At all educational levels, men have higher coefficients than women, i.e. men earn more than women for a given degree, all else equal (see from the results of t-tests in Annex 3 the degree of significance of gender differences). This suggests that part of the gender wage gap is due to the fact that women have on average a lower education level, and that even if they have an equivalent degree, it is less valued by the labour market in terms of wages[8]. The next part will

[8] Note that we only have information on the level of education and not on the type or the subject of the completed degree, which may also explain for a part gender differences in occupations and wages.

concentrate on this issue. A second observation is that the returns to education have decreased from 1984-87 to 1994-97 for full-time employees in the private sector (except for men holding a higher technical college degree), i.e. the relative advantage of being more highly educated is somewhat less in the second period, all else equal (see from the results of t-tests in Annex 3 the degree of significance of differences between period 1 and period 2).

As appears from the coefficients of the educational dummies in Table 4, the higher the education level, the higher the premium in terms of wages. However, obtaining a university degree requires more time than completing an apprenticeship after finishing low or intermediate schooling. Consequently, more wages are foregone in the former case than in the latter case. Thus, in order to obtain an idea[9] of the effective yearly return corresponding to each degree, one should take into account that the completion of the various degrees requires a different number of years of studies. Once controlled for the different study lengths, the master degree yields by far the highest return for both men and women, followed by tertiary level degrees (see Annex 4). At the bottom of the hierarchy, apprenticeship degrees, with or without high school diploma, yield the lowest return. Hence, holding a high school degree in addition to a vocational degree does not seem to bring any further return, since the advantage of the additional wage is cancelled out by the disadvantage of a longer time of studies. The decreasing pattern in the returns to education between period 1 and period 2 is still observable.

The return to potential labour market experience cannot be directly read off the table. From the specification of the wage equation above, the effect of labour market experience on the log wage is given by $\hat{\beta}_2 + 2\hat{\beta}_3 Experience$, where $\hat{\beta}_2$ and $\hat{\beta}_3$ are the estimated parameters of the linear and quadratic experience terms in the wage equation. Therefore, the return to one additional year of potential labour market experience depends on the level of experience. Annex 5 shows that the marginal return to potential labour market experience decreases substantially as the level of potential labour market experience increases. This is in line with the concavity in the wage-age profiles observed in the descriptive overview, since potential experience is largely determined by age. Furthermore, at all levels of experience, the marginal return to potential experience is slightly higher for women than for men. However, potential experience is only a sort of maximum labour market experience and does not describe it fully. If part of the potential work experience was only part-time, this will affects wages negatively, in particular for men[10]. Similarly, previous spells of unemployment have a negative impact on wages, especially for women. The number of years out of employment (for some other reason than unemployment) affects wages negatively, especially for women (for men in the first period, the effect is slightly positive but not significant). Tenure by the current employer has a positive effect on wages, but is not significant for women in the latest period. Whether the individual works in the area he has been trained for has a significant positive impact on wages for both men and women, but the effect is stronger for women. Interestingly, the degree of feminisation of the occupation proves to have a significant negative effect on wages for women, but not for men (period 1) or much less than for women (period 2). This points out the presence of some occupational segregation, with women working in lower paid jobs. Thus, part of the wage differences stems from gender differences in occupational choices, all the more since men who work in typically female jobs also earn less than the average, but by far not to the same extent as women who do so.

[9] Only approximately, because no information about the actual time needed to complete the course of studies is available. Thus, I relied on standard years needed to complete each specific educational or vocational degree.
[10] However, part-time employment is a really minor phenomenon among West German men, therefore, the effect on average wages is low.

3 Contribution of human capital to the gender wage gap

This section aims at analysing more specifically the extent and the nature of the contribution of gender differences to explaining the wage differential between men and women and its developments over time. The idea is to disentangle "price" (i.e. returns to human capital) and "quantity" (i.e. endowment in human capital) effects. Indeed, the average gender wage gap is the difference between the respective wage outcomes of the human capital attributes men and women are endowed with.

3.1 Human capital and gender wage gap

3.1.1 Decomposition method

A common approach when analysing the wage differential between two groups of workers (e.g. male versus female workers, black versus white workers, urban versus rural workers) consists in decomposing the gender wage gap, measured as the difference between average log wage, into an "explained" component and an "unexplained" component. The idea is that part of the gender wage gap can be explained by differences in human capital attributes across genders, while the residual wage gap results from group differences in the market valuation of productivity-related characteristics. The unexplained component is usually interpreted as the "discriminatory" component. Taking into account that the mean value of the stochastic error terms is zero, the typical decomposition, based on the method proposed by Oaxaca (1973) and Blinder (1973), is of the following form:

$$\overline{\ln Y}^t_m - \overline{\ln Y}^t_f = \hat{\beta}^t_m \bar{X}^t_m - \hat{\beta}^t_f \bar{X}^t_f = \underbrace{\hat{\beta}^t_m (\bar{X}^t_m - \bar{X}^t_f)}_{\text{explained}} + \underbrace{(\hat{\beta}^t_m - \hat{\beta}^t_f)\bar{X}^t_f}_{\text{unexplained}} \qquad (2)$$

The first part corresponds to the average wage gap which results from the differential in human capital characteristics provided there is no "discrimination", i.e. women's human capital is rewarded like that of men. The second part is attributed to "discrimination", i.e. to the fact female human capital is not valued like that of men. This way of measuring and interpreting wage differentials is somewhat problematic. As a matter of fact, it suggests that the male coefficients correspond to the "non-discriminating" returns to human capital, i.e. the market valuation of an individual's characteristics in the absence of "discrimination". However, this is only true if, assuming that there exists a difference in male and female returns to human capital, employers paid men in accordance to their marginal product but discriminate women negatively. Nevertheless, it is also conceivable that employers pay women at their marginal product but discriminate men positively. In that case, it would be appropriate to value the endowment gap by the female rather than the male coefficients in equation (3). A mixture of both is conceivable, with men being somewhat "overpaid" and women somewhat "underpaid". This would results in the "non-discriminating" coefficients lying somewhere between the male and the female ones, all other things being equal. The problem, then, is to determine where exactly the "non-discriminating" coefficients should be situated. Neumark (1988) proposed to determine the "non-discriminating" coefficient vector by estimating additionally a wage function on the pooled sample of men and women. Alternatively, Cotton (1988) preferred a weighted average of male and female coefficients, where the weights are the respective proportions of males and females in the sample. In any case, however, the choice of the "non-discriminating" reference remains somewhat arbitrary. The choice of the reference wage structure crucially affects the results (see Licht and Steiner 1994, Bonjour 1997). Moreover, this interpretation in terms of discrimination is somewhat abusive, since, on the one hand, part of the "explained" component may also be due to discrimination, e.g. if there is some discrimination in the access to education, and on the other

hand, part of the "discriminatory" component may not be attributable to discrimination, e.g. if unobservable factors influence individual's productivity. Therefore, the following alternative decomposition is preferred, which will not be interpreted in terms of discrimination:

$$\overline{\ln Y}^t_m - \overline{\ln Y}^t_f = \hat{\beta}^t_m \bar{X}^t_m - \hat{\beta}^t_f \bar{X}^t_f$$
$$= \underbrace{\hat{\beta}^t_f (\bar{X}^t_m - \bar{X}^t_f)}_{\text{endowment component}} + \underbrace{(\hat{\beta}^t_m - \hat{\beta}^t_f)\bar{X}^t_f}_{\text{return component}} + \underbrace{(\hat{\beta}^t_m - \hat{\beta}^t_f)(\bar{X}^t_m - \bar{X}^t_f)}_{\text{endowment-return component}} \quad (3)$$

A positive (negative) sign means that the component considered contributes positively (negatively) to the gender wage gap in favour of men. The first component ("endowment component") shows how much additional wage women would earn if, given their returns to human capital, they had the same human capital endowment as men. Put it differently, this first component can be interpreted as the part of the wage gap which stems from gender inequality with respect to human capital endowment. The second term ("return component") measures how much additional wage women would earn if, given their endowment in human capital, they had the same returns to human capital than men. In other words, it measures the part of the wage gap resulting from the gender inequality with respect to the returns to human capital, i.e. for an identical level of human capital, the wage outcome differs across genders, all else equal. Finally, the last interaction term ("endowment-return component") expresses how much additional wage women would earn if men had not the advantage of being better endowed with those human capital characteristics which are also better rewarded by the labour market for men than for women or less endowed in those attributes for which women are better rewarded than men. Thus, it can be interpreted as the part of the wage gap which is due to the structure of gender inequality in both endowment in and return to human capital. Table 5 shows the outcome of the decomposition of the gender wage gap for each period. In order to isolate the specific contribution of certain types of human capital, partial results for subgroups of variables are also reported: the education-related variables (set of educational dummies), the experience variables (potential experience, previous part-time employment, previous unemployment, other spells of non-employment and tenure) and the occupation-related variables (whether the person works in the occupation he was trained for and degree of feminisation of the occupation)[11].

3.1.2 Decomposition outcome

- *Overall effects*

Table 5 presents the outcome of the decomposition. In 1984-87, men earned on average some 45% (0.365 ln-%) more than women. Ten years later, the gender wage gap has decreased somewhat, but men still earn about 36% (0.30 ln-%) more than women. If women had the same human capital as men, they would earn some 0.15 ln-% wage more, which would reduce the gender wage gap by 40% in the first period and even more than 50% in the second period. Moreover, 60% of the gender wage gap is attributable to the fact that female human capital is less valued than that of men. This treatment difference of human capital has reduced significantly in the second period, both in absolute terms and in proportion of the total gender wage gap (less than 45% in the second period), which has itself decreased somewhat (from 0.365 down to 0.299). The composition effects of return and endowment inequality only account for a minor part of the gender wage gap. Nevertheless, in the second period, they have contributed to about 6% of the gender wage gap in favour of men.

[11] See Annex 6, Annex 7 and Annex 10 for more details.

Table 5: Origin of the gender wage gap by period

		1984-87	1994-97	Change[2)]
Endowment component		**0.153**	**0.152**	**-0.001**
% of gender wage gap		42.0%	50.8%	1.7%
Related to[1)]:	*Education*	*0.037*	*0.031*	*-0.006*
	Experience	*0.102*	*0.065*	*-0.037*
	Occupation	*0.032*	*0.055*	*0.024*
Return component		**0.220**	**0.130**	**-0.089**
% of gender wage gap		60.2%	43.5%	136.2%
Related to:	*Education*	*0.014*	*0.038*	*0.024*
	Experience	*-0.041*	*-0.037*	*0.005*
	Occupation	*0.035*	*0.002*	*-0.033*
Endowm.-return component		**-0.008**	**0.017**	**0.025**
% of gender wage gap		-2.2%	5.7%	-37.9%
Related to:	*Education*	*0.008*	*0.018*	*0.010*
	Experience	*-0.035*	*-0.002*	*0.033*
	Occupation	*-0.029*	*-0.034*	*-0.006*
Gender wage gap[3)]		**0.365**	**0.299**	**-0.066**
Male wage premium[4)]		44.7%	36.1%	-8.6%
Related to:	*Education*	*0.060*	*0.088*	*0.028*
	Experience	*0.026*	*0.027*	*0.001*
	Occupation	*0.038*	*0.023*	*-0.015*

Source: GSOEP, own calculations.

Notes: 1) Only the partial effects of variables directly related to human capital are reported here, but not those of the other control variables included in the regressions. 2) Period 2 (1994-97) minus period 1 (1984-87).
3) $\overline{lnY}_m - \overline{lnY}_f$. 4) $(\overline{Y}_m - \overline{Y}_f) / \overline{Y}_f \times 100$.

- *Contribution of education-related variables*

As can be seen from the table, education-related variables alone contribute to a large part of the gender wage gap, especially in the second period (0.060 corresponds to 16.4% of the gender wage gap and 0.088 to 29.4% of the gender wage gap). In the first period, this is mainly due to the fact than women have on average a lower education level than men (0.037), but even at an equivalent education level, the wage outcome is lower for women (0.014). Interaction effects of endowment and return work slightly in favour of men (0.008), which stems from the fact that men have more of the degrees for which they have higher returns than women. In period 2, the gender educational gap also contributes positively to the gender wage gap, but to a lesser extent (0.031), which means than women have improved their educational attainment relative to men. However, the treatment difference of degrees of equivalent level across genders in favour of men has widened markedly and produces a larger wage gap than in the first period (0.038). This also explains that the interaction effects of endowment and return inequality also yield a larger wage gap than ten years before.

- *Contribution of experience-related variables*

Experience-related variables also contribute to the gender wage gap in favour of men (some 0.026), but to a lesser extent than educational attainment. The contribution of the experience variables to the gender wage gap has the same order of magnitude in both periods. Interestingly, this is only due to the fact that women accumulate significantly less work experience than men, whereas for a given level of experience, women are given a higher return in terms of wages. Thus, women are favoured with respect to the valuation of their work experience by the labour market. Taking only the endowment aspect into account, women would earn some 10.7% (=[exp(0.102)-1]×100) more if they had the same work experience than men in the first period and 6.7% more in the second period. However, since years of experience yield a higher return for women than for men, and since interaction

effects also works in favour of women (especially in the first period), the wage gap resulting from labour market experience only amounts to less than 3% in both periods.

- *Contribution of occupation-related variables*

Occupation-related variables are also at the origin of a wage premium for men. A closer look at the variables (see in annex) shows that this is the result of occupational segregation, i.e. female crowding into lower paid occupations (0.049 in period 1 and 0.070 in period 2), while the adequacy of the occupation to the training area favours women (-0.011 in period 1 and -0.047 in period 2). Of course, more women work in occupations where the proportion of women is very important, and since there is a penalty for working in these occupations, the wage outcome is unfavourable to women (the endowment component related to occupational segregation contributes positively to the gender wage gap in favour of men). Moreover, women who work in these female-dominated occupations are also more heavily penalised than men in the same occupations in terms of wages. This leads to a positive return component, i.e. a positive wage premium for men. The interaction effects of endowment and return turn to the advantage of women, since, if men have an advantage in terms of wage return, they are not so numerous in those occupations. As far as the adequacy of the occupation is concerned, slightly more men than women work in the area they have been trained for, which brings them a wage bonus (positive endowment component). However, women working in their area of training enjoy a higher wage premium than men who do so. As a result, the return component tends to reduce the gender wage gap. The interaction effects of endowment and return inequality also favour women for this variable.

3.2 Human capital and wage increases

In the previous section, the role of human capital variables with respect to the gender wage gap was analysed for each period separately. Here, the contribution of these human capital variables to the wage increases observable in the ten years between 1984-87 and 1994-97 is examined.

3.2.1 Decomposition method

As mentioned previously, the average wage level amounts to the sum of the wage outcomes of the average human capital characteristics. Thus, wage increases may result from different factors. Either the endowment in human capital itself has changed or the returns it yields in terms of wages. Part of the wage increase may also be due to interaction effects between changes in the composition of human capital and changes in the structure of the returns to education. Departing from equation (1), the following decomposition is undertaken:

$$\begin{aligned}\overline{\ln Y}_g^{t+1} - \overline{\ln Y}_g^{t} &= \hat{\beta}_g^{t+1}\bar{X}_g^{t+1} - \hat{\beta}_g^{t}\bar{X}_g^{t} \\ &= \underbrace{\hat{\beta}_g^{t}(\bar{X}_g^{t+1} - \bar{X}_g^{t})}_{\text{change in endowment}} + \underbrace{(\hat{\beta}_g^{t+1} - \hat{\beta}_g^{t})\bar{X}_g^{t}}_{\text{change in return}} + \underbrace{(\hat{\beta}_g^{t+1} - \hat{\beta}_g^{t})(\bar{X}_g^{t+1} - \bar{X}_g^{t})}_{\text{change in endowment-return}}\end{aligned} \qquad (4)$$

where g = gender
t = period 1 (1984-87), $t+1$ = period 2 (1994-97)

Here again, a positive (negative) sign implies that the corresponding component yields a positive (negative) contribution to the wage increase. The first component represents the part of the wage increase which is due to a change in the endowment (assuming that the return has not changed). The second component shows to which extent the wage increase is due to a change in the returns to human capital (if endowment was unchanged), and the last

component points out the extent to which the increase in wages stems from interaction effects of changes in the endowment in and in the returns to human capital.

3.2.2 Decomposition outcome

- *Overall effects*

Table 6 summarises the results of the decomposition[12]. In the ten years between 1984-87 and 1994-97, gross hourly wages have increased by 20.5% for men and even 28% for women. As a result, the gender wage gap has decreased somewhat. The wage increases mainly reflect changes in the returns to human capital, which are responsible for 84% of the wage increase for men and 74% for women. Whereas the interaction effects of changes in the endowment and in the return seem to play a minor role in wages increases, the developments in human capital are responsible for about 19% for men and 25% for women of the total wage increase. This points to an improvement in human capital for both genders and slightly more pronounced for women.

Table 6: Origin of wage increases by gender

		Men	Women	Gender gap[2)]
Change in endowment		**0.036**	**0.063**	**-0.027**
% of wage increase		19.2%	25.0%	41.5%
Related to[1)]:	*Education*	*0.038*	*0.026*	*0.012*
	Experience	*-0.007*	*0.034*	*-0.041*
	Occupation	*0.003*	*0.005*	*-0.002*
Change in return		**0.156**	**0.187**	**-0.030**
% of wage increase		83.9%	74.2%	46.4%
Related to:	*Education*	*-0.019*	*-0.032*	*0.013*
	Experience	*0.015*	*-0.021*	*0.036*
	Occupation	*0.000*	*0.008*	*-0.008*
Change in endowm.-return		**-0.006**	**0.002**	**-0.008**
% of wage increase		-3.1%	0.9%	12.0%
Related to:	*Education*	*-0.004*	*-0.006*	*0.002*
	Experience	*0.001*	*-0.006*	*0.007*
	Occupation	*0.002*	*0.007*	*-0.005*
Wage increase[3)]		**0.186**	**0.252**	**-0.066**
Increase in %[4)]		20.5%	28.1%	-7.6%
Related to:	*Education*	*0.015*	*-0.013*	*0.028*
	Experience	*0.008*	*0.007*	*0.001*
	Occupation	*0.005*	*0.020*	*-0.015*

Source: GSOEP, own calculations.

Notes: 1) Only the partial effects of variables directly related to human capital are reported here, but not those of the other control variables included in the regressions. 2) Men minus women. 3) $\overline{lnY}^{t+1} - \overline{lnY}^{t}$.
4) $(\bar{Y}^{t+1} - \bar{Y}^{t}) / \bar{Y}^{t} \times 100$.

- *Contribution of education-related variables*

Changes in educational attainment have an opposite effect on wages for men and for women. Whereas they contribute to a wage increase for men (0.015), they would have caused female wages to decrease if nothing else had changed (-0.013). This is explainable by the fact that, for men, the positive impact of educational expansion on wages (0.038) exceeds the negative impact of the decline in the returns to education (-0.019), whereas for women, the educational improvement (0.026) is not strong enough to compensate for the stronger decline in the returns to education (-0.032).

[12] See Annex 8, Annex 9 and Annex 11 for more detailed results.

- *Contribution of experience-related variables*

Experience-related variables contribute slightly, but positively, to the wage increase (0.008 for men and 0.007 for women). Looking closer in details, the situation is different for men and for women. The developments in male average endowment in work experience has a slight negative impact on wages (-0.007), while it has a positive impact on female wages (0.034). This can be attributed to the fact that female work experience has significantly increased, contrary to male one, and previous unemployment duration, which has a negative impact on wages, has not increased in the same proportion for women as for men. Conversely, the returns to experience have contributed positively to the wage increase for men (0.015), and negatively for women (-0.021). Women face a decrease in their return to experience - particularly for previous years out of employment as well as previous part-time experience - which is not observable among men[13]. The effects resulting from joint changes in endowment in and returns to experience are rather minor for men but have a slight negative impact on female wages.

- *Contribution of occupation-related variables*

Occupation-related variables have on the whole a positive impact on wages, though it is very small for men. A closer look at the variables (see in annex) shows that, if changes in the adequacy of the occupation to the training have a definite positive impact on wages[14], especially for women, the developments in occupational segregation have a decreasing impact on wages, somewhat stronger for women. The latter is exclusively due to the return component, i.e. the fact that the wage penalty for working in typically female jobs has increased, while the extent of occupational segregation has remained fairly constant.

3.3 Human capital and reduction in the gender wage gap

This section aims at reconciling the analyses conducted in section 3.1 and section 3.2 in order to provide an overall assessment of the impact of human capital on the reduction in the gender wage gap between 1984-87 and 1994-97.

3.3.1 Decomposition method

In order to disentangle the effects of endowment and return in their time dimension, a further decomposition, based on both equation (3) and equation (4), was made. Equation (5) divides the change in the gender wage gap into the change in the endowment component, in the return and in the endowment-return component as defined in equation (3).

$$(\overline{\ln Y}_m^{t+1} - \overline{\ln Y}_f^{t+1}) - (\overline{\ln Y}_m^{t} - \overline{\ln Y}_f^{t}) = \underbrace{(\bar{X}_m^{t+1} - \bar{X}_f^{t+1})\hat{\beta}_f^{t+1} - (\bar{X}_m^{t} - \bar{X}_f^{t})\hat{\beta}_f^{t}}_{\text{change in endowment component (1)}} + \underbrace{\bar{X}_f^{t+1}(\hat{\beta}_m^{t+1} - \hat{\beta}_f^{t+1}) - \bar{X}_f^{t}(\hat{\beta}_m^{t} - \hat{\beta}_f^{t})}_{\text{change in return component (2)}} + \underbrace{(\hat{\beta}_m^{t+1} - \hat{\beta}_f^{t+1})(\bar{X}_m^{t+1} - \bar{X}_f^{t+1}) - (\hat{\beta}_m^{t} - \hat{\beta}_f^{t})(\bar{X}_m^{t} - \bar{X}_f^{t})}_{\text{change in endowment-return component (3)}} \quad (5)$$

Like previously, a positive (negative) sign means that the component observed contributes to increasing (reducing) the gender wage gap. The problem is that the change in the endowment component, for instance, is partly due to a change in the gender inequality with respect to their human capital endowment, and partly due to the fact that female returns

[13] Recall that men have lower returns to experience than women, even if the gap tends to reduce.
[14] This is mainly due to the strong increase in the reward for working in the area one has been trained for.

to human capital may also have changed. Similar considerations can be made for the other components. Therefore, each component of equation (5) can be further decomposed using equation (4):

Change in the endowment component (6)

$$= \underbrace{\hat{\beta}_f^t\left[(\bar{X}_m^{t+1}-\bar{X}_f^{t+1})-(\bar{X}_m^t-\bar{X}_f^t)\right]}_{\text{change in endowment inequality (1a)}} + \underbrace{(\hat{\beta}_f^{t+1}-\hat{\beta}_f^t)(\bar{X}_m^t-\bar{X}_f^t)}_{\text{change in the valuation of endowm. gap (1b)}} + \underbrace{(\hat{\beta}_f^{t+1}-\hat{\beta}_f^t)\left[(\bar{X}_m^{t+1}-\bar{X}_f^{t+1})-(\bar{X}_m^t-\bar{X}_f^t)\right]}_{\text{interaction change in endowm. inequality and in valuation of endowm. gap (1c)}}$$

Part (1a) shows the extent to which the gender wage gap has changed because women have improved (or deteriorated) their relative position in terms of human capital, if female returns to human capital had not changed. Part (1b) corresponds to the change in the gender wage differential which is due to a change in the return, assuming that the endowment gap has not changed. Finally, part (1c) gives the proportion of the change in the gender wage gap which stems from the fact that the endowment inequality and the returns have changed jointly. Similarly, the change in the return component can be decomposed in the following way:

Change in the return component

$$= \underbrace{(\hat{\beta}_m^t-\hat{\beta}_f^t)(\bar{X}_f^{t+1}-\bar{X}_f^t)}_{\text{change in endowment (2a)}} + \underbrace{\left[(\hat{\beta}_m^{t+1}-\hat{\beta}_f^{t+1})-(\hat{\beta}_m^t-\hat{\beta}_f^t)\right]\bar{X}_f^t}_{\text{change in return inequality (2b)}} + \underbrace{\left[(\hat{\beta}_m^{t+1}-\hat{\beta}_f^{t+1})-(\hat{\beta}_m^t-\hat{\beta}_f^t)\right](\bar{X}_f^{t+1}-\bar{X}_f^t)}_{\text{interaction change in return inequality and in endowment (2c)}} \quad (7)$$

Part (2a) describes how far the change in the gender wage gap is due to the fact that, for a given level of gender inequality with respect to the valuation of human capital by the labour market, female human capital has changed. Part (2b) shows the impact on the gender wage gap of the change in return inequality across genders, assuming female endowment in human capital had not changed. Finally, part (2c) gives the extent to which the change in the gender wage gap comes from the fact that both return inequality and endowment have changed jointly. As far as the component (3) is concerned, the retained decomposition is the following:

Change in the endowment-return component

$$= \underbrace{(\hat{\beta}_m^t-\hat{\beta}_f^t)\left[(\bar{X}_m^{t+1}-\bar{X}_f^{t+1})-(\bar{X}_m^t-\bar{X}_f^t)\right]}_{\text{change in endowment inequality (3a)}} + \underbrace{\left[(\hat{\beta}_m^{t+1}-\hat{\beta}_f^{t+1})-(\hat{\beta}_m^t-\hat{\beta}_f^t)\right](\bar{X}_m^t-\bar{X}_f^t)}_{\text{change in return inequality (3b)}} \quad (8)$$

$$+ \underbrace{\left[(\hat{\beta}_m^{t+1}-\hat{\beta}_f^{t+1})-(\hat{\beta}_m^t-\hat{\beta}_f^t)\right]\left[(\bar{X}_m^{t+1}-\bar{X}_f^{t+1})-(\bar{X}_m^t-\bar{X}_f^t)\right]}_{\text{interaction change in endowment and in return inequality (3c)}}$$

Part (3a) gives the proportion of the gender wage gap change which is due to a change in endowment inequality, provided return inequality had remained unchanged. Part (3b) shows for which part the reduction in the gender wage gap stems from the change in return inequality, assuming the gender human capital gap has not changed. Finally, part (3c) shows the extent to which the reduction in the gender wage gap results from the fact that both the return inequality and the endowment inequality have changed jointly.

Adding up (1a), (2a) and (3a) gives (a), the part of the change in the gender wage gap which is due to developments in the endowments in human capital, assuming that the returns have not changed (equation (10)).

$$\text{Change in the endowments} = (a) = (1a) + (2a) + (3a) = \hat{\beta}_m^t(\bar{X}_m^{t+1} - \bar{X}_m^t) - \hat{\beta}_f^t(\bar{X}_f^{t+1} - \bar{X}_f^t) \quad (9)$$

The sum of (1b), (2b) and (2c) gives (b), the part of the gender wage gap coming from a change in the returns, assuming the endowments have not changed (equation (11)).

$$\text{Change in the returns} = (b) = (1b) + (2b) + (3b) = (\hat{\beta}_m^{t+1} - \hat{\beta}_m^t)\bar{X}_m^t - (\hat{\beta}_f^{t+1} - \hat{\beta}_f^t)\bar{X}_f^t \quad (10)$$

Finally, (c), the sum of (1c), (2c) and (3c), corresponds to the change in the gender wage gap attributable to the fact that both the endowments and the returns have changed jointly (equation (12)). Table 7 reports the result of the decomposition.

$$\text{Interaction changes in endowments and returns} = (c) = (1c) + (2c) + (3c)$$
$$= (\hat{\beta}_m^{t+1} - \hat{\beta}_m^t)(\bar{X}_m^{t+1} - \bar{X}_m^t) - (\hat{\beta}_f^{t+1} - \hat{\beta}_f^t)(\bar{X}_f^{t+1} - \bar{X}_f^t) \quad (11)$$

3.3.2 Decomposition outcome

- *Overall effects*

The gender wage gap has reduced by 0.066 between 1984-87 and 1994-97, which amounts to men earning about 36% more than women in the second period instead of 45% in the first period (see Table 5). Table 7 is first read horizontally. As can be seen, this reduction in the gender wage gap is essentially the result of changes in the return component (2), whereas changes in the endowment component (1) do not play an important role. The latter does not mean that women have not caught up with respect to their human capital compared to men. Indeed, (1a) shows that women did improve their relative human capital position, but this was compensated by unfavourable developments in their returns to human capital (1b), which reduces the benefit of the relative human capital improvement. The contribution of the return component to the reduction in the gender wage gap mainly stems from a diminution in return inequality in favour of women (2b). The reduction in the gender wage gap would even have been stronger if component (3) had not, at the same time, contributed to widen the wage gap. This is mainly due to the changes in relative endowments: even if the structure of return inequality across genders had not changed, the change in endowment inequality would have caused the gender wage gap to increase because of the structure of the return inequality (3a).

Reading the table vertically, it appears that the changes in endowments alone, i.e. if one assumes the returns constant, are responsible for about 42% of the reduction in the gender wage gap (a), while the changes in the returns alone, i.e. if one assumes that the endowments have not changed, are responsible for some than 46% of the reduction in the gender wage gap (b). The interaction effects of joint changes in endowment and returns, however, seem less important (c).

Table 7: Origin of the reduction in the gender wage gap

	Change in endowments	Change in returns	Joint changes in returns and endowments	Total
Change in endowment component	**(1a) -0.052**	**(1b) 0.050**	**(1c) 0.002**	**(1) -0.001**
% of change in GWG	79.7%	-75.7%	-2.3%	1.7%
Related to[1)] *Education*	*0.004*	*-0.009*	*0.000*	*-0.006*
Experience	*-0.043*	*0.003*	*0.002*	*-0.037*
Occupation	*0.000*	*0.022*	*0.001*	*0.024*
Change in return Component	**(2a) 0.004**	**(2b) -0.89**	**(2c) -0.004**	**(2) -0.089**
% of change in GWG	-6.6%	136.0%	6.8%	136.2%
Related to: *Education*	*0.006*	*0.015*	*0.003*	*0.024*
Experience	*-0.011*	*0.010*	*0.005*	*0.005*
Occupation	*-0.002*	*-0.025*	*-0.005*	*-0.033*
Change in endowm.-return component	**(3a) 0.021**	**(3b) 0.009**	**(3c) -0.005**	**(3) 0.025**
% of change in GWG	-31.6%	-13.8%	7.5%	-37.9%
Related to: *Education*	*0.003*	*0.008*	*-0.001*	*0.010*
Experience	*0.012*	*0.022*	*-0.001*	*0.033*
Occupation	*0.000*	*-0.005*	*-0.001*	*-0.006*
Total	**(a) -0.027**	**(b) -0.030**	**(c) -0.008**	**Change in GWG -0.066**
% of change in GWG[2)]	41.5%	46.4%	12.0%	100%
Related to: *Education*	*0.012*	*0.013*	*0.002*	*0.028*
Experience	*-0.041*	*0.036*	*0.007*	*0.001*
Occupation	*-0.002*	*-0.008*	*-0.005*	*-0.015*

Source: GSOEP, own calculations.

Notes: 1) Only the partial effects of variables directly related to human capital are reported here, but not those of the other control variables included in the regressions. 2) GWG = gender wage gap.

- *Contribution of education-related variables*

On the whole, the developments in education have not contributed to the decrease in the gender wage gap. On the contrary, taken alone, they would have increased it by 0.028. Interestingly, this deterioration of women's wage position is stronger at higher levels of education (particularly among university graduates, see Annex 12). This is not due to developments in the endowment component (1), which, because of a change in the wage outcome of the educational gap (1b) (declining returns to education), turn out rather favourable to women – though only slightly. This is due to the change in the return component (2) and to a lesser extent to a change in the endowment-return component (3). Except for high school graduates, gender inequality in the returns to education has rather increased: the returns to education dropped stronger for women than for men, especially at higher education levels (2b). This is the main reason why the return component causes the gender wage gap to widen.

Taken together, the developments in male and female educational achievement alsone would lead to a widening of the wage gap by 0.012 (slightly less than 9% of the gender wage gap reduction), as shown by (a). Developments in the returns to education also have, altogether, an increasing influence on the gender wage gap of the same order of magnitude (b). To a much lesser extent, the effects of joint changes in the returns to education and educational attainment also tend to increase slightly the wage differential between genders.

- *Contribution of experience-related variables*

Overall, the developments in experience-related factors have a neutral influence on the gender wage gap. This is the result of several factors which work in different directions and cancel out. The endowment component (1) for experience develops significantly in favour of women, and it alone would explain, all else equal, around 60% of the gender wage gap reduction. This is attributable to a significant improvement in the relative position of women regarding their work experience (1a). Unfortunately for women, both the return component (2) and above all the endowment-return component (3) developed in a way favourable to men. This is mainly due to the fact that women have lost their advantage (see section 3.1.2 and 3.2.2) concerning the valuation of their work experience (2b) and (3b).

Reading the table vertically, the developments in labour market experience endowments taken together would have induced a decrease in the gender wage gap of -0.041 (more than 60% of total decrease) (a), whereas the developments in the returns to experience would have altogether widened the wage gap in almost the same proportion (b). The joint changes in endowment and return inequality have rather minor effects.

- *Contribution of occupation-related variables*

The occupation-related variables contribute to explain the reduction in the gender wage gap (-0.015). Looking at Annex 12, it appears that it is only due to the developments in the "adequacy of occupation to training" variable, whereas changes related to occupational segregation alone would have widened the gender wage gap. The former is due to the return component (2), and in particular to the change in return inequality (2b) in favour of women. The gender wage gap enhancing effect of changes in occupational segregation mainly stems from the endowment component (1), and in particular to the change in the valuation of the endowment gap (1b). In other words, this is due to the fact that the wage penalty for women working in female jobs has increased. The wage penalty for men working in typically female jobs has also increased, but not to the same extent. This means that gender return inequality has also increased somewhat, which is reflected by the widening effect of (2b) on the gender wage gap. The endowment-return component (3) only plays a minor wage gap reducing role.

Reading Table 7 vertically, it appears that the part of the gender wage gap reduction occasioned by the occupation-related variables is mainly due to the changes in the returns (b) as well as to the joint changes in returns and endowments (c). A further distinction using Annex 12 reveals that the changes in the returns to the adequacy of training altogether explain the bulk of the gender gap reducing effect of this variable, whereas all of the widening effect of the changes in occupational segregation is due to changes in the returns (in this case negative returns).

4 Summary and conclusions

This empirical analysis examined the extent to which gender differences in human capital contribute to explaining the observable wage differential in favour of men and its developments since the mid-eighties. The analysis focuses on full-time employees in the private sector in West Germany. A first descriptive overview showed that if women still have on average a lower level of education than men, educational expansion was stronger among women and there seems to be a convergence across genders in the qualification structure of the employees. At the same time, wage increases were stronger for women than for men at all education levels, but especially at lower qualification levels, so that the overall gender wage gap has reduced somewhat. This suggests that educational developments might have been at the origin of the reduction in the gender wage gap.

In order to test the validity of this hypothesis and precise it, empirical wage equations were estimated, which enable to also control for other determinants of wages. The results corroborate the view that investing in further education yields a positive return in terms of wages, and it appears that, at an equivalent education level, the wage outcome is higher for men than for women. Conversely, the return to potential labour market experience is higher for women than for men. Previous unemployment and non-employment have a negative impact on wages, somewhat stronger for women. Moreover, some occupational segregation puts women at a disadvantage. These first analyses show that, on the one hand, men and women have different endowments in human capital, and on the other hand, even equivalent human capital is not rewarded in the same way by the labour market. The observable gender wage gap is a consequence of both elements.

Basing on the results from the wage functions, the analysis then attempted to disentangle the extent to which the gender wage gap (and its reduction over time) results from different (changes in the) endowments in human capital and from different (changes in the) returns to human capital. In particular, the specific role of the education variables, as opposed to the experience or occupation-related variables has been examined.

A first decomposition of the gender wage gap in both periods shows that if a large part (60% in 1984-87 and 45% in 1994-97) of the gender wage gap is attributable to the fact that women have a lower endowment in human capital, an even large part of it stems from the fact that female human capital is less valued than that of men in terms of wages, while interactions between endowment and return effects play a less important role. A second decomposition aimed at enlightening the role of changes in endowments and in the returns to human capital in explaining male and female wage increases. The analysis reveals that the wage increases mainly reflect the changes in the returns to human capital (84% of the wage increase for men and 74% for women) rather than in endowment in human capital. Nevertheless, improvement in human capital endowment is responsible for 25% of the wage increase for women and slightly less than 20% for men. Reconciling those two decompositions in a third one enabled to identify more precisely the factors which are at the origin of the reduction in the gender wage gap. The reduction in the gender wage gap is essentially the result of changes in the return component, whereas changes in the endowment component do not play an important role. The latter does not mean that women have not caught up with respect to their human capital compared to men. They did, but this was compensated by a lower valuation of human capital by the labour market, which reduces the benefit of the relative human capital improvement. The decrease in the gender wage gap stems mainly from a diminution in return inequality which favours women and would even have been stronger if adverse interaction effects had not, at the same time, contributed to widen the wage gap.

Education-related variables are responsible for a large part of the gender wage gap. This is mainly because women have a lower educational attainment than men, but also - though to a lesser extent in the mid-1980s - because similar qualification levels yield lower returns for women. Interaction effects are slightly favourable to men. Changes related to education have an opposite effect on wages for men and for women. Whereas they contribute to a wage increase for men, they would have caused female wages to decrease if nothing else had changed. This is explainable by the fact that, for men, the positive impact of educational expansion on wages exceeds the negative impact of the decline in the returns to education, whereas for women, the educational improvement is not strong enough to compensate the decline in the returns to education. The latter was stronger for women than for men. As a result, the developments in education have not contributed to the decrease in the gender wage gap. On the contrary, taken alone, they would have increased it significantly. Certainly, the

lower returns to education imply that a given educational gap produces a lower wage gap, but this effect, favourable to women, was more than compensated by the fact that gender inequality in the returns to education has increased.

Experience-related variables also contribute to the gender wage gap in favour of men, though to a lesser extent than education. This is exclusively due to the fact that women accumulate less work experience than men, whereas women are favoured compared to men with respect to the valuation of their work experience in terms of wages. Interaction effects also work in favour of women. The changes in labour market experience have induced wage increases for both men and women, though very slight ones. Women have improved their relative position in terms of work experience but face decreasing returns to experience in terms of wages, whereas men have increasing returns to experience. As a result, changes related to labour market experience have a neutral influence on the gender wage gap. The endowment component for experience develops significantly in favour of women, because of a significant improvement in the relative position of women regarding their work experience. It alone would explain, all else equal, around 60% of the gender wage gap reduction. Unfortunately for women, both the return component and above all the endowment-return component developed in a way favourable to men. This is mainly due to the fact that women have lost their advantage concerning the valuation of their work experience.

Occupation-related variables generate a wage premium for men. This is due to some occupational crowding of women into lower paid occupations, whereas the adequacy of the occupation to the area trained for favours women, due to a higher return. Of course, more women work in occupations where the proportion of women is important, but women who do so have a stronger wage penalty than men who do so. If changes in the adequacy of the occupation to the training have a definite positive impact on wages, especially for women, the developments in occupational segregation have a decreasing impact on wages, somewhat stronger for women. The latter is exclusively due to the return component, i.e. the fact that the wage penalty for working in typically female jobs has increased, while female segregation into lower paid jobs has remained fairly constant. As a result, occupation-related variables contribute to explain the reduction in the gender wage gap, but this is only due to changes in the adequacy of training variable, whereas changes related to occupational segregation would have widened the gap.

On the whole, this simple analytical framework enabled to identify and disentangle the effects of the main human capital on the observable reduction in the average gender wage gap among full-time employees in the private sector. Other possible approaches could consist in analysing the role of human capital in explaining the distribution of wages across genders, or concentrate on differences between specific cohorts.

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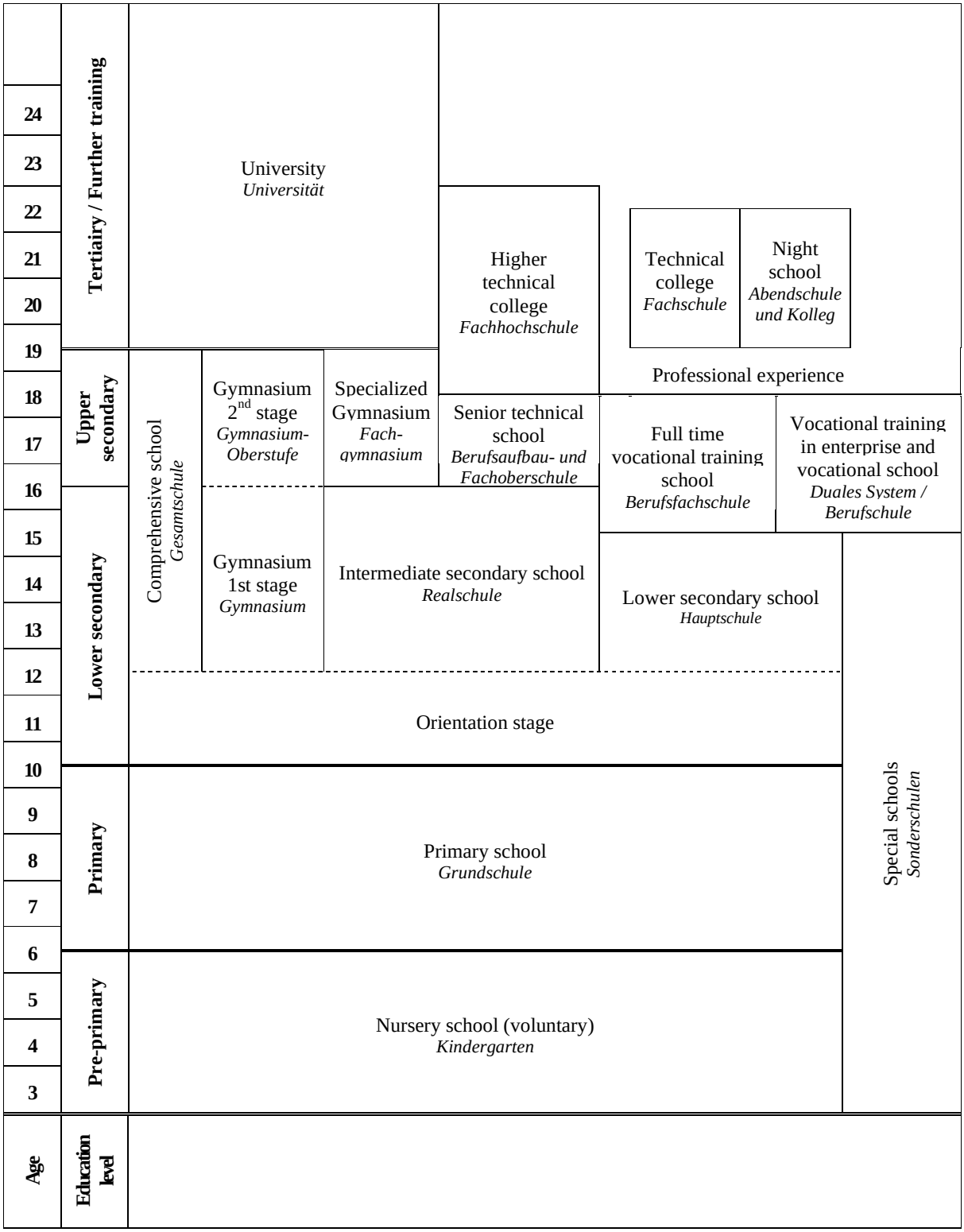
Annex

Annex 1: The German education system



Annex 2: Descriptive statistics of the variables in the wage equations

	Means				Gender diff.		Time diff.	
	Period 1		Period 2		Period 1	Period 2	Men	Women
	X_m	X_f	X_m	X_f	X_m-X_f	X_m-X_f	X^{t+1}-X^t	X^{t+1}-X^t
Low/interm. school+appr.	0.661	0.612	0.581	0.635	0.049	-0.054	-0.080	0.023
Low/interm. school+master	0.088	0.031	0.108	0.052	0.057	0.056	0.020	0.021
High school+/voc. degree	0.039	0.065	0.068	0.075	-0.025	-0.008	0.028	0.011
Higher technical college	0.049	0.014	0.065	0.025	0.036	0.039	0.015	0.012
University	0.046	0.027	0.080	0.044	0.019	0.035	0.034	0.018
Potential experience	22.034	16.716	21.174	18.353	5.318	2.820	-0.861	1.637
Potential experience^2 / 100	6.113	4.212	5.605	4.564	1.901	1.041	-0.508	0.351
Prev. part-time experience	0.139	0.741	0.194	1.225	-0.602	-1.031	0.054	0.484
Prev. unemployment	0.220	0.206	0.411	0.352	0.014	0.060	0.192	0.146
Prev. non-employment	1.009	2.915	1.064	2.811	-1.907	-1.748	0.055	-0.104
Tenure	12.130	7.882	11.772	8.315	4.248	3.456	-0.359	0.433
Occup. in area trained for	0.537	0.512	0.650	0.602	0.025	0.048	0.114	0.091
Femin. of occupation/100	0.231	0.586	0.240	0.584	-0.355	-0.344	0.009	-0.002

Source: GSOEP 1984-97, own calculations.

Annex 3: T-tests of equality of coefficients

	Gender differential				Time differential			
	Period 1		Period 2		Men		Women	
	$ß_m$-$ß_f$	t-stat.	$ß_m$-$ß_f$	t-stat.	$ß^{t+1}$-$ß^t$	t-stat.	$ß^{t+1}$-$ß^t$	t-stat.
Low/interm. school+apprent.	0.004	0.17	0.024	0.96	-0.015	0.78	-0.035	1.30
Low/interm. school+master	0.084	1.97	0.106	2.64	-0.033	1.27	-0.055	1.04
High school+/voc. degree	0.087	2.24	0.056	1.46	-0.086	2.75	-0.055	1.25
Higher technical college	0.111	1.82	0.189	3.64	0.018	-0.57	-0.061	0.82
University	0.088	1.83	0.189	4.27	-0.076	2.48	-0.177	3.05
Potential experience	-0.006	-2.05	-0.004	-1.04	0.001	-0.29	-0.002	0.44
Potential experience^2 / 100	0.011	1.53	0.001	0.17	0.000	-0.07	0.010	-1.12
Previous part-time experience	-0.006	-1.44	-0.006	-1.31	-0.010	1.89	-0.010	2.65
Previous unemployment	0.004	0.31	0.021	1.90	0.014	-1.76	-0.003	0.16
Previous non-employment	0.011	4.81	0.004	1.27	-0.007	2.48	0.000	0.14
Tenure	-0.001	-0.84	0.002	1.48	0.000	-0.14	-0.003	1.73
Occupation in area trained for	-0.023	-1.29	-0.082	-4.54	0.020	-1.64	0.079	-3.60
Femin. of occupation/100	0.079	2.34	0.088	2.42	-0.048	1.88	-0.056	1.32

Source: GSOEP 1984-97, own calculations.

Note: H_0: equality of the coefficients b_1 and b_2, with respective standard errors se_1 and se_2.

t-statistics = $(b_2 - b_1) / \sqrt{(se_1)^2 + (se_2)^2}$. If $|t|$>1.96 (resp. 2.58, 1.65), then the hypothesis of equality of the coefficients is rejected at a significance level of 5% (resp. 1%, 10%).

Annex 4: Return to educational degrees, corrected for the different lengths of studies – Full-time employees, private sector

	1984-87		1994-97	
	Men	Women	Men	Women
Low/interm. school+apprenticeship	0.072	0.067	0.062	0.051
Low/interm. school+master	0.128	0.079	0.107	0.064
High school+/apprenticeship/master	0.072	0.056	0.056	0.046
Higher technical college	0.080	0.073	0.080	0.053
University	0.076	0.070	0.068	0.050

Source: GSOEP 1984-97, own calculations.

Note: 1) Returns are given by $r_i = \beta_i / (d_i - d_{ref.})$, with d_i = number of years required to complete degree i. To obtain the return in percent, compute $[\exp(r_i)-1] \times 100$.

Annex 5: Return to potential experience at different levels of experience – Full-time employees, private sector

Years of potential labour market experience	1984-87		1994-97	
	Men	Women	Men	Women
5	0.027	0.032	0.027	0.031
10	0.021	0.025	0.021	0.025
15	0.015	0.018	0.016	0.019
20	0.009	0.011	0.010	0.013
25	0.003	0.004	0.004	0.007
30	-0.001	0.001	-0.002	0.001

Source: GSOEP 1984-97, own calculations.

Notes: 1) $\hat{\alpha}_2 + 2\hat{\alpha}_3 Experience$. To obtain the return in percent, compute $[\exp(\hat{\alpha}_2 + 2\hat{\alpha}_3 Experience)-1] \times 100$.
2) The computation of the standard errors is based on the "delta" method: For a given level of X, let the function $h(\alpha_2, \alpha_3) = \alpha_2 + 2\alpha_3 X$. The variance of the estimate $\hat{\alpha}$ obtained from $h(\hat{\alpha}_2, \hat{\alpha}_3)$ is $Var(\hat{\alpha}) = AVA'$, with the matrix $A = [\partial h / \partial \alpha_2, \partial h / \partial \alpha_3]$ and V = variance-covariance matrix of the estimates $\hat{\alpha}_2$ and $\hat{\alpha}_3$. The estimated coefficients were all significant at the 5% level except at 30 years of experience for men.

Annex 6: Decomposition of the gender wage gap 1984-87 (period 1)

	Endowment $(X_m-X_f)*ß_f$	**Return** $(ß_m-ß_f)*X_f$	**End.-Return** $(ß_m-ß_f)*(X_m-X_f)$	**Total**
Low/interm. school+apprent.	0.006	0.002	0.000	0.008
Low/interm. school+master	0.012	0.003	0.005	0.019
High school+/voc. degree	-0.007	0.006	-0.002	-0.004
Higher technical college	0.015	0.002	0.004	0.020
University	0.012	0.002	0.002	0.016
Potential experience	0.206	-0.105	-0.033	0.068
Potential experience^2 / 100	-0.133	0.045	0.020	-0.069
Previous part-time experience	0.000	-0.005	0.004	-0.001
Previous unemployment	-0.001	0.001	0.000	0.000
Previous non-employment	0.017	0.032	-0.021	0.028
Tenure	0.013	-0.009	-0.005	-0.001
Occupation in area trained for	0.001	-0.012	-0.001	-0.011
Femin. of occupation/100	0.030	0.046	-0.028	0.049
Total	**0.153**	**0.220**	**-0.008**	**0.365**
% wage gap	**42.0**	**60.2**	**-2.2**	**100**
related to:				
Education	0.037	0.014	0.008	0.060
Experience	0.102	-0.041	-0.035	0.026
Occupation	0.032	0.035	-0.029	0.038

Source: GSOEP 1984-97, own calculations.

Annex 7: Decomposition of the gender wage gap 1994-97 (period 2)

	Endowment $(X_m-X_f)*ß_f$	**Return** $(ß_m-ß_f)*X_f$	**End.-Return** $(ß_m-ß_f)*(X_m-X_f)$	**Total**
Low/interm. school+apprent.	-0.005	0.015	-0.001	0.009
Low/interm. school+master	0.008	0.006	0.006	0.020
High school+/voc. degree	-0.002	0.004	0.000	0.002
Higher technical college	0.014	0.005	0.007	0.026
University	0.015	0.008	0.007	0.030
Potential experience	0.104	-0.069	-0.011	0.024
Potential experience^2 / 100	-0.063	0.006	0.001	-0.056
Previous part-time experience	0.010	-0.008	0.006	0.009
Previous unemployment	-0.003	0.007	0.001	0.005
Previous non-employment	0.016	0.011	-0.007	0.021
Tenure	0.000	0.016	0.007	0.023
Occupation in area trained for	0.006	-0.049	-0.004	-0.047
Femin. of occupation/100	0.049	0.051	-0.030	0.070
Total	**0.152**	**0.130**	**0.017**	**0.299**
% wage gap	**50.8**	**43.5**	**5.7**	**100**
related to:				
Education	0.031	0.038	0.018	0.088
Experience	0.065	-0.037	-0.002	0.027
Occupation	0.055	0.002	-0.034	0.023

Source: GSOEP 1984-97, own calculations.

Annex 8: Decomposition of the wage increase between 1984-87 and 1994-97 (men)

	Endowment $(X^{t+1}-X^t)* ß^t$	**Return** $(ß^{t+1} - ß^t)* X^t$	**End.-Return** $(X^{t+1}-X^t)*(ß^{t+1}- ß^t)$	**Total**
Low/interm. school+apprent.	-0.010	-0.010	0.001	-0.019
Low/interm. school+master	0.006	-0.003	-0.001	0.002
High school+/voc. degree	0.010	-0.003	-0.002	0.004
Higher technical college	0.008	0.001	0.000	0.009
University	0.024	-0.003	-0.003	0.018
Potential experience	-0.028	0.017	-0.001	-0.011
Potential experience^2 / 100	0.030	0.002	0.000	0.032
Previous part-time experience	0.000	-0.001	-0.001	-0.002
Previous unemployment	-0.009	0.003	0.003	-0.003
Previous non-employment	0.000	-0.007	0.000	-0.008
Tenure	-0.001	0.001	0.000	0.001
Occupation in area trained for	0.003	0.011	0.002	0.017
Femin. of occupation/100	0.000	-0.011	0.000	-0.011
Total	**0.036**	**0.156**	**-0.006**	**0.186**
% wage gap	**19.2**	**83.9**	**-3.1**	**100**
related to:				
Education	0.038	-0.019	-0.004	0.015
Experience	-0.007	0.015	0.001	0.008
Occupation	0.003	0.000	0.002	0.005

Source: GSOEP 1984-97, own calculations.

Annex 9: Decomposition of the wage increase between 1984-87 and 1994-97 (women)

	Endowment $(X^{t+1}-X^t)* ß^t$	**Return** $(ß^{t+1} - ß^t)* X^t$	**End.-Return** $(X^{t+1}-X^t)*(ß^{t+1}- ß^t)$	**Total**
Low/interm. school+apprent.	0.003	-0.022	-0.001	-0.020
Low/interm. school+master	0.004	-0.002	-0.001	0.001
High school+/voc. degree	0.003	-0.004	-0.001	-0.001
Higher technical college	0.005	-0.001	-0.001	0.003
University	0.011	-0.005	-0.003	0.003
Potential experience	0.063	-0.029	-0.003	0.032
Potential experience^2 / 100	-0.025	0.041	0.003	0.019
Previous part-time experience	0.000	-0.007	-0.005	-0.012
Previous unemployment	-0.007	-0.001	0.000	-0.008
Previous non-employment	0.001	-0.001	0.000	0.000
Tenure	0.001	-0.024	-0.001	-0.024
Occupation in area trained for	0.005	0.041	0.007	0.053
Femin. of occupation/100	0.000	-0.033	0.000	-0.033
Total	**0.063**	**0.187**	**0.002**	**0.252**
% wage gap	**25.0**	**74.2**	**0.9**	**100**
related to:				
Education	0.026	-0.032	-0.006	-0.013
Experience	0.034	-0.021	-0.006	0.007
Occupation	0.005	0.008	0.007	0.020

Source: GSOEP 1984-97, own calculations.

Annex 10: Decomposition of the gender wage gap: 1994-97 minus 1984-87 (period 2 minus period 1)

	Endowment $(X_m-X_f)*ß_f$	**Return** $(ß_m-ß_f)*X_f$	**End.-Return** $(ß_m-ß_f)*(X_m-X_f)$	**Total**
Low/interm. school+apprent.	-0.010	0.013	-0.001	0.001
Low/interm. school+master	-0.003	0.003	0.001	0.001
High school+/voc. degree	0.005	-0.001	0.002	0.006
Higher technical college	-0.001	0.003	0.003	0.006
University	0.004	0.006	0.005	0.015
Potential experience	-0.102	0.036	0.023	-0.043
Potential experience^2 / 100	0.070	-0.039	-0.019	0.013
Previous part-time experience	0.010	-0.003	0.003	0.010
Previous unemployment	-0.002	0.006	0.001	0.005
Previous non-employment	-0.001	-0.021	0.014	-0.008
Tenure	-0.013	0.025	0.012	0.024
Occupation in area trained for	0.005	-0.038	-0.003	-0.036
Femin. of occupation/100	0.018	0.005	-0.002	0.021
Total	**-0.001**	**-0.089**	**0.025**	**-0.066**
% wage gap	**1.7**	**136.2**	**-37.9**	**100**
related to:				
Education	-0.006	0.024	0.010	0.028
Experience	-0.037	0.005	0.033	0.001
Occupation	0.024	-0.033	-0.006	-0.015

Source: GSOEP 1984-97, own calculations.

Annex 11: Decomposition of the wage increase between 1984-87 and 1994-97 (men minus women)

	Endowment $(X^{t+1}-X^t)*ß^t$	**Return** $(ß^{t+1}-ß^t)*X^t$	**End.-Return** $(X^{t+1}-X^t)*(ß^{t+1}-ß^t)$	**Total**
Low/interm. school+apprent.	-0.013	0.012	0.002	0.001
Low/interm. school+master	0.002	-0.001	0.000	0.001
High school+/voc. degree	0.007	0.000	-0.002	0.006
Higher technical college	0.003	0.002	0.001	0.006
University	0.013	0.001	0.001	0.015
Potential experience	-0.091	0.046	0.002	-0.043
Potential experience^2 / 100	0.055	-0.038	-0.004	0.013
Previous part-time experience	0.000	0.006	0.004	0.010
Previous unemployment	-0.001	0.004	0.003	0.005
Previous non-employment	-0.001	-0.006	0.000	-0.008
Tenure	-0.002	0.025	0.001	0.024
Occupation in area trained for	-0.001	-0.030	-0.005	-0.036
Femin. of occupation/100	0.000	0.022	-0.001	0.021
Total	**-0.027**	**-0.030**	**-0.008**	**-0.066**
% wage gap	**41.5**	**46.4**	**12.0**	**100**
related to:				
Education	0.012	0.013	0.002	0.028
Experience	-0.041	0.036	0.007	0.001
Occupation	-0.002	-0.008	-0.005	-0.015

Source: GSOEP 1984-97, own calculations.

Annex 12: Decomposition of the change in the gender wage gap between 1984-87 and 1994-97

	Endowment				Return component				Endowm.-Return component				Total			
	(1)	1a	1b	1c	(2)	2a	2b	2c	(3)	3a	3b	3c	1+2+3	a	b	c
apprentice.	-0.010	-0.012	-0.002	0.004	0.013	0.000	0.012	0.000	-0.001	0.000	0.001	-0.002	0.001	-0.013	0.012	0.002
master	-0.003	0.000	-0.003	0.000	0.003	0.002	0.001	0.000	0.001	0.000	0.001	0.000	0.001	0.002	-0.001	0.000
high school	0.005	0.005	0.001	-0.001	-0.001	0.001	-0.002	0.000	0.002	0.002	0.001	-0.001	0.006	0.007	0.000	-0.002
higher tech. coll.	-0.001	0.002	-0.002	0.000	0.003	0.001	0.001	0.001	0.003	0.000	0.003	0.000	0.006	0.003	0.002	0.001
university	0.004	0.010	-0.003	-0.003	0.006	0.002	0.003	0.002	0.005	0.001	0.002	0.002	0.015	0.013	0.001	0.001
pot. exp.	-0.102	-0.097	-0.009	0.004	0.036	-0.010	0.042	0.004	0.023	0.016	0.013	-0.006	-0.043	-0.091	0.046	0.002
(pot. exp)2	0.070	0.060	0.018	-0.008	-0.039	0.004	-0.039	-0.003	-0.019	-0.009	-0.018	0.008	0.013	0.055	-0.038	-0.004
part-time exp.	0.010	0.000	0.006	0.004	-0.003	-0.003	0.000	0.000	0.003	0.003	0.000	0.000	0.010	0.000	0.006	0.004
unempl.	-0.002	-0.002	0.000	0.000	0.006	0.001	0.003	0.002	0.001	0.000	0.000	0.001	0.005	-0.001	0.004	0.003
non-empl.	-0.001	-0.001	0.001	0.000	-0.021	-0.001	-0.020	0.001	0.014	0.002	0.013	-0.001	-0.008	-0.001	-0.006	0.000
tenure	-0.013	-0.002	-0.013	0.002	0.025	0.000	0.024	0.001	0.012	0.001	0.013	-0.002	0.024	-0.002	0.025	0.001
occ. adequacy	0.005	0.001	0.002	0.002	-0.038	-0.002	-0.030	-0.005	-0.003	-0.001	-0.001	-0.001	-0.036	-0.001	-0.030	-0.005
degree fem.	0.018	-0.001	0.020	-0.001	0.005	0.000	0.005	0.000	-0.002	0.001	-0.003	0.000	0.021	0.000	0.022	-0.001
Summe	**-0.001**	**-0.052**	**0.050**	**0.002**	**-0.089**	**0.004**	**-0.089**	**-0.004**	**0.025**	**0.021**	**0.009**	**-0.005**	**-0.066**	**-0.027**	**-0.030**	**-0.008**
% of (1+2+3)	**1.7**	**79.7**	**-75.7**	**-2.3**	**136.2**	**-6.6**	**136.0**	**6.8**	**-37.9**	**-31.6**	**-13.8**	**7.5**	**100**	**41.5**	**46.4**	**12.0**
related to:																
Education	-0.006	0.004	-0.009	0.000	0.024	0.006	0.015	0.003	0.010	0.003	0.008	-0.001	0.028	0.012	0.013	0.002
Experience	-0.037	-0.043	0.003	0.002	0.005	-0.011	0.010	0.005	0.033	0.012	0.022	-0.001	0.001	-0.041	0.036	0.007
Occupation	0.024	0.000	0.022	0.001	-0.033	-0.002	-0.025	-0.005	-0.006	0.000	-0.005	-0.001	-0.015	-0.002	-0.008	-0.005

Source: GSOEP 1984-97, own calculations.