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Wage Structure and Labour Mobility in the West German Private Sector 1993-2000

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Abstract

Since the early 90's the West German firms have to deal with sharp changes of economic environment: the German Unification, the emerging competitors in the east European countries and the deregulation of several labour market institutions. We analyse the wage structure, the wage changes and the labour mobility during this period using the linked employer-employee dataset from the Institute for Employment Research for the years 1993, 1995 and 2000. The dataset allows us to investigate especially the wage structure within firms and the exit and entry rates of workers at firm level. The main finding is that both wage inequality within and between firms and workers mobility was rising during the 90's. This development is mainly driven by the dynamics of high wage workers and high wage firms. The rising variance of wages can only partly be explained by a change in the occupational composition of firms. A decomposition of the variance of wages shows that the importance of the firm-specific variation increases, whereas that of human capital variation decreases.

This study is prepared as a chapter for the NBER volume *The Structure of Wages Within Firms – Europe and the United States*, edited by Edward Lazear and Katryn Shaw. The volume will do cross-country comparisons on some basic issues that relate to wage structures and hierarchical patterns and is a project form the Personnel Economics NBER Working Group. A former version of the material in this chapter was presented at the Empirical Personnel Economics NBER Meeting in Boston, April 17, 2004. We have benefited a lot from comments and valuable suggestions from Gesine Stephan, from the conference participants and especially from Edward Lazear and Kathryn Shaw.

1 Introduction

Since the early 90's the West German firms have to deal with sharp changes of economic environment: the German Unification and the emerging competitors in the east European countries. In the same time some parts of the labour market in Germany was deregulated. The changes have impacts on the labour market development in West Germany. Our study gives an overview about the West German structure and dynamics of wages and the mobility for different kinds of jobs in plants with a private ownership during the 90's. The German data have yet no information about the company (firm) as a commercial aggregate meaning that all analyses done for Germany refer to single plants. However, hereafter we make no difference between the terms firm, establishments, plants and employer.

We present descriptive statistics about wages, wage changes and labour mobility and provide for deeper analysis a variance decomposition and a propensity score matching analysis. The latter investigates the treatment effects of collective agreement on the structure and dynamics of wages as well as on turnover on establishment level in Germany for the years 1993, 1995 and 2000. The statistics are computed with a version of the linked-employer-employee-data of the IAB, LIAB. The LIAB consist of the IAB-establishment panel (a survey) and administrative individual data from the employment statistics of the German social security system.

The structure of the data is described in section 2. In section 3 we refer to the macroeconomic situation in the nineties and relevant labour market institutions. Then in section 4 we discuss the empirical results. Section 5 summarizes and concludes the paper.

2 Data

The employment statistics register of the Federal Employment Service is based on the integrated notification procedure for the health, pension and unemployment insurances, which was introduced first in 1975. This procedure requires employers to report the social security agencies about all employees covered by social security. Notifications have to be submitted to the social security agencies within certain periods at the beginning and the end of any employment relationship as well as each year on December 31st for all employment relationships subject to social security contribu-

tions. The notifications include information about employees' entries, exits and wages, gender, qualification and current occupation (3-digit). There are legal sanctions for misreporting and therefore we can expect a good reliability of the administrative data. The employment statistics register covers more than 90 percent of all employees in manufacturing and 75 percent in the service sector. Freelancers, civil servants, self employed persons and workers with earnings below a minimum level are not eligible to the social security system and therefore not included in the individual data. However, it is possible to obtain such information from the IAB-Establishment-Panel on the aggregate level of establishments.

The IAB-Establishment-Panel is a survey conducted since 1993. For the panel a stratified sample is drawn from the establishments included in the employment statistics register following the principle of optimum stratification according to the stratification cells of the establishment size class (10 categories) and the industry (16 categories[1]). These stratification cells are also used for the weighting of the sample. To correct for panel attrition, exits, and newly founded units, the samples are augmented regularly. This leads to an unbalanced panel. The attrition of the largest plants can only be corrected by an increasing number of smaller, but nevertheless large plants. Also on the demand side of the labour market we can expect a good reliability of the data, because the data are conducted via oral and structured interviews. Reliability checks improve the quality of the establishment level data.

To illustrate the effect of the weighting procedure for the establishment data, table 1 shows weighted and unweighted values of selected variables. In principle smaller establishments are sampled with a lower probability so that weighting increases their proportion.

The increase in the share of part-time workers is mostly driven by the rising participation rate of females in the labour market. Fixed-term contracts are distributed more equally between males and females. It should be noted that full time jobs are partly substituted by part time jobs meaning that there is often a negative growth of full time jobs on the plant level.

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[1] From 2000 onwards the stratification is done according to 20 industries.

Table 1: Weighted and unweighted values of selected variables

	percentage of ……		
	part-time workers	fixed-term contracts	blue-collar workers
unweighted			
1993	.09	.02	.36
1995	.17	n.a.	.38
2000	.20	.08	.43
weighted			
1993	.13	.03	.40
1995	.22	n.a.	.43
2000	.28	.09	.36

n.a. : not applicable

Sources: IAB-Establishment-Panel.

The Linked-Employer-Employee-Data of the IAB (LIAB) are constructed by merging the IAB-Establishment-Panel with the data of the employment statistics register using the administrative plant identifier. There are several versions of the LIAB data. We use for the most parts of this study the first version of the LIAB cross-sectional model. This dataset contains the employment spells of those persons employed in one of the establishments covered by the IAB establishment panel. Since the reference date of the questions in the IAB establishment panel is the end of June of each year, only those spells are included in the individual data which cover June 30th. An overview about the LIAB, the data models and the several versions, is given by Alda/Bender/Gartner (2005), further details are described in Data-Reports (Alda, 2005b-e). Appendix A 1 gives a short description of the two kinds of datasets which associate to the LIAB data and informs over applicable information which can be obtained with these data.

The cross-sectional LIAB contains the duration of employment spells on an annual basis. This allows the identification of movers and stayers as well as computing job tenure and the employees' change in wages if we use a balanced panel[2]. We constructed the tenure variable by checking whether

[2] To describe this in more detail: first, identify plants, which are in t and t-1 part of the panel. Second, identify employees, who are observed in t and t-1 (=stayers). Third, identify workers with only one observation (in t: entries; in t-1: exits). For the first

an employee in t appears also in the same plant in t-n (n∈ N). With larger n we have less plant observations due to panel attrition. Therefore we calculate only the job duration categories for at least *one year*, *two years* and *three years*. For some additional analysis we switch to another LIAB version: the first version of the LIAB longitudinal model. There, job durations can be computed on a daily precise base (left censored at January, 1st, 1990). By merging other years, the job tenure information can only be roughly computed in the LIAB cross-sectional model. Furthermore, there we cannot observe employees after they have left a plant. It follows that we are not able to compute the change in wages for workers who change their employer in this data model[3].

The plant size is constructed by aggregating the number of workers covered by the social insurance system in the employment statistics register. We include in the analysis only plants with at least 25 employees in t, where part-time workers, apprentices and workers not covered by the social insurance system do not count.

The obtained wages for employees are in general gross wages including all bonus payments. The information about wages is *censored*, because payments for the social security system are limited to a certain amount. More precise, wages in the employment register are left truncated and right censored. While the left truncation refers to workers with only a few working hours, the right censoring is more important, because this affects especially our descriptive wage statistics. The censoring varies from year to year. For example in the year 2000 it amounts to a gross monthly wage of 3427 Euros. Thus the threshold is the highest observable wage in the respective year.

The right censoring of the wage variable has implications on the distribution of wages and therefore for our wage statistics. To correct this, we im-

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year of the panel 1993 we identify the stayers directly with the data of the employment statistics register. We got from the data holders the requested information about employees by delivering the plant identifiers. This is the reason why we have the highest number of observations in 1993.

[3] We can only observe employees who move to plants that are also part of the IAB-Establishment Panel. We call this hereafter IAB-Turnover. But the IAB-Turnover is too small for calculating the change in wages for persons changing their employer.

pute censored wages with predicted values using a Mincerian earnings function augmented by ten sector and ten occupation dummies[4]. Varying from year to year eight to fifteen percent of all observations are imputed. In the group of employees with a university degree 50 % of all observations are censored.

From the employment statistics the working time is available only on a rough basis, which differs between full- and part-time workers. Furthermore, employers classify full-time workers by their working conditions customary in the respective establishment. Part-time workers and switchers from part-time to full-time (and opposite) are as well as apprentices[5] excluded from all of the analyses. All descriptive statistics about wage, wage changes and mobility presented in Appendix 3 are based on continuing workers in continuing plants. Appendix A 2 gives an overview for all the key variables (and their definitions) which we use in this study.

3 Macroeconomic situation and institutional setting in Germany

In this section we give some information about the macroeconomic situation in Germany during the nineties and inform over – in our opinion – relevant German labour market institutions. We start in table 2 with the description of the West German GDP and unemployment during the nineties to give reasons for our observation years.

In the first years after the German Unification the West German economy benefited from the growing demand for goods and services in the former German Democratic Republic. The West German GDP grew substantially from 1990 to 1992, but not enough to lower or at least stabilize the unemployment rate. Then, in 1993 there was a slump in economic activities. In 1994 and 1995 the GDP grew slightly. Since 1998 the GDP growth went hand in hand with a reduced unemployment rate. The peak of the GDP growth rate was reached in 2000 with 3 percent. Our time window is

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[4] A similar imputation method is described by Gartner/Rässler (2005). We add also an error term to the estimated wage, but different to Gartner/Rässler we use a frequentistic estimation instead of a bayesian estimation and do single imputation instead of multiple imputation.

[5] Apprentices work full-time and receive wages fixed by collective agreements. These wages are much lower even than those for unskilled blue collar workers.

- given the data from the IAB-Establishment-Panel - the period 1993 to 2000. We decided to choose the years 1993, 1995 and 2000. 1993 is a slump year in the German economic activities, the year 2000 a comparatively boom year. We prepare also information about 1995, a year, in which the economic growth as well as unemployment remains almost stable.

Table 2: Macroeconomic situation in West Germany 1991 to 2000

Year	GDP*	growth GDP 1 year	unemployment rate
1991	1.567.693		.063
1992	1.594.951	1,74%	.066
1993	1.557.562	-2,34%	.082
1994	1.578.491	1,34%	.092
1995	1.600.479	1,39%	.093
1996	1.607.803	0,46%	.101
1997	1.629.703	1,36%	.110
1998	1.664.769	2,15%	.094
1999	1.697.689	1,98%	.088
2000	1.749.554	3,06%	.078

* At constant 1995 prices in Mill. EUR, West Germany

Source: German Central Statistical Office.

Although we focus on the West German economy only, one should address the persistent high unemployment in East Germany (in 2000 about 17 percent) as well as the extensive money transfers from West to East Germany during our observation period. In the nineties there was an enormous governmental program to adapt the East German Economy to the Western level. But still in 2001, the productivity level of the establishments in the East German manufacturing sector for example is on average only 60 percent of the West German one (see Kölling/Rässler, 2004). All in all this leads to a strong trend of worker migration from East to West Germany.

Labour market institutions in Germany

The German system of vocational education is not the product of a single reform. It developed from pre-industrial apprenticeship roots and prevails not in Germany alone, but in similar fashion in Austria, Denmark and

Switzerland (cf. Winkelmann, 1997). The training duration is between two and three and a half years, so plants invest remarkable time and money in apprenticeship training. Although we decided to exclude apprentices from our analysis, it has to be stressed that the German system leads to a reduced mobility of employees especially in the group of young skilled blue collar workers in the first years after finishing their training because establishments try to amortize their human capital investment by means of longer job tenure of their trainees (Bender/Schwerdt, 2003). In several branches it is guaranteed by collective agreement that trainees can stay at least one year after the completing of their apprenticeship training in the firm. It is especially the mobility of younger blue collar workers which is hampered by the apprenticeship system.

On the OECD-scale of rigidities and employment protection Germany ranks in the midfield (OECD, 1999). Despite the trend of deregulating the German labour market in the nineties, there are still several institutions which enforce the position of insiders. Outsiders have especially in problematic economic times only small chances to (re-)enter the (internal) labour market.

A fairly prominent example for the protection of insiders is the German Protection Against Dismissal Acts (PADA), that applies for all plants with more than five (between 1996 and 1998 and since 2004 for plants with more than ten) employees. It should be noted that the following sentences concerning the PADA is more focussing on public and political discussions. In the field of application of the PADA, firms have to take into account for their dismissals fairness considerations to avoid social cases of hardship. As a result, especially young employees (workers with short job tenure) *must* be dismissed instead of others. Especially elder, married workers and workers with children are protected by this law. In all of the plants included in the analysis this law is valid. Thus we can expect that the mobility of individuals is mainly determined by (younger?) persons with shorter job durations (for an investigation of worker flows and dismissal protection see Bauer/Bender/Bonin, 2004 and Verick, 2004[6]).

[6] Both investigations find no significantly different growth patterns for plants in which the PADA is valid and in which it is not.

Another notable institution is the set-up of works councils. They have a strong legal base in Germany. Lots of studies were made about the effect of works councils on the mobility of employees (f. e. Addison/Bellmann/ Schnabel/Wagner, 2004). Nearly all of them come to the conclusion that the mobility of workers is hampered by this institution. A works council is guaranteed by law in all plants with more than five employees, if the majority of the plants' employees want to elect one (or keep him if he is still installed). In plants with more than 20 employees the works council must agree to dismissals. In case of mass dismissals, the regional labour office and the firms involved plants have to draft a social plan to avoid social cases of hardships, if possible. Especially in larger establishments works councils often exist in combination with collective agreements.

Table 3 shows the coverage of works councils, collective agreements on firm or branch level[7] and their combination in the years 1998 and 2002[8].

Table 3: Works Councils and collective agreement: coverage on full-time employees in the West German private sector

size class	coverage of collective agreement		coverage of collective agreement and works councils	
	1998	2002	1998	2002
1 - 4 employees	.46	.45	not possible	not possible
5 – 19 employees	.65	.55	.05	.05
20 – 99 employees	.73	.62	.24	.29
100 - 199 employees	.79	.72	.60	.61
200 – 499 employees	.85	.81	.79	.76
500 and more employees	.96	.94	.95	.92
Total	**.78**	**.71**	**.51**	**.48**

Source: IAB-Establishment-Panel 1998 and 2002, weighted values.

The coverage of works councils and collective agreement on full time workers is in larger firms above 90 percent. Firms being member in an employers' association can deviate from paying collectively agreed wages

[7] Approximately ten percent of all private establishments have wage arrangements on plant level (rising).

[8] In 1993 and 1995 the information are not applicable. We choose the years 1998 and 2002 in order to show that especially the coverage of collective agreement over plants is (still) decreasing.

only by negotiating with the union on firm level, but nevertheless the branch union must agree to the result of the bargaining process. Firms who are not member in an employers' association have no restrictions in setting wages. Hence, in Germany statutory minimum wages pay only firms in the construction sector. Tariff wages must be paid only for union members, but in fact such wages are very often paid to all employees in a firm. The coverage of collective agreement in manufacturing is higher than in the private service sector. Also the increase of bargained wage is often higher in manufacturing.

Some plants pay more than negotiated wages, but in regular not for all of their workers. This additional payment increases the flexibility in setting wages in labour markets with rigid wage structures (Kohaut/Schnabel, 2003a). In addition, centrally bargained wage arrangements cannot take into account all observed and unobserved heterogeneity of establishments and employees. It is possible to bargain wages on firm level, but unions have to agree if the employer is member of the employer association. In this perspective paying higher wages than fixed by collective agreements will cause larger wage dispersions within plants. Büttner/Fitzenberger (1998) show that wages being equal to collective arrangements occur mostly at the bottom end of the wage distribution. Paying more than fixed by collective agreement can be obtained especially for better jobs/workers. However, the proportion of plants paying higher wages than bargained is decreasing in our observation period (table 4). The effect of collective agreement on the wage structure, the dynamics and the mobility patterns will be investigated in the next section.

Table 4 shows, how many plants pay more than collectively agreed wages. Paying wages in excess of collectively agreed wages is often the only opportunity for unionized plants to react also in terms of wages to a changing economic environment in the short-run[9].

[9] In the year 1998 had 5 percent of all West German plants an employee participation in asset formation or share ownership (Möller, 2001). This form of payment – which can be also interpreted as firm flexibility in setting wages - covers about 15 percent of the total West German workforce.

Table 4: Summary statistics of payment in excess of collectively agreed wages

	proportion	mean	standard deviation	10%-ile	90%-ile
1993	.41	.134	.076	.05	.25
1995	.32	.112	.073	.05	.20
1998	.23	.111	.066	.05	.20
2000	.27	.115	.071	.05	.20

Source: IAB-Establishment-Panel 1993 – 2000, weighted values.

The proportion of plants paying more than fixed by collective agreement decreases until 1998 and increases in 2000 but did not reach again the level of 1993. The margin for adjusting wages has therefore decreased during the nineties for plants covered by unions. Referring to all plants in Germany we can expect that wage structures might change in the second half of nineties more by means of worker mobility than the adjustment of wages. This process should be guided by the changing institutional frame for regulating working contracts where employers gain more flexibility since the second half of the nineties.

4 Empirical findings

With regard to what was said in the data section 2 we prepared the descriptive statistics about wage, wage changes and mobility in Appendix 3 twice, with weighted and unweighted values. We focus at least for the wage statistics on the unweighted results, because they are more precise. The weighted values give an impression how the over sampling of larger plants in the IAB-Establishment affect the results. All figures and tables for wages are calculated on a monthly base and always in Euros. We deflated with the official consumer price index (2000 = 100). Furthermore, we complement our analyses with variance decompositions and assess the effect of collective agreement on wages and worker mobility via a non-parametric matching approach.

The sample is based on plants in the West German private sector. The IAB-Establishment-Panel allows distinguishing between the private and the public sector not only via the sector classification, but also via a question for the ownership of plants. Base for the analysis are all plants with a

private ownership and at least 25 full time employees in the respective year.

We use for the study the LIAB cross-sectional model, version 1 and the LIAB longitudinal model, version 1. While we restrict the cross-sectional model to plants in the private sector and those who have at least 25 full-time employees in the respective years, the analyses based on the LIAB longitudinal model covers all plants including the public sector with at least three full time employees in the time period 1996 to 2001. The longitudinal model allows us to make additional analyses, which are not possible with cross-sectional data, in especial computing daily precise job durations (left censored at January, 1st, 1990). Consequently the results for the average wage and other statistics differ slightly between the two data models. All key variables and definitions (Appendix A 2) are - if applicable - the same in both data models.

4.1 Structure of wages within and between plants

In this section we are discussing how German wages develop on the plant and worker level during the nineties. Figure 1 shows the Kernel densities of the workers' log wage distribution[10] in the years 1993, 1995 and 2000 and Figure 2 the distribution of the firm average wage for the same years.

Figure 1 and 2: German workers' and plants' wage distribution in 1993, 1995 and 2000

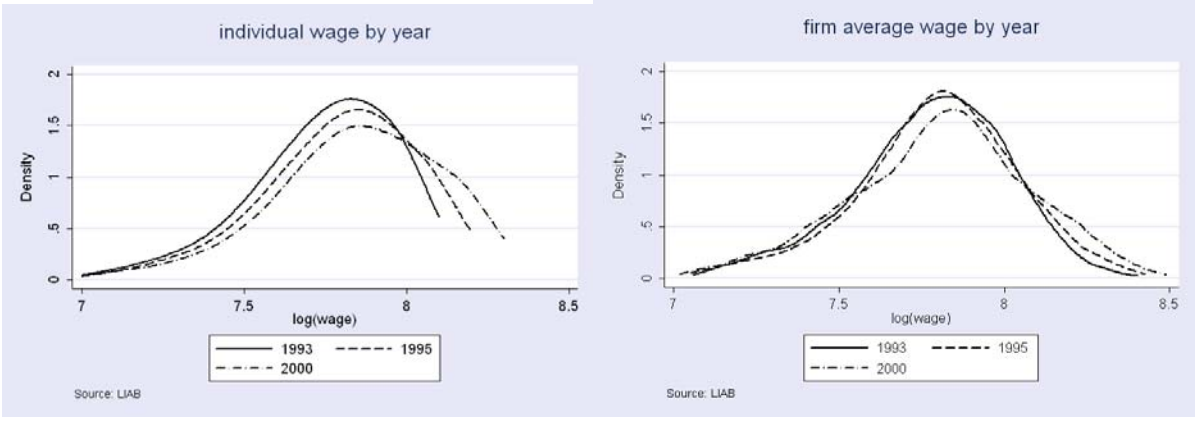

Figure 1 **Figure 2**

Source: LIAB cross sectional model, version 1.

[10] We cut off all censored wages for figure 1.

The distribution of workers' wages shifted to the right meaning that the weight of the higher wages has increased. Especially the contrast between the distributions for the years 1993 and 2000 is very clear, whereas the distribution in the year 1995 is lying between these. In the distribution of firm average wage the proportion of higher values has increased since 1993. Also on the plant level we obtain for the average wage a slight shift to the right meaning that we have in Germany in the year 2000 more high and low wage plants than in 1993. Appendix table A 3.1 shows that the standard deviation of the employees' and plants' average wage increases in our observation period which is a different manifestation of the same process. Workers and plants became in Germany more unequal regarding their wages during the nineties. The results from the matching approach (first two statistics in Appendix table A 7) show only in 1995 a significant wage compression for firms covered by collective contracts. In the other years there is no significant difference between firms with and without collective agreement[11]. At least three different interpretations are possible: First, firms without collective agreement react more flexible in boom or slump years to a changing economic environment while in stable years they compress the wage structure within firms. Second, unions change their policy during the nineties and allow a wider wage dispersion between employees (f. e. because of more collective agreement on firm than on branch level). Third, employers might have restricted the payment of collectively agreed wages to union members[12].

From table A 3.1 we can also derive that the higher standard deviation is mostly driven by the more dynamic development at the upper bound of wages on individual *and* plant level. This holds especially for the 90%-ile of both wage distributions. On individual level there is a wage growth during the observation period in all quartiles and deciles, on plant level the

[11] A grate part of the establishments (for example in 1999 more than 55 percent) in the dataset that are not covered by collective contracts orientate their wage payments on the collectively bargained wages. This could be an explanation why we find only small differences between unionized and non-unionized plants

[12] This seems unlikely, because then the employer would create incentives for his employees to become union member (Kohaut/Schnabel, 2003b). But unions in Germany have fewer members in 2000 compared to 1993. Another argument is that equal workers should be paid equal due to fairness considerations. Wage differentials within firms should be accepted by the employees (Stephan, 2001).

average wage decreases in the year 2000 compared to 1995 from the 75%-ile on downwards. While at the upper bound of the plants' wage distribution workers became more different concerning their wages (column average standard deviation of plants' average wage), workers at the bottom of the wage distribution are paid more equal within these plants. The average standard deviation of plants' average wage is about 30 percent of the average wage meaning that still a bulk of wage variation in the German economy is within firm, not between firms, but the latter becomes more important at the end of the observation period. The distribution of the individual wage shifted to the right that is the weight of the higher wages has increased. In the distribution of firms' average wage, the proportion of higher values has increased since 1993. Especially the contrast between the distributions for the years 1993 and 2000 is very clear, whereas in 1995 the distribution lies between these.

Regarding their wages the group of workers aged 25 to 30 and the group of workers aged 45 to 50 exhibits a similar development (Appendix table 3.1). The development of their wages (relative to their level) is nearly the same. Again, the wages at the upper bound of the wage distribution increased much more than at the lower bound.

The higher wages for persons aged 45 to 50 are not only based on the fact that larger plants pay higher wages and employee elder workers. The correlation between the log size and the average age of workers in plants is 0.111 in 1993, 0.026 in 1995 and 0.02 in 2000 (all coefficients are significant on the 5 percent level). More detailed analyses with wage regressions show that one year elder is ceteris paribus corresponding to a higher wage return rate for workers aged 30 of 2.8 percent (aged 40: 1.6 percent; aged 50: 0.4 percent) in the time period 1996 to 2001. Between the average tenure and the firm size there is a closer relationship: the log size correlates with the average tenure on plant level in the year 1996 with 0.375 and in 2000 with 0.284 (1993, 1995 not applicable). One interpretation of this result is that larger plants keep their workers with longer job duration more in stable or slump years (if we interpret the year 1996 as one) and less in boom years. Another is simply that large firms grow in boom

years[13]. We have to leave here open, whether the weaker correlation in 2000 is also corresponding with worker mobility mostly driven by employers or the respective employees (we come back to this point by discussing the mobility results). However, more detailed analyses show that the average wage return for one additional year of job duration is c. p. 2.1 percent in the time period 1996 to 2001.

Using data sets linking employees' and employers' information allows computing the proportion of the variance of wages related to human capital endowment and to firm-specific effects (Groshen, 1991, 1996); Stephan, 2001). Table 5 shows the coefficient of determination R^2 which can be attributed to human capital, firm-specific effects and their interaction within a Mincerian earnings function.

Table 5: Analysis of Variance for workers' wage levels

R^2	1993	1995	2000
Firm effects	0.273	0.284	0.347
Human capital	0.448	0.445	0.386
Human capital + firm effects	0.587	0.586	0.595

Source: LIAB cross-sectional, version 1; based on plants with at least 25 full-time employees in the respective years.

For the years 1993 to 2000 a clear trends emerge: The importance of the firm-specific effect increases, whereas that of the human capital effect decreases. The R^2 related to the interaction of firm-specific and human capital effects remains almost stable over that time period. These results fit very well to those obtained from the descriptive analyses of the structure of wages within and between plants.

Wages and within plant variance have a positive correlation in the German data (Appendix table 3.1). Of course, larger plants pay higher wages and use a wider range of different occupations, but the raising within variance of wages in the observation period can only be partly explained by a wider

[13] This seems unlikely. A comparison of the weighted and unweighted values in appendix table 3.5 shows that the employment growth in 2000 is 'larger' (in the sense of a less negative growth) in smaller establishments.

range of occupations[14]. Occupations are differently affected by sorting effects and unobserved components of human capital. We run wage regressions with the LIAB longitudinal data in order to show how this influence is shaped[15]. The first regression model is constituted only by dummies B_{it} for the occupational group and covariates x_{it} characterizing persons (like job tenure, their education level, the job experience and many others). The second model uses in addition the time-variant plant characteristics w_{jt} (like their reorganization activities, the existence of a works council and/or collective agreement, worker flow characteristics (i.e. churning) and others[16]). In these two models yearly data from 1996 to 2001 are pooled in the wage regressions. Model 3 captures additionally unobserved heterogeneity for plants θ_i and persons ψ_j . With y_{it} as the log-wage the three models are given by:[17]

(i) $y_{it} = \mu + x_{it}\beta + B_{it}\zeta + \varepsilon_{it}$

(ii) $y_{it} = \mu + x_{it}\beta + B_{it}\zeta + w_{jt}\gamma + \varepsilon_{it}$

(iii) $y_{it} = \mu + x_{it}\beta + B_{it}\zeta + w_{jt}\gamma + \theta_i + \psi_j + \varepsilon_{it}$.

In model (iii) we sweep out the unobserved plant and person level heterogeneities by subtracting averages on the spell level (which is each unique worker-plant combination). A short description of this 'Spell-Fixed-Effect' regression gives Appendix A 6. Abowd/Kramarz/Margolis (1999), hereafter AKM, discuss this model in section 3.3., but they use differences rather than mean deviations. However, we are here interested in the change of the ζ-coefficients for the vector of occupation groups. All regressions use in addition ten covariates for person and 21 for plant characteristics. The wage regressions are based on 2,282,926 full time worker years corre-

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[14] This shows also table A 3.5: plants use less occupations at the end of our observation period than at the beginning. The nearly unchanged weighted values for the observed time period show that only larger plants reduced their number of occupations.

[15] Therefore the 3-digit occupational code is recoded into ten occupational groups, which are not directly comparable to international classifications (ISCO-88 would be possible with the applicable 3-digit code). The grouping is done in order to downsize the wide range of occupations.

[16] The variables for model (i) and (ii) are comparable to the z-variables used in Abowd/Kramarz/Margolis, (1999). The observable covariates for the models (i) to (iii) are listed in Appendix A 4.

[17] Symbols and indices are listed in appendix A 5.

sponding to 673,606 persons in the observation period 1996 to 2001. Table 6 shows the results only for the occupational groups.

Table 6: ζ-Coefficients for occupational groups using different regression techniques

	West Germany 1996 to 2001		
	coefficients from model ...		
	(i)	(ii)	(iii)
unskilled manual occupations	reference		
skilled manual occupations	0.196	0.146	0.019
technicals, engeneers	0.293	0.284	0.058
unskilled service occupations	n.s.	- 0.004	n.s.
skilled service occupations	0.148	0.045	0.031
semi-professionals	0.303	0.146	0.059
professionals	0.467	0.342	0.100
unskilled civil servant occupations	0.058	0.047	0.003
skilled civil servant occupations	0.262	0.223	0.048
managers	0.458	0.426	0.127

notes: uses 2.28 million yit-observations; all reported coefficients are significant on a level of $\alpha < 0.01$ (n.s.: not significant); models are explained in the text

Source: LIAB longitudinal model, Version 1 for 1996 to 2001.

Compared to model 3 - which sweeps out the heterogeneities - the observed plant characteristics have often just small effects on the return rates for the occupation groups. The sorting effects are identified via the change of the zeta-coefficients. The more the specific occupation group is – relative to the unskilled manual occupations – sorted into observable high wage firms, the more is the decrease of the zeta-coefficient of model (ii) compared to model (i). The interpretation of the differences between the zeta-coefficients from model (ii) and (iii) is quite the same. The more the observable covariates are (positive) correlated with the unobservables, the larger is the decrease of the zeta-coefficient in model (iii) compared to model (ii).

Exceptions of only small observable firm effects are for example the skilled service occupations. Such employees work more often in high wage plants and here the unobserved worker and plant characteristics have just a small effect on the wage return rates in this occupational group. Also

(semi-)professionals are - in contrast to the unskilled manual occupations - more likely to be sorted in observable high wage plants, but here the unobservable workers and plant characteristics are more important than for skilled service occupations. To summarize, once controlled for unobserved plant and worker characteristics there are often only small wage differential between different occupational groups. Thus we can conclude that plants set wages not (only) by occupations but for (other) observed and unobserved person and plant characteristics.

To investigate this further table 7 shows the correlations of the observed and unobserved workers' and firms' characteristics.

Table 7: Correlation of observed and unobserved wage components

	$\hat{\theta}_i$	ψ_j	$x_{it}\hat{\beta}$	$w_{jt}\hat{\gamma}$
$\hat{\theta}_i$	**1,0000**			
ψ_j	-0,0960	**1,0000**		
$x_{it}\hat{\beta}$	0,3787	0,0002	**1,0000**	
$w_{jt}\hat{\gamma}$	-0,0276	-0,2376	0,0417	**1,0000**

notes: uses 673,606 averages on the level of persons, based on 2,282,926 y_{it}-observations; symbols and indices explains Appendix A 5

Source: LIAB longitudinal model, Version 1 for 1996 to 2001.

Like in many countries[18] corr($\hat{\theta}$,ψ) = - 0.0960 has the wrong sign if one expects that unobservably 'good' employers have unobservably 'good' workers[19]. It is especially the correlation between ψ and $w_{jt}\hat{\gamma}$ that looks

[18] Abowd/Creecy/Kramarz (2002) reports a strong negative correlation of – 0.283 for the French and – 0.025 for Washington State data. Goux/Maurin (1999) estimate (depending on the time period) + 0.01 to – 0.32. Gruetter/Lalive (2003) report – 0.543 for Austrian data and Barth/Dale-Olsen (2003) – 0.47 to – 0.53 for Denmark.

[19] Andrews/Schank/Upward (2004) report for Germany a correlation of nearly zero (-0.0172) in the time period 1993 to 1997 with comparable LIAB data, but less and different covariates. One reason for their weak correlation is that they did not use individual characteristics which describe their labour market behaviour (f. e. times of unemployment and leave of absence for family phases). These covariates are positive correlated with the unobserved person effects (meaning that the higher the integration in the labour market and the less there are events and times of unemployment, the higher is the unobserved person effect on wages). The correlation with the vector of covariates referring to labour market integration and the unobserved person effect θ_i is + 0.1526).

somewhat awry[20]. Observed and unobserved worker characteristics have a strong positive correlation meaning that high skilled workers also accumulate high unobserved person effects for which employers pay higher wages. The correlation of the observed plant characteristics with the observed and unobserved worker characteristics is weak, meaning that ignoring the one side of the labour market nearly has no effect on the results for the other. This holds especially for the standard errors. As shown for the occupation groups in table 6, the return rates for observable workers' characteristics sometimes change to a not neglectable amount by controlling for observed and unobserved plant characteristics. Referring to the unobserved worker heterogeneities, further investigations show that unobservably 'good' workers are more likely to sort into larger plants, in plants which reduce hierarchies and increase workers' responsibilities, in plants which have less turnover and those who are tied by collective agreement on plant level[21].

4.2 Wage dynamics

The statistics for the wage dynamics are printed in Appendix A 3.3 and A 3.4. Figure 3 shows the kernel densities for the change in wages on individual, figure 4 on plant level.

Figures 3 and 4: Change in log wages on worker and plant level

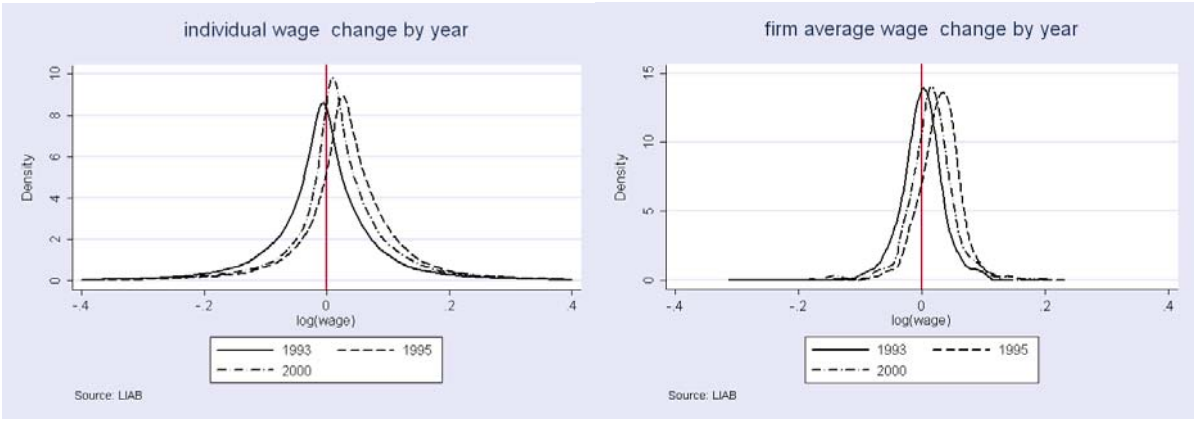

figure 3 figure 4

Source: LIAB cross sectional model, version1.

[20] The reason might be too little turnover between the plants in the sample.

[21] If plants pay wages by collective agreement on branch level, the averages of the unobserved person effects on plant level are smaller, but nevertheless higher than in plants not covered by unions. Hence, the wage regressions control for the observable average effect of collective agreement on plant and branch level.

The change in wage for workers (figure 3) gives no clear picture as well as the change of the plants' average wage. Both distributions shift to the right from 1993 to 1995. Between 1995 and 2000 there is a slight shift to the left. The peak of the density function changes for individuals meaning that workers became in 1995 (and 2000) more unequal regarding their wage change. On plant level the peaks are in all years nearly on the same level.

German plants offer a wide range of change in wages to their workers. There is also a wide range of within variation in the change in wages which increases during the observation period. The 90/10-ratio of the standard deviation of the change in plants' average wage is 2.383 in the year 1993, 2.545 in 1995 and 2.814 in the year 2000. There are two interpretations possible. First, the (rising) wage growth rate differences might match wage level differences. Maybe the wages in human capital intensive plants grew very fast while wages remain nearly unchanged in non-intensive plants. A tied argument is that heterogeneous plants have a large mixture of skills. Then there would be a high variance of wage growth rates within plants and little variation in the means across plants. Second the growth rates differences might reflect institutional differences. This could be unions or industries. Unionized environments for instance might compress wages as well as their growth rates, while others do not. In the perspective of our matching approach (Appendix A 7) the second explanation is less important. Plants with and without collective agreement differ not significantly in their average change in wages in any year. Only the coefficient of variation in the change in wages is in 1995 significantly lower in unionized plants. However, depending on the year the standard deviation of the change in plants' average wage is twice to fourth as high as the average change in wage. Further analyses are needed to interpret this.

From the rough tenure variable in the LIAB cross-sectional model (Appendix 3.3) we can deduce no clear interpretation for the results. If wages grow different in heterogeneous plants the *average* change in wages for workers is not a good indicator for what drives this development. The high standard deviations support this argument. Looking at the rough tenure variable we find that in all quartiles and deciles the growth rates for workers with shorter job durations appear in a better light. In table 8 we inves-

tigate this further by looking at the change in wages using the LIAB longitudinal model due to a more precise classification of the tenure variable.

Table 8: Change in monthly wages (in Euro) by job tenure in the years 1999 to 2001

		Males			females		
		1999	2000	2001	1999	2000	2001
all employees		**126.75**	**54.51**	**46.03**	**86.64**	**35.93**	**24.62**
tenure	less than one year	88.08	- 5.82	- 9.19	47.25	37.75	40.09
	one to two years	178.93	99.14	99.51	97.52	91.63	64.62
	two to three years	150.89	130.96	95.27	49.41	65.12	56.26
	three to four years	158.46	95.35	116.11	87.93	41.84	58.05
	four to five years	97.17	86.50	67.76	62.83	50.19	28.90
	five and more years	125.64	89.08	72.00	67.60	28.60	17.54

Source: LIAB longitudinal model, version 1.

We distinguish between males and females. The reason for this is that - despite that males have on average higher wage growth rates than females, which is not our issue here - we can observe a fairly clear trend for male workers. An entrance cohort at a certain time can be identified by diagonals. Each year an entrance cohort is going one group downwards until they finally reach the group with a job duration over five years. The male entrance cohort 1997/98 (this is the category tenure one to two years in the year 1999) has in all years the highest growth rates relative to all other groups in the respective years. It follows that wage growth rates are also joined with the date of entrance in a plant and therefore maybe in addition depending on the (macro-)economic conditions at a certain time. The latter will be different in heterogeneous plants. Rising wage differentials (wage growth rates) between otherwise equal workers (f. e. regarding their skills or occupation) within plants are also a consequence of their date of entrance by the employer. Between firms are rising wage differentials for equal workers (now including their job tenure) a result of firms' heterogeneities. In other words: at a fixed time point is the same economic environment good (regarding their wages) for workers in the one plant and not so good for equal workers in another plant.

In table 9 we would like to know in addition, how much of the variance of the change in wage of workers is explained by firms' fixed effect and by occupation.

Table 9: Adjusted R^2 for occupation and firm effects on the change in workers' log wages

	adjusted R^2 for change in log wages		
	1993	1995	2000
occupation[1]	0.1801	0.1383	0.1689
firm	0.0856	0.1275	0.1341
occupation[1] plus firm	0.2171	0.2214	0.2474

note: 1 3-digit; about 330 occupations

Source: LIAB cross-sectional model, version 1.

In 1993 the occupation has a much larger effect on the change in wages meaning that firms set wages more by occupations than by their own heterogeneities. In the year 1995 there is nearly no difference between these two specific effects on the change in employees' wages. In the year 2000 wages are more set by occupations and plants compared to 1995. The plant effect became higher during the observation period which is roughly an equal development like in table 5 meaning that the firm heterogeneities became more important for the workers' development of wages. For the occupation effect on the change in wages is not a clear time trend emerging. However, in each year the occupation explains better the variance in the change of wages for workers than the firm, where the latter becomes more important during the observation period.

The analysis of table 9 allows us to come back to the interpretation that firm heterogeneities are more important for the change of worker wages within specific entrance cohorts. Table 10 repeats the analyses of variance of table 9 by holding the entrance cohort constant[22].

[22] The results of table 9 and 10 are not directly comparable because we have to switch between the LIAB data models.

Table 10: Adjusted R^2 for occupation and firm effects on the change in workers' log wages by tenure

	adjusted R^2 of ANOVA for change in workers log wages					
	occupation		firm		firm plus occupation	
entrance cohort	1997	2000	1997	2000	1997	2000
1999 / 2000	-	0.209	-	0.266	-	0.381
1998 / 1999	-	0.110	-	0.183	-	0.228
1997 / 1998	-	0.121	-	0.174	-	0.240
1996 / 1997	0.216	0.141	0.232	0.143	0.328	0.227
1995 / 1996	0.129	0.135	0.186	0.157	0.235	0.222
1994 / 1995	0.151	0.125	0.178	0.158	0.254	0.230
1993 / 1994	0.159	0.107	0.157	0.145	0.234	0.207
1992 / 1993	0.144	0.146	0.185	0.172	0.233	0.247
1991 / 1992	0.123	0.145	0.134	0.147	0.202	0.241
1990 / 1991	0.127	0.141	0.149	0.169	0.210	0.231
1990 and earlier	0.115	0.114	0.093	0.137	0.175	0.203

Source: LIAB longitudinal model, version 1.

For most of the entrance cohorts - especially for the later ones - the picture compared to table 9 changed. As suggested by discussing table 8, now the firm explains for employees with shorter durations better the variance of the change in their wages. Only for workers with job durations of more than eight years in 1997, the occupation is better in predicting the change in wages than the firm. Comparing the observation points we have the same picture as for many other statistics: in 2000 the firm effects are more important than in 1997 and the human capital (here approximated by occupation) can explain less of the variance (here the change of workers wages). The combination of the occupation and the firm shows that they explain in the year 2000 for earlier entrance cohorts more of the wage change variance than in 1997. To conclude, wage growth rates are joined with the date of entrance by the employer. This confirms the hypotheses that firms have a large mixture of skills and so there is a lot within variance of the change in wages and less variation in the means across firms.

4.3 Mobility patterns

In this section the issue is on exit and entry rates on the establishment level. The differences between weighted and unweighted values are more

important, because smaller and larger plants differ in their mobility patterns. If we speak in this section about larger plants we always refer to unweighted values, otherwise we mean all plants in Germany. Weighted values analyze the mobility for the typical German plant, unweighted values reflect more the worker flows in larger plants. Growth rates are computed as $2(N_t - N_{t-1})/(N_t+N_{t-1})$ with N as the total number of full-time workers in plant i. Entry and exit rates were quite similar constructed as $2E_t/(N_t+N_{t-1})$. E is the total number of exits or entries on plant level. The correlation statistics are always computed with the log of the (average, change in, standard deviation of) establishment level wages.

Panel A: All jobs

In Appendix table A 3.5 we prepare the results for all jobs. As mentioned in section 2, we have in 1993 nearly all larger establishments existing in Germany in our sample. Referring to full time jobs, the decreasing firm size in the unweighted results is partly a result from sample attrition. The weighted values correct for this selectivity. The large firm size and the large standard deviation of the firm size in the unweighted results compared with the weighted results are reflecting the oversampling. However, according to other studies especially larger German plants became smaller in the second half of the nineties, as in- and outsourcing activities became more important. With this background we observe a negative growth for full time jobs on the establishment level. As explained in section 2, this decline in the number of full-time jobs is often compensated by an increasing number of part time jobs.

The number of occupations declines during the period for larger plants by approximately 30 percent. This may be a result from the declining firm size, but could also reflect the old fashioned occupational classification system of the 70th, which is still valid even in our data of the year 2000. Occupations in the declining industrial sector are more microscopic classified than occupations in the expanding service sector. Last, but not least, plants sometimes really drive down their number of occupation due to concentrate on their core business. Wage regressions show that workers in plants with fewer occupations receive higher wages[23].

[23] In the wage regressions an index is used by the number of different occupations divided by the total number of employees times hundred.

The exit rate for all jobs rises from 0.19 to 0.23 in our observation period. These values are slightly higher than in Nordic counties, but still lower than in France or in Italy. The entry rate rises from 0.16 to 0.18. This is comparable with the Nordic countries. The rising entry and exit rates may be attributable to the flexibilization of the labour market institutions. Furthermore, the exit rates are higher than the entry rates reflecting the declining trend of (full time) employment in the nineties. In the perspective of our matching approach (Appendix table A 7), collective agreement reduces in turbulent economic times worker flows – no matter, if these are hirings or firings. Exit and entry rates in unionized plants are in the years 1993 and 2000 significantly different (lower) from non-unionized plants. In our 'stable' year 1995 instead, the mobility patterns between these two types of plants show no significant differences

As expected, the mobility patterns differ for high and low wage firms. Low wage firms have higher exit and entry rates than high wage firms. This seems to be consistent across all sizes. A clear time trend emerges only in 2000 compared to the former years, where the workers mobility becomes higher. This has consequences for the percentage of core workers (persons with job tenure over three years). There are less core workers in the year 2000 than in former years. Looking at the results of the propensity score matching, institutional guidance does not stop this. Unionized plants protect – compared to non-unionized plants - insiders in the years 1993 and 1995 more than in 2000, where the difference between both groups of plants diminishes.

The correlation of the exit and entry rates with the average wage in establishments is negative. This means that high wage firms have less often turnover in order to keep their human capital. But the correlation is getting weaker at the end of the observation period. As expected, exit rates are lower and entry rates are higher if plants raise the wages for their workers. Table 8 shows that especially the new hires receive a higher change in wage. This suggests that growing firms raise wages to attract (new) workers. Firms with a wider range of wages have higher worker mobility shown by the positive correlation between the entry/exit rate and the standard deviation of the average wage.

Panel B: High-level jobs and Panel C: Low-level jobs

The comparison of the results for all jobs, high-level and low-level jobs exhibits several differences. The definition of high and low level jobs is based on the occupational classification (on a 3-digit level). High level jobs are above the 80 percentile of the wage distribution, if occupations are ranked by their median wage. Low level jobs are below the 20 percentile. So we focus now on the extremes.

High and low level jobs are a matter of larger establishment meaning that both kinds of jobs create big differences in the number of employees between weighted and unweighted values. As expected, high wage earners have less mobility in high wage firms and more in low wage firms (low level jobs vice versa). In all kind of plants the exit and entry rates for low level jobs are higher than for high level jobs, consistent with predictions of human capital theory. For the low level jobs, the entry rate in 2000 is higher than the exit rate - suggesting an expanding sector of low wage jobs in Germany.

High wage firms have lower exit and entry rates of high level jobs and higher exit and entry rates for low level jobs. If high wage firms can be regarded as high human capital firms, they have little reason for a high turnover. The correlation between the average wage change and the entry rates is for both kinds of jobs negative in 1995 and positive in 2000. If we suggest that firms grow in boom years, then these firms raise their wages to attract workers. A supporting argument is our result of table 8. Especially the change in wages for the new hires (with job duration of one to three years) is higher than for employees with longer job tenure.

Between the wage dispersion in a firm and the exits and entry rates the results for the high level jobs are more complicated. For high and low level jobs we observe with only one exception (entry rate of high level jobs in 1993) lower turnover if firms have a compressed wage structure. We can expect this result for the low level jobs. As said in section 3, especially jobs at the lower bound of wages are often protected against downward mobility and empirical investigations show that this is more often the case in firms with compressed wage structures. But high wage earners leave more often firms with compressed wage structures (table 11).

Table 11: Exit rates for top, middle and bottom earners

	1993	1995	2000
90%-ile wage (top earners)	0.133	0.131	0.178
median-wage (middle earners)	0.129	0.118	0.158
10%-ile wage (bottom earners)	0.232	0.219	0.283
exit-90%-ile wage (compressed)	0.139	0.145	0.211
exit-90%-ile wage (spread out)	0.126	0.116	0.142

Source: LIAB cross-sectional model, Version 1.

There are two differences between the Appendix tables A 3.6/A 3.7 and table 11. First, for calculating the top, middle[24] and bottom earners we do this not via the use of the median wage of occupations. The wage distribution therefore differs when calculating deciles (or quintiles). Second, there might be a difference between the 80%-ile and the 90%-ile. However, table 11 shows that middle earners are the group with the most stable employment. Their exit rates are lower than for the extremes leading to the conclusion that this is an effect of the strong (insider) position of skilled blue collar workers resulting from the apprenticeship system in Germany. Especially the wages for skilled blue collar workers are fixed by collective agreements and unemployment for this skill group is not very high meaning that also those firms which are not covered by unions have often to pay tariff wages if they require these skills. So there are no incentives for blue collar workers – who are the majority of middle earners – to change their employer. The mobility of bottom earners is often induced by the employer, while top earners more often exit from firms with a compressed wage structure[25] suggesting that they quit more often seeking their chance elsewhere.

5 Summary and outlook

The West German Private Sector is characterized by a rising inequality of the payments of employees and the wages employers offer. While firms

[24] Middle wage earners are in the 45 to 55%-ile of the wage distribution.

[25] A compressed wage structure is defined for those plants, which are below the average 90/50-ratio of the firm wage distribution, a spread out wage structure have firms, if their 90/50-ratio is above the average.

'start' in the year 1993 more representing a microcosm of the whole economy - meaning payments are more equally distributed between workers and firms - they 'end' in the year 2000 with higher wage differentials on the individual and firm level meaning that firm heterogeneities became more important for the setting and the within and between variation of wages in Germany during the nineties. There were a lot of reorganization activities in German plants in the nineties. Outsourcing, new customer-producer relationships and changes in the work organization were necessary for making firms more competitive. Such activities change the wage structure between and within plants. Wage structures in Germany are rather rigid and payment adjustments can be more expected via the mobility of workers. Skill biased technological change adversely affects both the risks of job loss and the wage development of different skill groups (f. e. Bauer/Bender, 2002; Kölling/Schank, 2002). The institutional frame of the German labour market can be described as more or less protecting insiders, but employers gain more flexibility in designing working contracts. All this is resulting in a large mixture of heterogeneous workers in heterogeneous plants, in the sense that some of them are more affected by new developments than others at the same time. This leads to our observed rising inequality and larger wage dispersion.

This key result for the structure of wages within and between firms is mostly driven by the more dynamic development at the upper bound of workers and firms' wages. There is still a lot of wage variation within firms. The variation of wages between firms becomes more important during our observation period 1993 to 2000 meaning that compared to the (observable) human capital firm effects became more important. In 1993 there is a strong correlation between the firm size and the age of employees which nearly diminishes in 2000. More important is the tenure of workers meaning that holding workers is more a matter of job duration than age, and the latter does not necessarily reflect the former.

The rising within variance of wages can only be partly explained by a change in firms' mixture of occupations[26]. They are differently affected by

[26] We estimate an average wage return rate for workers of c. p. one percent, if their employer drives down the proportion of different occupations in his plant by five percent (relative to all of his employees).

sorting effects and unobserved components of human capital. Once controlled for unobserved firm and worker characteristics there are only small wage differentials between occupation groups meaning that German firms set wages not (only) by occupations but for other observed and especially unobserved human capital. Unobservably 'good' workers work more often in plants which reduce hierarchies, improve worker responsibilities and have fewer worker flows. The results are only sometimes affected by the coverage of collective agreement over plants. Unionized plants pay in 2000 on average significantly higher wages and have in 1995 a more compressed wage structure, whereas in other years we find no significant differences between unionized and non-unionized plants.

A decomposition of the variance of wages shows that the importance of the firm-specific effect increases, whereas that of the human capital effect decreases. The R^2 attributed to the interaction of both human capital and firm-specific effects remains almost stable during the years 1993 to 2000.

Analyses of the wage dynamics in Germany show, that firms offer a wide range of change in wages. In general, workers with shorter job durations receive higher wage changes than workers with longer job durations. The range of the change in wage especial on individual level is getting wider during the nineties. The 90/10-ratio of the standard deviation of the change in plants average wage is 2.383 in 1993 and 2.814 in 2000, whereas the mean remains nearly unchanged. Referring to all employees it seems that firms set wages more by occupation, but wage growth rates are connected with the date of entrance by the employee. The same economic environment affects differently in heterogeneous plants the wage dynamics on individual level. Once controlled for the date of entrance, the firm explains better than the occupation the change in wages for employees. For unionized plants we find nearly no significant differences to non-unionized ones. Only in 1995 the coefficient of variation is smaller in plants covered by collective agreement meaning that the change in wages for workers is more compressed if wages are collectively bargained.

From the figures for the mobility of employees we learn that in general there was more mobility in the second half of the nineties. We think that this effect is not only driven by the business cycle but also by a strong trend of deregulation in the formal institutional setting for working con-

tracts in the German labour market. On the other hand several institutions tend to protect insiders. It can be concluded that a notable part of the higher mobility in the second half of the nineties was undertaken by a minority of employees, while (still) the majority of employees remained in stable employment.

Such mobility patterns become also obvious in our Appendix tables A 3.5 to A 3.7. While the entry rates in most cases grew moderately (but nevertheless there was more mobility), the exit rates become higher during the nineties. Despite that fact, stable employment is still normal in Germany. The protection of insiders became most obvious in the percentage of workers with duration of job tenure of more than three years. Especially in stable years the proportion of core (full-time) workers rises in German establishment.

How can future work to our research issues be shaped? In our opinion the objective is at least twofold. The one perspective is focussing on data, the other on understanding the changes in the wage structure, the wage dynamics and the mobility patterns.

The linked employer employee data from Germany, LIAB, make major steps forward. New technologies, in especial ICT, allow building up better datasets with a wider range of possible investigations. In the foreground is the association of the two LIAB-data models meaning integrating the working histories of persons in the cross-sectional model for all plants of the IAB establishment panel. Meanwhile, over ten thousand plants join the panel in West Germany and nearly 5000 in East Germany. Integrating key variables to the associated administrative individual data - like daily precise job durations, the wage of workers paid by the former employer, times of unemployment and many more - will make research with LIAB data not only easier, but also more fruitful. Many questions, which can at present only roughly be answered, will lead to new perspectives.

For better understanding the structure and dynamics of wages and the mobility of employees in Germany, we would like to take a deeper look into the structure and dynamics of wages *within* plants in order to understand what is happening *between* them. Maybe this should also include

plant closing and how newly found units develop over time[27] with special attention given to the in- and outsourcing activities of (other) firms. What is the impact on the wage structure for the remaining staff? What follows for the mobility of workers in an economy? Such questions might give also a partial answer how internal labour markets change over time. Become workers more equal within plants and more different between plants?

We would like to note that - and this seems to be consistent in a cross-country comparison - unobservable worker and firm characteristics become more important. They are correlated with the observables and maybe a key for understanding the wage dispersion as well as the sorting on (national) labour markets, in especial whether countries become more equal in labour market mechanisms.

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Appendix

Appendix A 1: Description of the data[28]

a) The IAB establishment panel (Betriebspanel)

The IAB establishment panel covers in the period 1993 – present of plants located in West and 1996 – present in East Germany. Establishment are selected by using a fairly complicated weighting procedure. Unweighted the IAB establishment panel covers 1 percent of all plants (but nearly every larger one) and about 8 percent of all employees. Information on each establishment includes:

- total employment
- standard and overtime hours
- wage recognition
- output
- exports
- investment
- urbanicity
- ownership
- technology (subjective measure)
- organisational change
- profitability
- age of plants and whether parent is a single firm

b) The employment statistic register (Beschäftigtenstatistik)

For the other side of the labour market the IAB has access to the federal employment statistics register. It covers 1975 – present for West and 1992 – present for the East Germany. It contains about 400 million records, covering about 46 million employees. Information on each worker includes

- gender, age and nationality
- start and end of every employment spell
- occupation (3-digit)

[28] Andrews/Schank/Upward (2004), pp. 13-14.

- daily gross wages (left truncated and right censored)
- qualifications (education/apprenticeship)
- industry, region
- establishment identification number
- information about multiple jobs and times of unemployment

By using the establishment identification number, the IAB is able to associate each worker in the employment statistics register with an establishment in the IAB establishment panel.

Appendix A 2: Variables and definitions

Remark: For the structure of the linked-employer-employee-datasets of the IAB see the data sections in this article or IAB-Discussion-Paper No. 6/2005 (Alda/Bender/Gartner, 2005). Hereafter we describe how the applied key variables are computed and defined.

wages
Gross wages are applicable on a daily precise base. They are multiplied times 30.5 to get monthly wages. Wages are truncated at a lower bound and censored at an upper bound. Censored wages are imputed similar as described by Gartner/Rässler in IAB-Discussion-Paper No. 5/2005. After the imputation procedure we deflate all wages with the consumer price index (2000 = 100). All wages and statistics refer to full time employees. Wages are restricted to the interval of [500; 22026] Euros or in logs [5.5; 10].

full time employees
In the individual data are no information about the working hours, but if employees work the plant usual full-time hours or not. Apprenticeships are excluded from all analyses.

movers
We use in this paper the LIAB cross-sectional model. Movers can in this model only be identified, if they move to another plant, which is also part of the IAB-Establishment-Panel in the following year (we call this "IAB-Turnover"). In the longitudinal model it is possible to follow the working history of persons. The correlations of observed and unobserved employer and employee characteristics are based on this first Version of the LIAB longitudinal model.

tenure
In the cross-sectional model it is only possible to check whether the individual identifier occurs in three consecutive years. In the longitudinal model it is possible on a daily precise base to compute job durations (left censored at January, 1st, 1990). We use this information to report the correlation of the firm size with the tenure variable.

sector classification

We use the sector classification from the IAB-Establishment-Panel. It covers the whole German economy. We excluded all branches of the public sector and all services having a public ownership. In the manufacturing sector – which is a subpopulation of the whole sample – we exclude the agrarian sector as well as mining and construction plants (number of observations (plants) in remaining manufacturing: 1993: 1161; 1995: 915; 2000: 730).

mobility and growth rates

All mobility rates are based on the formula $2*E_t/(N_{t-1} + N_t)$, where E is the event (entries, exits) and N is the total number of employees. This means for example that the exit rate of high level jobs is based on all exits of high level jobs times two divided by the sum of all existing high level jobs at time t and at time t_{t-1}. Growth rates are quite similar constructed: $2*(N_t - N_{t-1}) / (N_t + N_{t-1})$.

high / low level jobs and top, middle, bottom earners

For high and low level jobs we compute for each occupation (on a 3-digit level) the median wage. High level jobs are those jobs in the top 80 (low level bottom 20) decile of the wage distribution.

For the definition of top, middle and bottom earners the occupation variable is not used. Top earners are persons in the 90%-ile of the yearly wage distribution, bottom earners the 10%-ile and 'middle'-earners employees in the 45%-55%-ile.

coefficient of variation

Constructed as $r = \sigma / |\bar{y}|$, where r is the coefficient, σ the standard deviation and y the (change in) wage on plant level. For the tables with the wage dynamics the coefficient of variation is much higher than for the structure of wages. In the tables for wage dynamics the coefficient is therefore divided by 100.

size

All size information used is based only on full time employees excluding apprenticeships. For analyses with the cross sectional LIAB we include only plants with at least 25 full-time employees and for the longitudinal LIAB data at least three.

switch rate

The switch rate measures a change in the occupational code of a full-time employee between t and t-1 for all non-movers in a plant.

Appendix A 3: Tables of Wage, Wage Changes and Mobility Patterns

Table A 3.1: Structure of wages within and between plants

	monthly wages in Euros			log monthly wages in Euros		
	1993	1995	2000	1993	1995	2000
average wage, observation = a person	3,089.97	3,187.36	3,314.24	7.989	8.018	8.052
(median)	2,855.75	2,934.31	3,054.59	7.957	7.984	8.024
(s.d.)	995.96	1,048.59	1,144.24	0.303	0.308	0.328
(90%-ile)	4,438.33	4,606.65	4,844.97	8.398	8.435	8.486
(75%-ile)	3,569.87	3,697.24	3,850.25	8.180	8.213	8.256
(25%-ile)	2,408.41	2,469.87	2,543.85	7.787	7.811	7.841
(10%-ile)	2,076.52	2,126.95	2,175.74	7.638	7.662	7.685
[N – workers]	1,613,662	1,059,419	622,307	1,613,662	1,059,419	622,307
average of plant average wage, observ = a plant	2,774.89	2,875.68	2,861.15	7.869	7.884	7.878
(median)	2,758.07	2,845.02	2,820.62	7.890	7.895	7.897
(s.d.)	557.49	601.23	677.69	0.213	0.220	0.251
(90%-ile)	3,493.73	3,664.33	3,806.67	8.115	8.145	8.192
(75%-ile)	3,144.38	3,263.71	3,251.82	8.021	8.037	8.038
(25%-ile)	2,408.39	2,478.56	2,430.48	7.747	7.758	7.747
(10%-ile)	2,078.78	2,145.13	2,007.83	7.589	7.611	7.547
[N – firms]	2,163	1,709	1,578	2,163	1,709	1,578
average of s.d. of wages, observ = a plant	790.99	818.24	829.83	0.267	0.266	0.274
(median)	790.18	821.16	833.26	0.264	0.264	0.271
(s.d.)	210.66	226.69	265.19	0.062	0.064	0.076
(90%-ile)	1,061.06	1,113.54	1148.94	0.346	0.345	0.366
(75%-ile)	929.03	973.55	1014.69	0.306	0.304	0.315
(25%-ile)	648.77	663.67	657.91	0.226	0.225	0.225
(10%-ile)	524.44	522.29	473.57	0.191	0.190	0.189
[N – firms]	2,163	1,709	1,578	2,163	1,709	1,578
average Coefficient of variation of wages, observ = a plant)	0.288	0.284	0.293	0.034	0.034	0.035
(median)	0.286	0.286	0.291	0.033	0.033	0.034
(s.d.)	0.067	0.071	0.081	0.008	0.009	0.010
(90%-ile)	0.370	0.372	0.387	0.044	0.044	0.047
(75%-ile)	0.329	0.327	0.339	0.039	0.039	0.040
(25%-ile)	0.245	0.245	0.243	0.029	0.029	0.028
(10%-ile)	0.206	0.202	0.196	0.024	0.024	0.024
[N – firms]	2,163	1,709	1,578	2,163	1,709	1,578

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	monthly wages in Euros			log monthly wages in Euros		
	1993	**1995**	**2000**	**1993**	**1995**	**2000**
Correlation(average wage, s.d. of wage), observ = a plant	0.571*	0.589*	0.616*	n.a.	n.a	n.a.
Average Wage for workers between 25 and 30, observation = a person	2,708.43	2,731.13	2,832.01	7.878	7.887	7.916
(median)	2,628.39	2,647.54	2,738.93	7.874	7.881	7.915
(s.d.)	639.17	634.27	740.02	0.227	0.224	0.257
(90%-ile)	3,483.24	3,504.48	3,688.77	8.156	8.161	8.213
(75%-ile)	3,003.81	3,038.16	3,190.57	8.007	8.019	8.067
(25%-ile)	2,293.15	2,319.55	2,360.98	7.737	7.749	7.767
(10%-ile)	2,023.95	2,053.61	2,062.87	7.612	7.627	7.631
[N – workers]	292,220	172,243	69,017	292,220	172,243	69,017
Average Wage for workers between 45 and 50, observation = a person	3,280.06	3346.05	3,438.98	8.046	8.064	8.086
(median)	3,040.57	3,095.89	3,161.72	8.019	8.038	8.059
(s.d.)	1,072.67	1,115.22	1,204.48	0.313	0.318	0.336
(90%-ile)	4,706.99	4,833.69	5,048.48	8.457	8.483	8.527
(75%-ile)	3,920.19	3,981.54	4,082.18	8.274	8.289	8.314
(25%-ile)	2,514.67	2,560.34	2,612.21	7.829	7.847	7.867
(10%-ile)	2,136.32	2,166.89	2,211.54	7.667	7.681	7.701
[N – workers]	227,483	158,982	105,460	227,483	158,982	105,460

* significant on a level of $\alpha < 0.05$

Source: linked-employer-employee-data of the Institute of Employment Research/ Germany, cross-sectional model, Version 1.

Table A 3.2: Structure of wages within and between plants (weighted values)

	monthly wages in Euros			log monthly wages in Euros		
	1993	**1995**	**2000**	**1993**	**1995**	**2000**
Average Wage, observation = a person	2808.99	2874.33	3,021.66	7.882	7.904	7.947
(median)	2614.68	2662.79	2,778.85	7.869	7.887	7.929
(s.d.)	984.09	1025.72	1,130.84	0.343	0.347	0.368
(90%-ile)	4150.29	4284.84	4,552.66	8.331	8.363	8.423
(75%-ile)	3291.25	3361.08	3,576.89	8.099	8.120	8.182
(25%-ile)	2151.25	2194.55	2,267.37	7.674	7.693	7.726
(10%-ile)	1776.12	1813.39	1,858.69	7.482	7.503	7.527
[N – workers]	9,083,054	8,187,154	4,652,141	9,083,054	8,187,154	4,652,141
Average of plant average wage, observ = a plant	2,535.99	2,595.01	2,645.80	7.773	7.780	7.795
(median)	2,507.45	2,546.38	2,623.53	7.779	7.801	7.809
(s.d.)	555.01	597.57	690.68	0.233	0.242	0.269
(90%-ile)	3,251.58	3,347.32	3,616.41	8.045	8.073	8.148
(75%-ile)	2,895.55	2,925.65	3,044.09	7.931	7.935	7.972
(25%-ile)	2,171.04	2,220.07	2,151.13	7.644	7.648	7.618
(10%-ile)	1,847.67	1,875.74	1,799.47	7.465	7.482	7.455
[N – plants]	292,220	172,243	69,017	292,220	172,243	69,017
Average of s.d. of wage, observ = a plant	703.75	708.16	760.17	0.269	0.265	0.286
(median)	695.81	693.25	762.97	0.265	0.261	0.277
(s.d.)	224.42	248.17	289.53	0.076	0.084	0.105
(90%-ile)	992.09	1,038.20	1,110.95	0.367	0.363	0.416
(75%-ile)	850.89	862.11	972.49	0.320	0.316	0.335
(25%-ile)	547.89	533.42	556.28	0.218	0.209	0.218
(10%-ile)	414.79	388.57	362.78	0.173	0.160	0.160
[N – plants]	292,220	172,243	69,017	292,220	172,243	69,017
Average Coefficient of variation of wages, observ = a plant)	0.281	0.278	0.289	0.035	0.034	0.037
(median)	0.277	0.276	0.288	0.034	0.033	0.035
(s.d.)	0.082	0.091	0.095	0.010	0.011	0.014
(90%-ile)	0.384	0.386	0.416	0.047	0.047	0.054
(75%-ile)	0.334	0.327	0.346	0.041	0.041	0.043
(25%-ile)	0.226	0.218	0.226	0.028	0.027	0.028
(10%-ile)	0.177	0.167	0.164	0.023	0.020	0.020
[N – firms]	292,220	172,243	69,017	292,220	172,243	69,017
Correlation(average wage, s.d. of wage), observ = a plant	0.498*	0.480*	0.604*	n.a.	n.a	n.a.

* significant on a level of $\alpha < 0.05$

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	monthly wages in Euros			log monthly wages in Euros		
	1993	**1995**	**2000**	**1993**	**1995**	**2000**
average Wage for workers between 25 and 30, observation = a person	2,472.50	2,490.99	2,571.29	7.779	7.786	7.809
(median)	2,395.12	2,425.38	2,451.72	7.781	7.794	7.804
(s.d.)	650.78	657.61	765.63	0.261	0.263	0.299
(90%-ile)	3,286.77	3,299.86	3,515.17	8.097	8.101	8.164
(75%-ile)	2,795.77	2,822.11	2,956.56	7.935	7.945	7.991
(25%-ile)	2,049.23	2,066.89	2,084.02	7.625	7.633	7.642
(10%-ile)	1,763.34	1,767.69	1,766.04	7.475	7.478	7.476
[N – workers]	2,075,194	1,402,819	548,181	2,075,194	1,402,819	548,181
average Wage for workers between 45 and 50, observation = a person	3,033.17	3,069.02	3,142.69	7.956	7.964	7.982
(median)	2,828.37	2,842.27	2,890.66	7.947	7.952	7.969
(s.d.)	1,071.39	1,121.66	1,197.33	0.357	0.364	0.381
(90%-ile)	4,459.18	4,583.83	4,743.76	8.402	8.431	8.464
(75%-ile)	3,683.26	3,689.56	3,776.64	8.211	8.213	8.236
(25%-ile)	2,289.23	2,306.39	2,339.59	7.736	7.743	7.757
(10%-ile)	1,853.41	1,857.98	1,879.18	7.525	7.527	7.538
[N – workers]	1,327,249	1,159,054	770,242	1,327,249	1,159,054	770,242

Source: linked-employer-employee-data of the Institute of Employment Research/ Germany, cross-sectional model, Version 1, weighted values.

Table A 3.3: Wage dynamics

	change in monthly wages (in Euros)			change in log monthly wages (in Euros)		
	1993	**1995**	**2000**	**1993**	**1995**	**2000**
Average change in wage observation = a person	-29.82	136.08	63.13	-0.101	0.043	0.018
(median)	-26.67	105.48	43.21	-0.100	0.039	0.016
(s.d.)	486.69	482.26	601.42	0.115	0.112	0.013
(90%-ile)	294.74	476.43	444.63	0.094	0.147	0.131
(75%-ile)	80.89	238.19	171.86	0.296	0.083	0.059
(25%-ile)	-144.83	11.08	-48.33	-0.051	0.004	-0.017
(10%-ile)	-372.37	-163.01	-299.75	-0.118	-0.053	-0.089
[N – workers]	1,612,065	1,058,246	621,576	1,612,065	1,058,246	621,576
Average of firm average change in wage, observ = a plant	-9.44	103.43	53.67	- 0,004	0.038	0.021
(median)	-1.01	100.52	48.46	- 0.001	0.038	0.019
(s.d.)	80.57	95.16	90.83	0.027	0.034	0.034
(90%-ile)	75.83	214.74	148.51	0.025	0.072	0.055
(75%-ile)	39.28	154.22	94.99	0.013	0.055	0.035
(25%-ile)	-49.55	51.81	10.87	- 0.017	0.023	0.006
(10%-ile)	-109.31	5.97	-34.62	- 0.039	0.004	- 0.012
[N – plants]	2,163	1,709	1,578	2,163	1,709	1,578
Average of s.d. of change in wage, observ = a plant	217.41	210.17	207.16	0.073	0.069	0.070
(median)	209.51	203.61	199.28	0.071	0.066	0.067
(s.d.)	71.37	73.77	81.81	0.019	0.020	0.024
(90%-ile)	311.77	307.57	317.35	0.094	0.090	0.096
(75%-ile)	264.51	255.27	254.62	0.083	0.079	0.081
(25%-ile)	168.29	157.57	151.62	0.060	0.057	0.055
(10%-ile)	130.83	120.84	112.77	0.051	0.049	0.045
[N – plants]	2,163	1,709	1,578	2,163	1,709	1,578
Avg Coefficient** of variation of change in wages, observ = a plant)	4.814	3.849	6.086	0.228	0.231	0.294
(median)	3.423	2.755	3.822	0.223	0.219	0.284
(s.d.)	107.33	26.309	385.056	0.058	0.069	0.097
(90%-ile)	9.127	7.639	15.978	0.307	0.313	0.392
(75%-ile)	5.487	4.219	8.046	0.249	0.259	0.336
(25%-ile)	2.189	1.742	1.553	0.186	0.188	0.238
(10%-ile)	0.989	0.816	-4.934	0.159	0.161	0.191
[N – plants]	2,163	1,709	1,578	2,163	1706	1,578

** divided by hundred

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	change in monthly wages (in Euros)			change in log monthly wages (in Euros)		
	1993	**1995**	**2000**	**1993**	**1995**	**2000**
Avg change in wage for people with tenure < 3 years, observ = a person	34.75	156.25	94.51	0.012	0.053	0.030
(median)	18.09	117.59	54.61	0.007	0.046	0.021
(s.d.)	443.73	467.19	558.82	0.118	0.118	0.138
(90%-ile)	336.82	500.61	461.33	0.119	0.163	0.149
(75%-ile)	137.28	258.54	197.19	0.054	0.095	0.073
(25%-ile)	-84.71	23.55	-26.61	-0.036	0.009	-0.010
(10%-ile)	-254.06	-134.86	-203.64	-0.093	-0.048	-0.071
[N – workers]	236,672	165,071	105,938	236,672	165,071	105,938
Avg change in wage for people with tenure $\geq$ 3 years, observ = a person	-40.93	132.36	56.68	-0.014	0.042	0.017
(median)	-33.54	103.45	41.10	-0.012	0.038	0.015
(s.d.)	492.86	484.90	609.62	0.105	0.111	0.120
(90%-ile)	284.58	471.55	440.42	0.083	0.144	0.121
(75%-ile)	68.94	234.15	166.52	0.026	0.081	0.156
(25%-ile)	-154.89	8.64	-53.66	-0.046	0.003	-0.018
(10%-ile)	-392.05	-168.39	-321.58	-0.107	-0.054	-0.092
[N – workers]	1,375,393	893,175	515,638	1,375,393	893,175	515,638

Source: linked-employer-employee-data of the Institute of Employment Research/ Germany, cross-sectional model, Version 1.

Table A 3.4: Wage dynamics (weighted values)

	change in monthly wages (in Euros)			change in log monthly wages (in Euros)		
	1993	**1995**	**2000**	**1993**	**1995**	**2000**
Average change in wage observation = a person	-13.82	103.49	57.08	-0.005	0.036	0.016
(median)	-13.71	78.86	37.22	-0.006	0.032	0.014
(s.d.)	405.27	398.19	485.91	0.108	0.104	0.129
(90%-ile)	255.01	378.33	364.73	0.092	0.131	0.127
(75%-ile)	81.05	188.90	148.10	0.033	0.073	0.056
(25%-ile)	-110.37	-1.84	-38.67	-0.043	-0.001	-0.015
(10%-ile)	-294.32	-144.37	-215.48	-0.104	-0.053	-0.075
[N – workers]	9,069,945	8,187,154	4,646,177	9,069,945	8,187,154	4,646,177
Average of firm average change in wage, observ = a plant	6.51	73.33	36.94	0.003	0.031	0.018
(median)	6.35	71.29	36.26	0.003	0.032	0.018
(s.d.)	94.71	98.65	105.52	0.038	0.039	0.041
(90%-ile)	115.87	177.89	143.22	0.047	0.071	0.060
(75%-ile)	54.48	124.58	87.27	0.022	0.051	0.036
(25%-ile)	- 43.16	18.91	-10.21	- 0.017	0.012	- 0.001
(10%-ile)	- 95.49	-35.57	-69.94	- 0.041	- 0.009	- 0.021
[N – plants]	292,220	172,243	69,017	292,220	172,243	69,017
Average of s.d. of change in wage, observ = a plant	189.82	180.21	185.73	0.072	0.068	0.071
(median)	181.54	166.99	168.60	0.069	0.062	0.065
(s.d.)	76.26	78.41	93.09	0.027	0.027	0.038
(90%-ile)	296.17	285.94	310.75	0.108	0.097	0.105
(75%-ile)	236.89	222.80	243.11	0.085	0.082	0.084
(25%-ile)	135.12	121.86	126.14	0.053	0.051	0.048
(10%-ile)	96.84	90.27	80.85	0.043	0.040	0.037
[N – plants]	292,220	172,243	69,017	292,220	172,243	69,017
Avg Coefficient** of variation of change in wages, observ = a plant)	1.213	0.061	0.163	0.214	0.074	0.510
(median)	0.048	0.027	0.039	0.045	0.024	0.034
(s.d.)	31.55	0.156	2.322	0.262	0.040	4.712
(90%-ile)	0.217	0.119	0.182	0.093	0.092	0.207
(75%-ile)	0.095	0.052	0.088	0.092	0.047	0.078
(25%-ile)	0.025	0.017	0.021	0.022	0.014	0.019
(10%-ile)	0.152	0.011	0.014	0.014	0.010	0.014
[N – plants]	292,220	172,243	69,017	292,220	172,243	69,017

** divided by hundred

(continued on next page)

	change in monthly wages (in Euros)			change in log monthly wages (in Euros)		
	1993	**1995**	**2000**	**1993**	**1995**	**2000**
Avg change in wage for people with tenure < 3 years , observ = a person	27.61	115.40	73.78	0.011	0.044	0.026
(median)	13.48	85.01	46.08	0.067	0.037	0.019
(s.d.)	356.03	374.94	481.62	0.113	0.111	0.133
(90%-ile)	283.85	388.67	389.21	0.114	0.144	0.137
(75%-ile)	119.53	199.81	167.38	0.052	0.082	0.067
(25%-ile)	-74.59	6.64	-29.35	-0.033	0.003	-0.013
(10%-ile)	-223.79	-128.74	-183.85	-0.091	-0.051	-0.073
[N – workers]	2,089,873	2,002,997	1,160,379	2,089,873	2,002,997	1,160,379
Avg change in wage for people with tenure ≥ 3 years, observ = a person	-26.22	99.64	51.65	-0.009	0.033	0.016
(median)	-21.28	77.17	36.60	-0.008	0.303	0.014
(s.d.)	418.09	405.36	517.64	0.106	0.102	0.119
(90%-ile)	242.58	374.98	360.59	0.829	0.126	0.114
(75%-ile)	67.77	185.52	143.07	0.026	0.069	0.052
(25%-ile)	-121.17	-4.019	-36.78	-0.046	-0.002	-0.014
(10%-ile)	-317.24	-150.51	-223.47	-0.107	-0.054	-0.073
[N – workers]	6,980,071	6,184,157	3,486,152	6,980,071	6,184,157	3,486,152

Source: linked-employer-employee-data of the Institute of Employment Research/ Germany, cross-sectional model, Version 1, weighted values.

Table A 3.5: Mobility Panel A: all jobs

	all plants			all plants (weighted values)		
	1993	**1995**	**2000**	**1993**	**1995**	**2000**
Employees	812.415	696.544	453.927	100.315	94.229	86.165
(s.d.)	2119.559	1552.058	1286.649	395.994	310.298	374.508
Number of occupations	35.012	33.351	26.455	13.776	13.152	13.013
(s.d.)	27.262	25.798	21.565	11.056	10.612	10.356
Employment growth	-0.049	-0.020	-0.047	-0.017	-0.002	-0.042
(s.d.)	0.153	0.163	0.237	0.151	0.158	0.231
Exit rate	0.169	0.147	0.202	0.187	0.163	0.227
(s.d.)	0.135	0.132	0.204	0.132	0.128	0.195
Exit rate, top decile of plant wages	0.154	0.156	0.226	0.183	0.137	0.223
(s.d.)	0.183	0.182	0.246	0.177	0.142	0.199
Exit rate, top quartile of plant wages	0.147	0.139	0.193	0.161	0.127	0.213
(s.d.)	0.158	0.152	0.210	0.144	0.133	0.182
Exit rate, bottom decile of plant wages	0.246	0.209	0.338	0.247	0.228	0.292
(s.d.)	0.153	0.140	0.213	0.153	0.147	0.184
Exit rate, bottom quartile of plant wages	0.209	0.179	0.306	0.219	0.191	0.291
(s.d.)	0.127	0.150	0.229	0.134	0.139	0.181
Entry rate	0.111	0.121	0.150	0.159	0.157	0.179
(s.d.)	0.102	0.113	0.156	0.125	0.141	0.177
Entry rate, top decile of plant wages	0.097	0.109	0.137	0.200	0.227	0.161
(s.d.)	0.101	0.139	0.155	0.152	0.194	0.151
Entry rate, top quartile of plant wages	0.090	0.096	0.125	0.137	0.117	0.150
(s.d.)	0.085	0.105	0.135	0.125	0.118	0.148
Entry rate, bottom decile of plant wages	0.182	0.194	0.306	0.200	0.227	0.248
(s.d.)	0.143	0.169	0.271	0.152	0.194	0.234
Entry rate, bottom quartile of plant wages	0.147	0.162	0.261	0.181	0.187	0.250
(s.d.)	0.123	0.143	0.231	0.132	0.166	0.218
% of employees who switch jobs** internally	0.027	0.021	0.020	0.024	0.014	0.015
(s.d.)	0.048	0.035	0.045	0.052	0.030	0.034
% of workers who have been at plant 3+ years	0.664	0.665	0.590	0.585	0.584	0.545
(s.d.)	0.194	0.275	0.337	0.217	0.282	0.324

** change in the 3-digit occupational code

(continued with correlations on next page)

	all plants			all plants (weighted values)		
	1993	**1995**	**2000**	**1993**	**1995**	**2000**
correlation (exit rate, log average wage), observ = a plant	- 0.225*	- 0.143*	- 0.109*	- 0.248*	- 0.267*	- 0.165*
correlation (exit rate, log average wage change), observ = a plant	- 0.017*	- 0.118*	0.015	0.006	- 0.026*	- 0.025*
correlation (exit rate, s.d. of log wage), observ = a plant	0.079*	0.079*	0.062*	0.114*	0.125*	- 0.080*
correlation (entry rate, log average wage), observ = a plant	- 0.321*	- 0.291*	- 0.244*	- 0.218*	- 0.292*	- 0.183*
correlation (entry rate, log average wage change), observ = a plant	0.205*	0.069*	0.073*	0.142*	0.089*	0.014
correlation (entry rate, s.d. of log wage), observ = a plant	0.139*	0.128*	0.093*	0.057*	0.073*	- 0.118*

notes: all statistics are on establishment level ; a * indicates significance on a level of $\alpha < 0.05$

Source: linked-employer-employee-data of the Institute of Employment Research/ Germany, cross-sectional model, Version 1.

Table A 3.6: Mobility Panel B: high level jobs

	all plants			all plants (weighted values)		
	1993	1995	2000	1993	1995	2000
Employees	157.661	131.322	68.213	29.900	28.225	21.523
(s.d.)	313.019	257.689	123.875	72.246	60.801	42.907
Number of occupations	15.290	14.098	9.595	6.786	6.596	5.495
(s.d.)	12.728	11.612	7.740	5.302	4.984	4.103
Employment growth	-0.081	-0.105	-0.080	-0.089	-0.030	-0.099
(s.d.)	0.308	0.317	0.385	0.339	0.329	0.387
Exit rate	0.114	0.116	0.159	0.119	0.119	0.156
(s.d.)	0.186	0.190	0.242	0.254	0.260	0.292
Exit rate, top decile of plant wages	0.121	0.131	0.182	0.148	0.113	0.175
(s.d.)	0.173	0.178	0.223	0.175	0.127	0.185
Exit rate, top quartile of plant wages	0.109	0.109	0.156	0.106	0.088	0.167
(s.d.)	0.149	0.141	0.192	0.138	0.120	0.180
Exit rate, bottom decile of plant wages	0.134	0.149	0.269	0.159	0.184	0.358
(s.d.)	0.307	0.317	0.524	0.410	0.389	0.719
Exit rate, bottom quartile of plant wages	0.116	0.141	0.226	0.127	0.155	0.286
(s.d.)	0.232	0.291	0.452	0.323	0.366	0.604
Entry rate	0.060	0.074	0.091	0.079	0.086	0.093
(s.d.)	0.111	0.175	0.183	0.171	0.239	0.220
Entry rate, top decile of plant wages	0.062	0.065	0.093	0.092	0.087	0.101
(s.d.)	0.080	0.081	0.131	0.121	0.122	0.117
Entry rate, top quartile of plant wages	0.053	0.054	0.081	0.075	0.061	0.089
(s.d.)	0.068	0.066	0.118	0.099	0.091	0.139
Entry rate, bottom decile of plant wages	0.104	0.110	0.219	0.127	0.118	0.125
(s.d.)	0.229	0.276	0.421	0.304	0.331	0.367
Entry rate, bottom quartile of plant wages	0.079	0.100	0.138	0.096	0.093	0.997
(s.d.)	0.169	0.256	0.338	0.234	0.278	0.351
% of employees who switch jobs** internally	0.026	0.019	0.019	0.024	0.013	0.014
(s.d.)	0.060	0.049	0.068	0.077	0.047	0.055
% of workers who have been at plant 3+ years	0.636	0.669	0.628	0.561	0.627	0.605
(s.d.)	0.259	0.310	0.391	0.277	0.330	0.389

** change in the 3-digit occupational code

(continued on next page with correlations)

	all plants			all plants (weighted values)		
	1993	**1995**	**2000**	**1993**	**1995**	**2000**
correlation (exit rate, log average wage), observ = a plant	- 0.046*	- 0.047*	- 0.031*	- 0.090*	- 0.117*	- 0.055*
correlation (exit rate, log average wage change), observ = a plant	- 0.004	- 0.129*	0.025*	0.007	- 0.067*	0.138*
correlation (exit rate, s.d. of log wage), observ = a plant	- 0.063*	- 0.089*	- 0.075*	- 0.072*	- 0.103*	- 0.146*
correlation (entry rate, log average wage), observ = a plant	- 0.128*	- 0.137*	0.016	- 0.096*	- 0.143*	- 0.013
correlation (entry rate, log average wage change), observ = a plant	0.118*	- 0.004	- 0.055*	0.135*	- 0.013	0.060*
correlation (entry rate, s.d. of log wage), observ = a plant	0.053*	- 0.035*	- 0.051*	- 0.001	0.016	- 0.092*

notes: all statistics are on establishment level ; a * indicates significance on a level of $\alpha < 0.05$

Source: linked-employer-employee-data of the Institute of Employment Research/Germany, cross-sectional model, Version 1.

Table A 3.7: Mobility Panel C: low level jobs

	all plants			all plants (weighted values)		
	1993	1995	2000	1993	1995	2000
Employees	223.284	181.506	111.529	66.920	59.406	54.314
(s.d.)	839.317	562.563	494.572	300.380	217.421	301.362
Number of occupations	17.890	16.660	11.807	11.795	10.997	9.409
(s.d.)	17.825	16.750	13.458	10.090	9.539	9.223
Employment growth	-0.039	-0.081	-0.060	-0.027	-0.084	-0.044
(s.d.)	0.305	0.303	0.360	0.231	0.237	0.348
Exit rate	0.252	0.222	0.317	0.240	0.214	0.313
(s.d.)	0.189	0.206	0.319	0.182	0.178	0.264
Exit rate, top decile of plant wages	0.333	0.349	0.450	0.309	0.298	0.451
(s.d.)	0.295	0.342	0.429	0.352	0.287	0.367
Exit rate, top quartile of plant wages	0.309	0.298	0.383	0.312	0.288	0.377
(s.d.)	0.261	0.291	0.374	0.299	0.273	0.317
Exit rate, bottom decile of plant wages	0.251	0.211	0.316	0.218	0.203	0.327
(s.d.)	0.159	0.143	0.211	0.129	0.118	0.168
Exit rate, bottom quartile of plant wages	0.225	0.186	0.289	0.211	0.176	0.262
(s.d.)	0.137	0.105	0.237	0.116	0.123	0.197
Entry rate	0.181	0.203	0.352	0.203	0.241	0.373
(s.d.)	0.182	0.192	0.363	0.184	0.229	0.329
Entry rate, top decile of plant wages	0.248	0.277	0.476	0.261	0.359	0.420
(s.d.)	0.269	0.297	0.495	0.249	0.386	0.465
Entry rate, top quartile of plant wages	0.216	0.245	0.418	0.232	0.313	0.409
(s.d.)	0.229	0.258	0.430	0.219	0.321	0.410
Entry rate, bottom decile of plant wages	0.190	0.201	0.306	0.189	0.212	0.369
(s.d.)	0.163	0.179	0.287	0.143	0.181	0.335
Entry rate, bottom quartile of plant wages	0.163	0.176	0.267	0.176	0.183	0.322
(s.d.)	0.142	0.153	0.244	0.144	0.167	0.305
% of employees who switch jobs** internally	0.022	0.015	0.021	0.020	0.012	0.023
(s.d.)	0.074	0.054	0.083	0.062	0.051	0.090
% of workers who have been at plant 3+ years	0.831	0.767	0.708	0.835	0.728	0.733
(s.d.)	0.234	0.327	0.403	0.202	0.349	0.395

** change in the 3-digit occupational code

(continued on next page with correlations)

	all plants			all plants (weighted values)		
	1993	**1995**	**2000**	**1993**	**1995**	**2000**
correlation (exit rate, log average wage), observ = a plant	0.134*	0.193*	0.187*	0.078*	0.099*	0.112*
correlation (exit rate, log average wage change), observ = a plant	0.024*	- 0.025*	0.045*	0.088*	0.016*	- 0.022*
correlation (exit rate, s.d. of log wage), observ = a plant	- 0.057*	- 0.087*	- 0.083*	- 0.051*	- 0.035*	- 0.104*
correlation (entry rate, log average wage), observ = a plant	0.046*	0.099*	0.194*	0.135*	0.008	0.156*
correlation (entry rate, log average wage change), observ = a plant	0.181*	0.083*	0.039*	0.070*	0.055*	- 0.015
correlation (entry rate, s.d. of log wage), observ = a plant	- 0.057*	- 0.067*	- 0.158*	- 0.131*	- 0.100*	- 0.257*

notes: all statistics are on establishment level ; a * indicates significance on a level of $\alpha < 0.05$

Source: linked-employer-employee-data of the Institute of Employment Research/Germany, cross-sectional model, Version 1.

Appendix A 4: Covariates in the wage regressions for table 6 and 7

(regression results not printed; they will be published in Alda (2005a) and are available upon request)

a) worker characteristics

time/spell variant (= x_{it}):

age (age²/100; age³/10000)	tenure (in years)	education level
current occupation group	multiple jobs (yes/no)	days of employment/ days of unemployment * 100
days of employment / days unobserved * 100	no. of employers	no. of unemployment phases

time/spell invariant:

gender	nationality	existence of leave of absence (f.e. sabbaticals)

b) plant characteristics

time/spell variant (= w_{it}):

size (ten dummies)	collective agreement (branch/plant level yes/no)	works council (yes/no)
economic situation (subjective measure)	paying more than collectively negotiated wages (yes/no)	sum of investment (log) per capita
weekly worked hours	outsourcing activities	vacancies
organizational change	no. of occupation	churning

proportions of: fixed-term contracts, females and university degrees

time/spell invariant:

ownership	single-plant firm (yes/no)	urbanity

sector (ten dummies)

Appendix A 5: Symbols and indices for wage regressions

Indices:

i : individuals j : plants t : time (years)

Symbols:

μ : constant

x : observable time variant person characteristics

w : observable time variant plant characteristics

θ_i : unobserved person fixed effect

ψ_j : unobserved firm fixed effect

B : occupation groups

note: θ_i and ψ_j include the time invariant covariates of persons/plants.

Appendix A 6: Information about the regression techniques

A more detailed description of the regression techniques is given by Andrews/Schank/Upward (2004), hereafter ASU:

For the spell-level fixed effect regression (Spell-FE) we define

(A 2.1) $\lambda_s = \theta_i + \psi_j$

for each unique worker-firm combination (=spell). Neither θ_i nor ψ_j vary within a spell. The wage regression is then

(A 2.2.) $y_{it} = x_{it}\beta + w_{jt}\gamma + \lambda_{ijt} + \varepsilon_{it}$

with

(A 2.3.) $\bar{\lambda}_s = \sum \lambda_{ijt}/ n = \lambda_{ijt}$

n is the number of observations (worker years) within a specific spell. Computing the mean deviations for each observation within a spell is

(A 2.4.) $y_{it} - \bar{y}_s = (x_{it} - \bar{x}_s)\beta + (w_{jt} - \bar{w}_s)\gamma + (\lambda_{ijt} - \bar{\lambda}_s) + (\varepsilon_{it} - \bar{\varepsilon}_s)$.

Because of (A 2.3.) is $\bar{\lambda}_s - \lambda_{ijt} = 0$. The estimator is consistent, because he sweeps out both unobserved heterogeneities. He is not the most efficient one (because a Least Square Dummy Variable regression, LSDV, is).

The time-invariant covariates are constant within a spell and therefore swept out. The following example for a standard one-way-fixed-model with worker data only shows, how the wage effect of the time-invariant covariates are identified. The one-way wage regression is:

(A 2.5.) $y_{it} = \mu + x_{it}\beta + \theta_i + \varepsilon_{it}$.

The standard fixed effect (FE) estimator of β can be interpreted as an Instrumented Variable (IV) estimator (ASU, 10; Verbeek (2004), section 10.2.5.)). Then we can formulate

(A 2.6.) $\hat{\beta}_{FE} = [\sum_i \sum_t (x_{it} - \bar{x}_i)' (x_{it} - \bar{x}_i)]^{-1} \sum_i \sum_t (x_{it} - \bar{x}_i)' (y_{it} - \bar{y}_i)$

$= [\sum_i \sum_t (x_{it} - \bar{x}_i)' x_{it}]^{-1} \sum_i \sum_t (x_{it} - \bar{x}_i)' y_{it}$

Further details for the Spell-FE regression can be found in ASU, page 10-11. All variables correlated with the unobservables are instrumented by their mean deviations. Time-invariant variables are "instrumented with themselves" making the usual random effect assumption. The estimator is a special case of the Hausman/Taylor estimator (Hausman/Taylor 1981).

For explicitly calculating (and not sweeping out) the unobserved fixed effects we set all firm effects with less than 16 movers into a single common effect (AKM, 293). This allows us to connect all groups (45) into one by constructing an artificial plant which contains all plants (and workers) who experience little turnover. After this procedure we time-demean the remaining plant dummies (this is what ASU call FE_iLSDV_j) and compute θ_i with the estimated values of ψ_j.

Appendix A 7: Comparison of mean values using propensity score matching

		1993	1995	2000
average wage	collective contract	2737.12	2718.51	2871.85
	without col. contr.	2680.51	2775.73	2724.71
	t-value	0.64	-0.53	2.77
s.d. of wage	collective contract	792.28	744.24	847.53
	without col. contr.	806.30	837.45	818.31
	t-value	-0.45	-2.25	1.43
change in wage	collective contract	29.53	94.18	49.96
	without col. contr.	16.31	87.88	60.32
	t-value	0.99	0.33	-1.38
coefficient of variation of change in wage	collective contract	0.29	0.27	0.30
	without col. contr.	0.31	0.31	0.31
	t-value	-1.39	-2.67	-1.54
exitrate	collective contract	0.18	0.17	0.20
	without col. contr.	0.26	0.19	0.22
	t-value	-3.74	-1.13	-3.30
entryrate	collective contract	0.17	0.18	0.15
	without col. contr.	0.19	0.19	0.19
	t-value	-1.37	-0.50	-3.10
% of workers who have been at plant 3+ years	collective contract	0.56	0.63	0.55
	without col. contr.	0.49	0.49	0.52
	t-value	2.28	3.37	1.46

Notes:

Treatment group are plants without collective contract, control group are plants with collective contract; t-value for H_0: identical mean values.

There are in 1993 120 (1995: 91; 2000: 193) plants without collective agreement in the sample. For each of these plants a statistical twin plant is drawn using a nearest neighbour propensity score matching. Statistical twins are in the same of eight size and ten sector classes. The probit estimation for obtaining propensity scores uses covariates equal to Kohaut/Schnabel, 2003b augmented by the proportion of university degrees and the average age of workers in a plant.

Source: linked-employer-employee-data of the Institute of Employment Research/Germany, cross-sectional model, Version 1.

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