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Work Characteristics, Firm Size and Wages *

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Abstract

A positive wage-firm size relationship is well documented in the empirical literature in industrial organization and labor economics. Firm size seems to proxy various unobserved determinants such as job satisfaction, monitoring costs, more complex technologies and worker participation in monopoly profits. It is generally argued that, the greater the possibility of controlling for these latent factors, the less likely that a significant size effect will appear. This paper attempts to distinguish firm size from other wage determinants for a rich data source for West Germany and demonstrates the persistence of the size premium.

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I. Introduction

It is frequently observed that concentrated industries pay unusually high wages and large firms pay more than small firms.¹ These studies reveal that the size-wage effect is quite large. Among the various attempts to explain these findings we can find the following hypotheses: (i) larger firms exhibit higher profits, and organized labor obtains a larger share; (ii) working in larger firms is more unpleasant, which has to be compensated; (iii) larger firms must employ higher quality workers since they use more complex technologies; (iv) firm size only captures industry differences or firm types; (v) in larger firms, productivity is more sensitive to wages due to higher turnover costs, higher monitoring costs, or the greater negative effects of shirking; (vi) workers have differential information about different firms so that larger firms must pay more to attract more workers.

In applied work, it is often difficult to examine these hypotheses due to lack of adequate data. Therefore, it is natural to observe a positive employer size-wage effect which proxies these determinants. The greater the possibility of measuring these variables, the less likely that a significant size effect will appear.

Most hypotheses can be considered in the framework of equalizing wage differences (see Rosen, 1986, for an overview). Thus, it seems natural to study the issue in the framework of human capital theory (see Willis, 1986, for an overview) and formulate an earnings function which can be extended by worker, firm and industry characteristics to account fully for other relevant determinants of earnings.

The paper is organized as follows. Section II presents a more detailed survey of these issues. Section III describes the rich West German data set used in this study. In Section IV, the econometric findings are discussed. Section V concludes. The empirical result is that the size variable is significant whatever additional information is included in the regressions: job seniority, innovative activity, industry- and firm-type dummies, demographic variables, and a rich set of work characteristics.

II. Basic Hypotheses

There is substantial evidence from many countries of a positive impact of firm size or plant size on observed earnings. To explain this phenomenon several hypotheses on wage determination have been put forth. All imply that firm size serves as a proxy for one or more unobserved determinants. Many of them can be captured within the basic long-term equilibrium concept of labor economics, the theory of compensating wage differentials. Among others, Masters (1969) has argued that working in larger firms or larger plants is more unpleasant due to increased work division and impersonal atmosphere and requires workers who are particularly dependable and willing to be regimented. In larger firms, we expect

¹ See Blanchflower (1986), Haywood (1986), Brown/Medoff (1989) and Dunn (1986), for instance.

greater reliance on rules and formal procedures governing the production process. Furthermore, more commuting may be required since large firms tend to be located in industrial areas and hence further from residential areas. For these elements of disutility, firms have to offer compensating differentials.

Our empirical work concentrates on testing the neoclassical explanations of the size-wage differential. The standard earnings function of human capital theory explaining wages by years of schooling and experience can be justified in a compensating differential framework (Willis, 1986). Typically, variables measuring individual human capital, although imperfectly, are added as controls. Thus, to test the importance of the equalizing difference argument, it is natural to estimate an earnings function augmented by firm size and to add variables capturing work characteristics. If the size differential persists, other hypotheses have to be considered.

It is frequently argued that large firms use more complex production technologies and show greater capital intensity together with by capital-skill complementarities. The well-known Schumpeter hypothesis states that larger firms are more innovative. For both reasons, a large firm requires workers who are more highly qualified and have more specialized skills, and is moreover seeking a lower rate of turnover (Oi, 1983). To test the hypothesis of superior labor quality, one has to control for the observed measures of individual human capital. Again, persistence of a size differential hints at the need for different explanations, in particular, since it was argued that ability bias in earnings regressions is only of a magnitude of about 10%. (See also Griliches, 1977.) Additionally, a variable capturing the employing firm's innovative activity should be able to decrease the size differential.

Another line of reasoning is concerned with the payment of efficiency wages, i.e. wages that lie above the market-clearing level in order to provide incentives for lower turnover or to deter shirking. In particular, one could argue that monitoring is typically more difficult in larger than in smaller firms. Thus, in general, whether due to higher turnover cost, higher monitoring cost or greater negative effects of shirking, productivity in large firms is more sensitive to wages (Salop, 1973). Therefore the efficiency wage may increase with firm size. To test for this hypothesis in the context of an earnings function is very difficult since the neoclassical approach presented above predicts the same positive correlation between productivity and wages as the efficiency wage hypothesis and it is virtually impossible to distinguish between the presence of efficiency wages and unmeasured labor quality.

Strand's (1987) model that is based on informational imperfections in the labor market is also difficult to test. Here more productive firms will have a larger size and therefore have a larger labor stock in long-run equilibrium. Consequently, they must employ more workers per period and have to offer higher average wages than small firms.

Another group of arguments focuses on the organization of labor. According to the "monopoly wage theory" large firms exhibit higher profits, and organized

labor will obtain a larger share. Also, in general, labor is expected to be organized better in large than in small firms (Weiss, 1966). Furthermore, firms in less competitive industries might be able to use excess profits to pursue nonmarket objectives like the improvement of public image with wage payment as one possible instrument. In the Federal Republic of Germany collective bargaining is mainly organized on the industry level, and thus, firm size can be expected to proxy industry characteristics. To test for this argument the industry or sector can be incorporated explicitly into the estimated earnings function.

Yet another important argument is concerned with the impact of job seniority. Here the idea is that workers with more seniority on their current job earn more than other workers with the same educational background. This could be explained by explicit employment contracts to provide workers with more incentives to keep turnover low and effort high. Larger firms may find it easier to offer such contracts, perhaps because of the greater opportunity to move from one assignment to another without leaving the firm. Indeed, it is reported that, independent of the size-wage effect, years of tenure grow significantly with firm size. If this observed behavior is due solely to superior packages of working conditions offered by large firms — a view diametrically opposed to the arguments presented above — we should be able to detect this in the estimated earnings function augmented by working conditions, if our information on these conditions is complete enough.

Abraham and Farber (1987) find for the US that earnings are not very much affected by seniority if one incorporates the quality of worker, job, or worker-employer match. This view was challenged by Topel (1988). While this debate is still unsettled, in the particular context of the Federal Republic of Germany many collective wage contracts explicitly specify how to reward seniority and therefore consideration of seniority arguments seems highly appropriate.

The empirical investigation will be as follows: First, seniority and job mobility will be considered. Second, differences in innovative activities between firms will be taken into account to proxy differences in labor quality. Third, a general model on sector differences in wage payments will be employed, testing for institutional differences. Fourth, we consider the demographic characteristics of each employee. Fifth, a large set of working condition variables is taken into account. Given the impact of the hedonic wage literature (see also Hübler and Gerlach, 1989, and Schmidt and Zimmermann, 1989 for German data), this is a straightforward approach. Differences in working conditions have been offered as an alternative to differences in labor quality. Because the undesirable working conditions generally correlate with firm size, larger firms will have to pay higher wages to get a certain labor quality.

Section III contains a description of the data. The empirical investigation is presented in Section IV.

III. Data and Variable Construction

All estimations were performed with data provided by the Zentralarchiv für Empirische Sozialforschung zu Köln. The data set is a random survey of employed individuals in the age group 18-65 years in the Federal Republic of Germany and West-Berlin. We decided to concentrate on male full-time workers to circumvent the usual problems with female labor supply, and to exclude self-employed males and managers. The 891 observations offer detailed information on demographic characteristics, characteristics of the current job and also on the individuals' educational and occupational history.

In particular we directly used or constructed the variables described below (for a list of variables reported in our tables see the Appendix). Following standard courses of education, we constructed the variable years of schooling (SCHOOL) on the basis of the last completed degree. Related to this, we constructed a variable experience (EXP) by subtraction of age and the first six, i.e. preschool, years of life from the schooling variable. Additionally, we constructed experience squared (EXPSQ), to be able to account for possible nonlinear effects of experience. As an indicator of mobility, we used the number of jobs held in different firms (JOBN). Using white-collar workers and skilled workers as the reference group, we used a dummy for individuals being unskilled workers (WO), and a dummy for individuals being qualified white-collar workers (QWCW). Finally, as an indicator of firm-specific human capital formation, the duration of the current job was available in the form of three dummy variables, indicating job durations of 5 to 10 years (JOB5), of 10 to 20 years (JOB10) and of over 20 years (JOB20), respectively. The reference group consisted of the individuals with the duration of the current job being less than 5 years.

A second group of variables provided the basis for the investigation of our main hypothesis. As a reference group for firm size, we chose firms with the number of employees lying between 100 and 499. Firms with less than 100 employees (F-SMALL) or more than 499 employees (F-LARGE) were represented by appropriate dummy variables. The innovative activity of the firm currently employing a specific individual is indicated by a dummy variable (INNO), which realizes the value 1 if the individual experienced a dramatic innovative change in either the machinery used or the organizational structure in recent years.

Two different methods were used to describe further the firms currently employing the observed individuals. The first alternative classifies firms according to types, using manual skill firms as a reference group. The second alternative follows a sectoral classification, taking agriculture and forestry as a reference group. These classifications are not one and the same at different levels of detail.

Additionally two important demographic variables were available: the number of children below 14 years of age living in the individual's household and marital status. Here the reference group is single persons, with appropriate dummies representing married individuals (MA) or individuals widowed, divorced or separated (WD).

Finally, the data set offered information on a variety of individually reported work conditions. Each individual was allowed to report more than one entry from the list of possible conditions. The information was coded in dummy variables which take the value 1 whenever the respective condition applies. These conditions were, in particular, week-end commuting (business allows time at home only on weekends, COM), work on Sundays (WOS), shift work, working outside company premises (WOC), piecework, heavy physical work (HW), work requiring constant concentration, fast-paced work (FPW), monotonous work, uncomfortable posture during work, hazardous work (HAZW), high noise level, weather conditions (WECO), dirty work and finally, polluted air (POLA). Only those work characteristics listed in the Appendix turned out to be statistically significant in the earnings regressions. As the endogenous variable we used the natural logarithm of monthly earnings (take-home pay).

IV. Estimation Results

The empirical investigation was done in various steps. First, a standard earnings function enriched by job duration variables and job mobility was estimated. Then, firm size and innovation activity was considered successively. The main findings of these steps are reported in Table 1. Table 2 contains tests for inter-sectoral differences and firm types. Table 3 studies the impact of job characteristics and the demographic characteristics of the employee. All variable names used in Tables 1-3 are explained in the Appendix.

The standard earnings function in column 1, Table 1 gives quite satisfying results. Log earnings increase with years of schooling (SCHOOL) and experience (EXP), but decrease with experience squared (EXPSQ). It is interesting to note that all of these coefficients are relatively small in absolute terms (see Willis 1986, pp. 541-545 for comparisons). The mobility variable 'number of jobs' (JOBN) is mostly insignificant. Here the basic problem seems to be that there are two countervailing effects: a 'job shopping effect' where more successful people tend to climb the career ladder by moving faster to better jobs and individuals having had more matches are more likely to have found a good one, and a 'lemon effect', in which bad workers are more likely to have lost their jobs more frequently in the past. These effects may be offsetting. The status variables 'other workers' (WO) and 'qualified white-collar worker' (QWCW), however, exhibit correct and significant signs.

The tenure variables are all positive, with the coefficient of the first category (JOBDS) being lower than that of the last category (JOBDS20), strongly indicating a seniority principle, but higher than the coefficient of the middle category. Again this could be explained by selection arguments. It might well be that those holding one particular job for a period longer than 10 years tend to be lower quality workers. Only after a long period of time will these individuals' wages catch up with the wages of more able persons due to the growing effect of seniority.

The robustness of this basic earnings function specification has been tested in various forms. We allowed the influence of schooling and number of jobs to be

nonlinear by incorporating quadratic terms into the regression. Instead of years of schooling, we used a fine breakdown of educational characteristics by defining appropriate dummy variables. Also, the constructed continuous experience variable was replaced by a set of dummies reflecting work experience by broadly defined categories given in the survey. All previous results were qualitatively robust, and hence these alternative estimates are not reported.

In the second step of the empirical investigation, the basic earnings function was augmented by our firm size variables. Having both size dummies in the specification allows for different levels of wages for small, middle, and large firms: using only one of them at a time allows for a wage differential between small and large firms. In the course of investigation we used both variations. The specification using both dummies is reported in Table 1, column 2. It turns out that both coefficients have t-statistics only on the verge of significance. Nevertheless, the appropriate F-statistic has the value 7.30, whereas the critical 5% point for $F(2, 879)$ is 3.0. This shows that together they improve significantly the explanatory power of the regression.

As indicated above it is our basic interest to test for the persistence of size-wage differentials in the presence of a variety of control variables proxying labor quality. Whereas labor quality is partly represented by the human capital variables used in the basic earnings specification, one can suspect that there are unobserved components still omitted from the regression. The following steps all try to proxy these unobserved components in different ways.

The Schumpeterian innovation argument implies the existence of a size-wage differential if large firms are more innovative and innovative activity is left out of the regression. Therefore, we incorporated innovative activity as an indicator of unobserved labor quality in our specification. If indeed innovative activity at the current job is strongly correlated with labor quality, we would expect low quality workers to exhibit steeper experience profiles than high quality workers, but high quality workers to get a sizeable quality premium. Therefore, we allowed for interaction terms between the innovation dummy and experience and experience squared. Leaving these terms out of the specification would lead to a severe downward bias of the innovation coefficient. Indeed, the specification augmented by the innovation dummy alone has shown a small and insignificant coefficient for innovations.

The specification shown in Table 1, column 3, allowing for interaction terms between the innovation dummy and experience and experience squared, however, reports exactly the expected earnings-experience profile and a significant innovation effect. Nevertheless, there could still be a downward bias of the quality premium since innovative behavior captures quality only imperfectly (see Jakubson, 1986). Overall, the consideration of the innovation variables as a group increases the regression's explanatory power significantly. The F-statistic is 3.75, whereas the critical 5%-point for $F(3, 876)$ is 2.60. The size variables, however, stay significant. The specifications in Table 1, columns 4 and 5, make this more visible by just considering one dummy for small firms. (Additionally insignificant variables are excluded from the regressions.)

Whether the correct specification should include both or only one of the size dummies is open to debate. Focusing on monitoring arguments, it seems very reasonable to argue that the supervision of a handful of individuals requires a monitoring technology quite distinct from that needed to supervise individuals in a medium or large size organization, but that the technologies for both latter cases tend to be relatively similar, in particular involving high fixed costs. This point of view thus favors the specification in Table 1, columns 4 and 5, and efficiency wage theory predicts persistence of this size premium as discussed above.

To what extent can wage differences be explained by inter-sectoral differences or firm types? Large firms are more likely to come from concentrated industries. If the documented size-wage effect is merely an expression of the monopoly rent to be divided in less competitive industries, or if some industries use workers of a higher quality for which we could not control using our observables, we should be able to induce a deterioration of the size premium by incorporating our information on firm types or industry groups.

Columns 1 and 2 in Table 2 report estimates of firm type and sectoral dummies alone. Firm types are significantly different from the reference group manual skill firms but exhibit very similar coefficients. Thus, the results seem merely to reflect the fact that manual skill firms are a declining firm type. None of the sector coefficients is significant. This is a surprisingly clear finding.

These results are confirmed when one considers the specifications of Table 1 augmented by the firm type and industry variables (see Table 2, columns 3-4). Now all firm-type variables are insignificant, individually and as a group. The F-statistic is 1.79, whereas the critical 5% point for F (3, 873) is 2.60. Among the sectors, only S11 (education and social and health services) is significant and has a negative parameter. The coefficient of S2 (banking and insurance) is also negative and close to significance. As a group, the industry variables hardly add anything to the explanation of wages. The F-statistic is 1.66, whereas the critical 5% point for F (15, 861) is 1.67. The size variables, however, still show a persistent effect.

It could well be the case that the persistence of the size differential is due to the omission of demographic variables or work characteristics, again these measures proxying worker quality in some form. Therefore, Table 3 includes work characteristics and demographics (columns 2 and 3), whereas column 1 contains the last specification of Table 2 to allow easier comparisons. Also, non-significant industry dummies were excluded.

The variables 'married' (MA) and 'number of children' (NC) have a statistically significant positive impact on earnings. A priori considerations suggest a positive effect parameter for all included work characteristics. Only the significant parameters are included in Table 3. The coefficients of 'commuting' (COM), 'work on Sundays' (WOS), 'working outside company' (WOC), 'fast-paced work' (FPW) and 'hazardous work' (HAZW) all have the correct signs as well. However, the coefficients of 'heavy physical work' (HW), 'weather conditions' (WECO) and

'polluted air' (POLA) are negative, which is not in accordance with the theory of equalizing differences.

It is of considerable importance that the seniority variables (JOBDS - JOBDS20) are all significant again in spite of the inclusion of all available information on labor quality and that firm size variables are larger and exhibit higher t-values than before the inclusion of the labor-quality variables (compare column 2, Table 3 and column 2, Table 1). This finding bears a certain similarity to that of Krueger and Summers (1986) in their investigation of inter-industry wage differentials whose magnitude increases upon controlling for characteristics in their regressions.

Some efforts were made to check for heteroskedasticity. A test for arbitrary heteroskedasticity was suggested by Breusch and Pagan (1979). This is a Lagrange multiplier test against the hypothesis that the error term can be approximated as some function of the exogenous variables. White (1980) has proposed an appropriate asymptotic covariance matrix for the ordinary least squares estimates. Although the Breusch-Pagan test indicated some heteroskedasticity, the White estimates of the t-values turned out not to be notably different, namely the findings for firm size remained stable. This finding was confirmed by weighted least squares, a more general likelihood-ratio test used by Maddala (1986, 263), and a self-weighted regression. Therefore, these results were not included in the paper.

V. Summary and Conclusions

The paper studies the relationship between firm size and employee compensation using as its framework the earnings function of human capital theory. A large and rich data set for West Germany containing detailed information about education, job duration and other work experience, demographic characteristics, job characteristics, and innovative activity and size of the firm was employed. The hypothesis under study was that unmeasured labor quality contributes to the strong positive relationship between firm size and wages reported in the literature. However, we found that even after incorporation of all possible controls, wages increase with firm size. Size and significance of the respective coefficients were not reduced. There have to exist other reasons why large firms are able to survive the competitive disadvantages of higher labor costs in the long-run. Non-production economies of scale may be one possible explanation. Similar results are also obtained by Dunn (1986) and Brown and Medoff (1989).

Of further interest are the findings on job seniority. In contrast to Abraham and Farber (1987), we do not find that the positive impact of job duration on earnings disappears if labor quality is taken into account. This indicates the existence of implicit employment contracts to ensure incentives regarding labor turnover and work effort. It has to be understood, however, that the results on

job tenure have been derived within a different institutional context (for West Germany) than most of the current seniority discussion.

Finally, the effect of some job parameters on earnings remains a puzzle. According to the theory of compensating wage differentials, one expects characteristics generally viewed as positive (negative) to have a positive (negative) influence on the individual earnings. This was not the case for heavy work, weather conditions and polluted air. Similar results were found by Zimmermann and Schmidt (1989), Woittiez and Kapteyn (1989) and Hübler and Gerlach (1989). A possible explanation is the potential endogeneity of work effort, job satisfaction and job characteristics, especially if there exists a causal chain from work characteristics to work effort. Thus, viewing the unexpected signs of the work characteristics mentioned above as an indication of a lack of motivation could be a fruitful approach to explain deviations from the simple approach of compensating wage differentials.

TABLE 1. — LOG EARNINGS: FIRM SIZE AND INNOVATIONS^a

	(1)	(2)	(3)	(4)	(5)
CONSTANT	6.604* (63.98)	6.627* (63.92)	6.555* (61.58)	6.577* (62.15)	6.586* (62.27)
SCHOOL · 10 ⁻¹	0.375* (4.61)	0.367* (4.54)	0.366* (4.54)	0.371* (4.60)	0.374* (4.63)
EXP · 10 ⁻¹	0.217* (6.84)	0.214* (6.78)	0.290* (7.15)	0.301* (7.76)	0.316* (8.39)
EXPSQ · 10 ⁻³	-0.445* (-7.08)	-0.438* (-7.01)	-0.617* (-7.26)	-0.631* (-7.64)	-0.645* (-7.81)
JOBN · 10 ⁻²	0.871 (1.51)	0.901 (1.57)	0.990* (1.73)	0.733 (1.38)	-
WO · 10 ⁻¹	-0.747* (-3.49)	-0.833* (-3.89)	-0.832* (-3.90)	-0.844* (-3.96)	-0.841* (-3.98)
QWCW	0.194* (9.90)	0.186* (9.49)	0.184* (9.44)	0.183* (9.39)	0.181* (9.29)
JOB5 · 10 ⁻¹	0.645* (2.86)	0.549* (2.43)	0.532* (2.36)	0.412* (2.12)	0.357* (1.90)
JOB10 · 10 ⁻¹	0.380 (1.56)	0.291 (1.20)	0.291 (1.20)	-	-
JOB20 · 10 ⁻¹	0.812* (2.59)	0.621 (1.97)	0.583* (1.84)	0.373 (1.51)	-
F-SMALL · 10 ⁻¹	-	-0.396 (-1.80)	-0.343 (-1.56)	-0.578* (-3.47)	-0.593* (-3.60)
F-LARGE · 10 ⁻¹	-	0.290 (1.41)	0.314 (1.52)	-	-
INNO	-	-	0.147* (2.64)	0.146* (2.61)	0.141* (2.53)
INNO · EXP · 10 ⁻¹	-	-	-0.158* (-2.92)	-0.152* (-2.81)	-0.150* (-2.77)
INNO · EXPSQ · 10 ⁻³	-	-	0.360* (3.10)	0.346* (2.98)	0.345* (2.97)
$\bar{R}^2$	0.251	0.261	0.268	0.267	0.266
SSR	46.485	45.725	45.145	45.339	45.493

^a Number of observations: 891. t-values in parentheses. A * indicates significance at the 5% level (one-tailed test).

TABLE 2. - LOG EARNINGS: INTER-SECTORAL DIFFERENCES ^a

	(1)	(2)	(3)	(4)
CONSTANT	7.262* (372.65)	7.334* (140.89)	6.531* (60.49)	6.536* (56.45)
SCHOOL ·10 ⁻¹	-	-	0.374* (4.62)	0.413* (5.05)
EXP ·10 ⁻¹	-	-	0.294* (7.25)	0.280* (6.87)
EXPSQ ·10 ⁻³	-	-	-0.623* (-7.23)	-0.589* (-6.90)
JOBN ·10 ⁻²	-	-	0.973* (1.70)	0.851 (1.48)
WO ·10 ⁻¹	-	-	-0.852* (-3.98)	-0.763* (-3.54)
QWCW	-	-	0.185* (9.03)	0.206* (10.03)
JOBDS ·10 ⁻¹	-	-	0.536* (2.38)	0.492* (2.18)
JOBDS10 ·10 ⁻¹	-	-	0.266 (1.09)	0.231 (0.95)
JOBDS20 ·10 ⁻¹	-	-	0.548* (1.73)	0.417 (1.30)
F-SMALL ·10 ⁻¹	-	-	-0.294 (-1.26)	-0.438* (-1.95)
F-LARGE ·10 ⁻¹	-	-	0.315 (1.51)	0.334 (1.60)
INNO	-	-	0.153* (2.74)	0.144* (2.57)
INNO · EXP ·10 ⁻¹	-	-	-0.167* (-3.08)	-0.152* (-2.79)
INNO · EXPSQ ·10 ⁻³	-	-	0.380* (3.26)	0.345* (2.95)
F-TYPE1	0.111* (4.74)	-	0.024 (0.97)	-
F-TYPE2	0.110* (3.79)	-	0.025 (0.94)	-
F-TYPE3	0.101* (3.43)	-	-0.023 (-0.80)	-

TABLE 3. - LOG EARNINGS: WORK CHARACTERISTICS
AND DEMOGRAPHICS^a

	(1)	(2)	(3)
CONSTANT	6.530* (61.35)	6.505* (64.50)	6.508* (65.03)
SCHOOL ·10 ⁻¹	0.399* (4.93)	0.382* (5.00)	0.395* (5.18)
EXP ·10 ⁻¹	0.283* (7.04)	0.178* (4.43)	0.180* (4.47)
EXPSQ ·10 ⁻³	-0.599* (-7.08)	-0.384* (-4.59)	-0.384* (-4.59)
JOBN ·10 ⁻²	0.939* (1.66)	-0.834* (1.56)	0.906 (1.70)
WO ·10 ⁻¹	-0.817* (-3.85)	-0.732* (-3.68)	-0.725* (-3.64)
QWCW	0.196* (9.87)	0.171* (8.36)	0.167* (8.22)
JOB5 ·10 ⁻¹	0.530* (2.36)	0.549* (2.63)	0.554* (2.66)
JOB10 ·10 ⁻¹	0.246 (1.02)	0.416* (1.84)	0.424* (1.87)
JOB20 ·10 ⁻¹	0.474 (1.50)	0.682* (2.30)	0.723* (2.44)
F-SMALL ·10 ⁻¹	-0.370* (-1.70)	-0.418* (-2.03)	-0.593* (-3.67)
F-LARGE ·10 ⁻¹	0.312 (1.53)	0.243 (1.27)	- -
INNO	0.141* (2.54)	0.136* (2.62)	0.136* (2.63)
INNO · EXP ·10 ⁻¹	-0.149* (-2.77)	-0.142* (-2.80)	-1.40* (-2.77)
INNO · EXPSQ ·10 ⁻³	0.341* (2.95)	0.319* (2.94)	0.312* (2.88)
S2 ·10 ⁻¹	-0.701 (-1.60)	-0.588 (-1.43)	- -
S11	-0.200* (-3.52)	-0.229* (-4.28)	-0.226* (-4.23)

TABLE 3. - CONTINUED

	(1)	(2)	(3)
COM $\cdot 10^{-1}$	—	0.880*	0.906*
	—	(3.02)	(3.11)
WOS $\cdot 10^{-1}$	—	0.830*	0.839*
	—	(4.14)	(4.19)
WOC $\cdot 10^{-1}$	—	0.718*	0.710*
	—	(3.91)	(3.87)
HW $\cdot 10^{-1}$	—	-0.335*	-0.356*
	—	(-1.90)	(-2.02)
FPW $\cdot 10^{-1}$	—	0.727*	0.721*
	—	(4.97)	(4.93)
HAZW $\cdot 10^{-1}$	—	0.274	0.304*
	—	(1.55)	(1.73)
WECO $\cdot 10^{-1}$	—	-0.376*	-0.363*
	—	(-2.00)	(-1.94)
POLA $\cdot 10^{-1}$	—	-0.582*	-0.580*
	—	(-3.65)	(-3.63)
MA $\cdot 10^{-1}$	—	0.845*	0.735*
	—	(3.36)	(3.17)
WD $\cdot 10^{-1}$	—	0.612	—
	—	(1.33)	—
NC $\cdot 10^{-1}$	—	0.750*	0.757*
	—	(4.31)	(4.35)
$\bar{R}^2$	0.291	0.378	0.377
SSR	44.414	37.786	38.023

* Number of observations in columns is 891, t-values in parentheses. A * indicates significance at the 5% level (one-tailed test).

REFERENCES

- Abraham, Katharine G., and Henry S. Farber, "Job Duration, Seniority, and Earnings", *American Economic Review* 77 (3) (June 1987), 278-297.
- Altonji, Joseph G., and Robert Skakotko, "Do Wages Rise with Job Seniority?", *Review of Economic Studies* 54 (1987), 437-459.
- Blanchflower, David, "Wages and Concentration in British Manufacturing", *Applied Economics* 18 (1986), 1025-1038.
- Breusch, T.S. and Adrian R. Pagan, "A Simple Test for Heteroskedasticity and Random Coefficient Variation", *Econometrica* 47 (Sept. 1979), 1287-1294.
- Brown, Charles, and James L. Medoff, "The Employer Size Wage Effect", NBER Working Paper No. 2870 (March 1989).
- Dunn, Lucia F., "Work Disutility and Compensating Differentials: Estimation of Factors in the Link between Wages and Firm Size", *Review of Economics and Statistics* 68 (1) (1986), 67-73.
- Griliches, Zvi, "Estimating the Returns to Schooling: Some Econometric Problems", *Econometrica* 45 (Jan. 1977), 1-22.
- Heywood, John S., "Labor Quality and the Concentration-Earnings Hypothesis", *Review of Economics and Statistics* 68 (2) (May 1986), 342-346.
- Hübler, Olaf, and Knut Gerlach, "Sectoral and Occupational Earnings Patterns: Towards a Test of the Efficiency Wage Hypothesis", 1989, in H. König, *Recent Developments in Wage Determination*, (Heidelberg, F.R.G.: Springer Verlag), forthcoming.
- Jakubson, George, "Measurement Error in Binary Explanatory Variables in Panel Data Models: Why Do Cross Section and Panel Estimates of the Union Wage Effect Differ?", Mimeo., 1986, Princeton University.
- Krueger, Ann B. and Lawrence H. Summers, "Reflections on the Inter-Industry Wage Structure", NBER Working Paper No. 1968 (1986).
- Lundberg, Shelley, "Tied Wage-Hours Offers and the Endogeneity of Wages", *Review of Economics and Statistics* 67 (1985), 405-410.
- Maddala, G.S., *Econometrics*, (London: McGraw Hill, 1986).
- Masters, Stanley H., "Wages and Plant Size: An Interindustry Analysis", *Review of Economics and Statistics*, 68(1) (1969), 67-73.
- Oi, Walter, "Heterogenous Firms and the Organization of Production", *Economic Inquiry* 21 (1983), 147-171.
- Rosen, Sherwin, "The Theory of Equalizing Differences", in O. Ashenfelter and R. Layard (eds.), *Handbook of Labor Economics*, vol. 1, (Amsterdam: North-Holland, 1986), 641-692.

- Salop, Steven C., "Wage Differentials in a Dynamic Theory of the Firm", *Journal of Economic Theory* 6(4) (Aug. 1973), 321-344.
- Schmidt, Christoph M. and Klaus F. Zimmermann, "Der implizite Markt für Arbeitsbedingungen: Ein Test der hedonischen Theorie", 1988, *Jahrbuch für Sozialwissenschaften*, forthcoming.
- Strand, Jon, "The Relationship Between Wages and Firm Size: An Information Theoretic Analysis", *International Economic Review* 28(1) (Feb. 1987), 51-68.
- Topel, Robert, "Wages Rise with Job Seniority", 1987, mimeo.
- Weiss, Leonard W., "Concentration and Labor Earnings", *American Economic Review* 56 (March 1966), 96-117.
- White, Halbert, "A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity", *Econometrica* 48 (May 1980), 817-838.
- Willis, Robert J., "Wage Determinants: A Survey and Reinterpretation of Human Capital Earning Functions", in O. Ashenfelter and R. Layard (eds.), *Handbook of Labor Economics*, vol. 1, (Amsterdam: North-Holland, 1986), 525-602.
- Woittiez, Isolde, and Arie Kapteyn, "A Model of Job Choice, Labor Supply and Wages", 1989, in H. König, *Recent Developments in Wage Determination*, (Heidelberg, F.R.G.: Springer Verlag), forthcoming.
- Zimmermann, Klaus F., "Wages and the Quantity and Quality of Labor", 1989, in H. König, *Recent Developments in Wage Determination*, (Heidelberg, F.R.G.: Springer Verlag), forthcoming.
- Zimmermann, Klaus F. and Christoph M. Schmidt, "Quellen des Wachstums: Leistungsbereitschaft der Erwerbstätigen oder Nachfrage kinderreicher Familien?", in K.F. Zimmermann (ed.), *Demographische Probleme der Haushaltsökonomie* (Bochum, 1986), 97-125.

APPENDIX

DESCRIPTION OF VARIABLES

(a) Human Capital Variables

SCHOOL	Years of schooling
EXP	Experience = age - SCHOOL - 6
EXPSQ	EXP - squared
JOBN	Number of jobs in different firms
WO	Unskilled worker
QWCW	Qualified white collar worker
JOB5	Job duration 5 - 10 years
JOB10	Job duration 10 - 20 years
JOB20	Job duration > 20 years

(b) Firm Size and Innovations

F-SMALL	Number of employees < 100
F-LARGE	Number of employees > 499
INNO	Yes (1), no (0); new machine, technical advance or an organizational change

(c) Type of Firm

F-TYPE1	Manufacturing industry
F-TYPE2	Trade and service industry
F-TYPE3	Public service

(d) Sectoral Classification

S1	Trade
S2	Banking and insurance
S3	Mining and energy
S4	Chemical industry
S5	Iron, steel and machinery
S6	Automobile industry
S7	Electrotechnical industry, optics and fine machinery
S8	Textile, leather and clothing
S9	Construction industry
S10	Transportation, postal services and telecommunications
S11	Education and social and health services
S12	Maintenance, hotel and restaurant services
S13	Other manufacturing industries
S14	Other services
S15	Food

(e) Demographics

MA	Married
WD	Widowed/divorced/separated
NC	Number of children under 14 years

(f) Work Characteristics

COM	Commuting: Required business travel allowing time at home only on weekends
WOS	Work on Sundays
WOC	Working outside company premises
HW	Heavy physical work
FPW	Fast-paced work
HAZW	Hazardous work
WECO	Weather conditions
POLA	Polluted air