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ABSTRACT

Flexible Work Systems and the Structure of Wages: Evidence from Matched Employer-Employee Data*

A growing theoretical and empirical literature is concerned with the effects of flexible workplace systems or high performance work organizations (HPWOs) on wages. Existing theoretical literature suggests that these forms of organization should lead to higher inequality across firms, increased segregation of labour markets and decreased within-firm inequality. This Paper makes use of a new employer-employee linked data set for Germany to examine the labour market effects of flexible workplace systems. Our results suggest that HPWOs increase both across- and within-firm inequality. We do not find evidence, however, that HPWOs affect their employment structure.

JEL Classification: J30, L20 and O30
Keywords: employment, inequality, linked employer-employee data set and organizational change

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1. Introduction

In the past two decades, the labor markets in most developed countries have witnessed dramatic changes. Starting in the early 1970s inequality of earnings rose, in particular in the US and UK. In continental Europe, where wage rigidities are more common than in the US and the UK, unemployment rates of unskilled workers rose relative to skilled workers.[1] These developments occurred even though the supply of skilled labor in all of these countries increased, suggesting that the increasing supply of skilled labor could not keep pace with increasing demand. Two prominent hypotheses have been put forward to explain these trends. First, it has been argued that the increase in internationally traded goods and services and international capital flows led developed countries to specialize in the production of skill-intensive goods and services and to import goods and services that are intensive in unskilled labor. Second, theoretical as well as empirical studies suggest that improvements in technology, especially developments in information technology, have been "skill-biased".

Snower (1999), however, argues that these two explanations are not sufficient to explain the observed changes in the labor market, because they leave several empirical observations unexplained, such as the reduction of the gender wage gap, increasing earnings instability and rising within-group wage inequality. He suggests that recent changes in the organization of work, which could be observed in most industrialized economies, might be able to provide important insights for the explanation of rising inequality.[2] A growing theoretical and empirical literature is concerned with the determinants of this organizational change - often also called *flexible* or *innovative workplace systems* or *High Performance Work Organizations* (HPWOs) - and its labor market and productivity effects.[3] Most scholars use the same broad

[1]See Gottschalk and Smeeding (1997) and Snower (1999) for a survey of income inequality in different countries. Wage inequality in Germany has been investigated, for example, by Abraham and Houseman (1995), Krueger and Pischke (1995), and Biewen (1998, 2001).

[2]See e.g. Lindbeck and Snower (1996, 2000), OECD (1996, 1999), Milgrom and Roberts (1990, 1995), and Snower (1999).

[3]See, for example, Bartel and Lynch (1997), Caroli et al. (2000), Egger and Grossmann (2000), Osterman (1994, 2000) and Lindbeck and Snower (1996, 2000). Surveys are given by Aghion et al.

set of characteristics to describe these flexible work systems: the increasing importance of team work and job rotation, decentralization of decision making within firms, a reduction in the number of hierarchical levels, the replacement of vertical by horizontal communication channels, the introduction of employee problem-solving groups or quality circles, Total Quality Management (TQM) and a change from task specialization to task diversification. Betcherman (1997) and OECD (1999) identify the following main characteristics of flexible workplace systems: job design involving multi-tasking, use of team-work, reduced hierarchy levels, and the delegation of responsibilities to individuals and teams.

Existing theoretical models suggest that the introduction of flexible work practices should lead to increased wage inequality across firms. However, they predict different effects on the wage structure within firms. One strand of the theoretical literature concludes that organizational change is *skill-biased* in itself. Because of the characteristics of flexible work practices, i.e. a high level of cooperation among workers and the need to acquire new skills, mainly high-skilled workers are involved in these practices. These workers will receive a wage premium in firms who introduced HPWOs leading to increasing wage inequality across and within firms. Another group of theoretical models predicts that organizational change leads to a segregation of the labor market resulting in increased homogeneity of skills within firms. In such a segregated labor market, workers in firms who employ only skilled workers earn more than workers in firms who employ only unskilled workers. Because of the increased homogeneity of the skills of workers in firms, the segregation of the labor market also results in a more homogeneous wage structure within firms. Most of the existing empirical evidence on the wage effects of organizational change is only concerned with across-firm inequality and the results are rather mixed.

This study makes use of a unique employer-employee matched panel data set for Germany, with detailed information on the use of flexible workplace systems and the structure of the work force of an establishment. The data set allows us not only to test the hypotheses that organizational change is "skill-biased" but also to analyze

(1999) and Snower (1999).

the effects of HPWOs on the wage structure within establishments. The panel structure of the data set further enables us to control for unobserved firm heterogeneity and to address the potential endogeneity of variables indicating HPWOs in wage and employment regressions by using lagged values of organizational change.

The paper is organized as follows. In the next section we discuss the theoretical background on the labor market effects of flexible working systems and provide a brief survey of the existing empirical literature. Section 3 gives a detailed description of the data set we use in our empirical analysis. The estimation results of the impact of HPWOs on wages, the within-establishment and within-establishment-within-group wage structure and employment for six different skill-groups of workers are presented in Section 5. Section 6 concludes.

2. Background

2.1. Wage Effect of HPWOs: Theoretical Considerations

A growing number of theoretical studies analyze the labor market effects of organizational change. Two mechanisms have been identified by this literature through which HPWOs might shift the relative demand for workers towards the high-skilled and hence might contribute to the explanation of increasing inequality (see Aghion et al., 1999). First, several models conclude that organizational change is skill-biased in itself, i.e. that it increases the relative demand for skilled labor directly. The main argument of these models is based on the nature of the process of re-organization of firms as it has been observed in various countries.[4] This restructuring process typically includes the introduction or increasing importance of team work and job rotation, decentralization of decision making within firms, a reduction in the number of hierarchy levels, the replacement of vertical by horizontal communication channels and a change from task specialization to task diversification. These new work

[4]Evidence for Europe is given by the European Foundation (1997,1998). See also Osterman (1994, 2000) for the U.S., NUTEK (1996, 1999) for the Nordic countries and Gallie et al. (1998) for the UK. Surveys are given by Snower (1999) and OECD (1999).

practices require a high level of cooperation among workers and workers need to be willing to acquire new skills, to perform multiple tasks and to care about quality and productivity[5]. In addition, flexible work practices typically reduce the ease with which firms can monitor their workers.

Both implications of organizational change - a high commitment of workers to their firm and the latter's reduced opportunity to monitor workers - might result in the need to pay higher efficiency wages. Furthermore, firms who restructure their organization often introduce alternative compensation practices such as bonuses or profit sharing[6]. Hence, if organizational change leads to an increased performance of the firm[7] and if the resulting gains are shared between the firm and the worker, one might expect higher wages in firms which introduced flexible work practices. Assuming that skilled workers have a relative advantage in multi-tasking and a greater ability to learn new skills, they will receive a wage premium in firms who have changed their organizational structure which in turn may lead to increased inequality across and within firms.

Another line of argument connects increasing across-firm inequality with an increase in skill segregation arising through organizational change.[8] The main idea behind these models is that an increasing supply of skilled labor induces firms to change their organizational structure which in turn leads to a greater homogeneity of the skill structure within firms. The economy moves from an equilibrium where firms employ both skilled and unskilled labor, towards a segregated equilibrium, where firms employ only skilled or only unskilled workers. This segregation of labor markets by skill group leads to increased inequality across firms, if firms employing only skilled workers are more productive than those employing only unskilled

[5]Using firm-level data for the US, Breshnahan et al. (1999), for example, show that new workplace organization, including broader job responsibilities, decentralized decision making and self-managing teams, and worker skills are complements.

[6]Ostermann (1994), Gittleman et al. (1998) and OECD (1999) provide evidence that flexible workplace practices are positively associated with the use of profit-sharing and pay for skill.

[7]There is substantial evidence that the introduction of new work practices improves the productivity of firms. See, for example, Bartel (1995), Bartel and Lynch (1997), Bonin et al. (2001), Ichniowski et al. (1997), Caroli and van Reenen (2000), and McNabb and Whithfield (1999). A survey is given by OECD (1999).

[8]See, for example, Acemoglu (1999), Kremer and Maskin (1996) and Thesmar and Thoenig (1999).

workers. However, the segregation of the labor market should also result in reduced inequality within firms, because the skill structure inside firms becomes more homogeneous.

There are several arguments which cast doubts on the above conclusions. First, even if organizational change is associated with productivity gains, workers might not have the bargaining power to force the firm to share these gains with them. Second, it might be the case that workers have a preference for working under HPWOs compared to a traditional, Tayloristic organization of the workplace and hence are willing to accept lower wages for the opportunity to participate in HPWOs. There is indeed some empirical evidence that employees prefer to work under HPWOs (see, for example, Freeman and Rogers, 1999).

Finally, as Aghion et al. (1999) note, the effect of organizational change on wage inequality depends on the type of flexibility chosen by the firm. They differentiate between *external* and *internal* flexibility. In the former, organizational change leads firms to fire unskilled workers and to hire the required type of worker from the outside labor market. This type of flexibility, which is prevalent in the US and the UK, increases wage inequality since it shifts the demand for skills upwards. If firms rely on *internal* flexibility, they chose to train unskilled workers in order to promote them. Hence, organizational change associated with *internal* flexibility might reduce both across-firm and within-firm inequality. In Germany and Japan, for example, one might expect *internal* flexibility to be more important than in the US or UK, since on-the-job training is more prevalent in the former countries.

2.2. Previous Empirical Studies

Overall, theory gives no clear conclusion about the effects of organizational change on wages and employment. The empirical evidence on the labor market effects of organizational change, however, is relatively scarce and the results of these studies are mixed. Most existing evidence is based on US data. Capelli (1996) uses the Educational Quality of the Workforce National Employers Survey (EQW), a representative

sample of establishments in the US collected by the U.S. Bureau of the Census, to analyze the effect of Total Quality Management (TQM) and self-managed teams on earnings. Controlling for the structure of the workforce in an establishment, he finds that TQM and self-managed teams have a positive effect on the wages of production workers. The wages of supervisors are positively affected by the presence of self-managed teams only. Capelli (1996) could not find any significant effect of his indicators for new work practices on the ratio of the wages of production workers to the wages of supervisors, suggesting that flexible workplace systems increase across-firm inequality without changing within-firm inequality. Using the same data set as Capelli (1996), Black and Lynch (2000) find that re-engineering a workplace to incorporate more high performance practices and the proportion of workers meeting regularly in groups is associated with higher wages, in particular for unionized establishments. These results hold even after controlling for establishment fixed effects.

Osterman (2000) analyzes the employment and wage effects of High Performance Work Organizations (HPWOs), such as quality circles, job rotation, team-work and total quality management, using a survey of U.S. establishments collected in 1992 and 1997. Controlling for an establishment's labor force composition, his results show that the adoption of HPWOs results in increasing layoff rates whereas it has no or even negative effects on workers compensation. His results further indicate that the introduction of HPWOs is related to other changes in the organizational structure, in particular with a reduction in the employment of managers and contingent workers. Based on a representative employer-employee-matched data set of non-agricultural private US establishments, Handel and Gittleman (1999) investigate the effects of flexible work practices on wages at the establishment and individual level. Irrespective of the aggregation level of the analysis, they do not find significant wage effects of flexible work practices.

Many existing studies are based on data of establishments in specific industries. Based on a sample of 303 U.S. bank branches, Hunter and Lafkas (1998) find that "high-involvement" practices, measured as an index of the authority to perform

various tasks and the participation of a branch in a Quality Circle, increase wages. Furthermore, Quality Circels moderate the negative wage effects of new information technologies designed to automate basic tasks. Bailey et al. (2001) use survey data on over 4,000 employees in 45 establishments in the apparel, steel and medical electronic industry collected in 1995-1997 to investigate the earnings effects of different forms of HPWOs. Their results indicate that employees in establishments that have more high-performance work practices earn more than employees in establishments with a traditional organization of work. In the steel and apparel industry this result persists even after adding controls for the personal characteristics of the workers. Based on a representative survey of 354 service and sales centers in the telecommunication industry, Batt (2001) finds that wages are higher in establishments that provide their workers with higher discretion, have higher variable pay and offer more full-time employment. However, she could not find significant wage effects of problem solving groups and self-directed teams.

Only a few studies exist for European countries. Based on panel data of French firms, Entorf and Kramarz (1998) classify the use of new techniques according to their relation to computers and to the amount of autonomy left by the use of these modern technologies. In contrast to the studies mentioned above, this classification indicates the autonomy of a worker in organizing his work place rather than a change in the organizational structure of a firm such as the reduction of hierarchy levels or the introduction of team-work. Based on cross-section estimates Entorf and Kramarz (1998) find that workers who use computer-based new technology with high autonomy earn more than workers who use computer-based technology with average or low autonomy in the use of these technologies. Allowing for person fixed-effects, however, Entorf and Kramarz (1998) show that firms select their most able workers for the use of new technologies with high autonomy. They conclude that workers gain from the introduction of new technologies not by the mere use but rather from acquiring experience in using these new technologies. Using representative panel data of British and French establishments, Caroli and van Reenen (2000) show that organizational change tends to reduce the demand for unskilled workers in both

countries. Estimating wage share equations for workers of different skills, they find that the wage share of unskilled workers is significantly lower in firms that introduced HPWOs than in firms that did not change their workplace organization.

Most of the studies discussed above are based on cross-section data. They might suffer from the problem that they are unable to analyze the impact of organizational change on employment and wage outcomes over several years. In addition, these studies are unable to control for unobserved firm heterogeneity, which might lead to biased coefficients. Furthermore, only a few studies are able to control for the structure of the work force of the establishments they investigate. Not controlling for these characteristics might lead to biased results if the educational structure of the work force and the probability to introduce new workplace practices are positively correlated. With the exception of Capelli (1996), the empirical literature is only concerned with the labor market effects of organizational change across firms and does not investigate the effects of these changes occurring within firms. Finally, only Caroli and van Reenen (2000) and Osterman (2000) address the problem that variables indicating the use of HPWOs in wage and employment equations are likely to be endogeneous.

Using a unique employer-employee matched panel data for Germany, this study investigates whether flexible workplace practices in German establishments are "skill-biased", i.e. that the use of these practices is associated with higher wages and higher employment of high-skilled workers. We further investigate the effects of HPWOs on the internal wage structure of a firm, i.e. whether flexible work practices leads to a lower or higher earnings inequality within establishments and within different skill groups in an establishment. The data set allows us to control for the characteristics of the employees in an establishment. The panel character of the data set further enables us to control for unobserved firm heterogeneity and to address the mentioned problem that variables indicating the use of HPWOs are potentially endogenous.

3. Econometric Strategy and Data

3.1. Econometric Strategy

To examine the impact of new workplace practices and IT technology on wages and the internal wage and employment structure in an establishment, we estimate equations of the form

$$Y_{ijt} = \alpha_{ij} + X_{it}\beta + Z_{it}\gamma + \epsilon_{ijt}, \tag{1}$$

where X_{it} is a vector of the characteristics of establishment i at time t, Z_{it} is vector of variables indicating the use of flexible workplace practices and new IT-technologies at establishment i, α_{ij} is an establishment fixed effect, and ϵ_{ijt} is a standard error term. As dependent variables, Y_{ijt}, we consider the mean log daily wage as well as the log daily wages in the 20th, the 50th and the 80th percentile of skill-group j in establishment i in order to study the effects of organizational change on the wage structure across and within establishments. The estimations are performed separately for all workers in an establishment and for six different skill-groups j. In addition, we estimate employment share equations to investigate the effects of HPWOs on the employment structure.

Even though our data set allows us to control for many characteristics of an establishment and the structure of its workforce, cross-section estimates might still suffer from omitted variable bias due to unobserved establishment characteristics. Therefore, we eliminate all observed and unobserved time invariant establishment fixed-effects by taking first differences.

A further problem which occurs when estimating equation (1) is that the introduction of HPWOs is likely to be endogenous (Athey and Stern, 1998; Caroli and van Reenen, 2000; Lindbeck and Snower, 2000; Ostermann, 2000). A negative demand shock, for example, can lead firms to simultaneously lay-off unskilled workers and re-organize the company (Caroli and van Reenen, 2000). According to Lindbeck and Snower (2000), changes in human capital that increase worker versatility could lead a firm to restructure from a Tayloristic into a holistic orga-

nization. Finally, positive wage effects of organizational change might be observed because well-performing firms, who pay high wages, can also afford to experiment with HPWOs (Ostermann, 2000). Hence, the direction of causation is unclear when estimating the effect of a change in workplace organization on wages in the same period, i.e. it is not clear whether introducing HPWOs increases wages or whether high wages increase the probability of using HPWOs. To address this problem, we follow the strategy of Caroli and van Reenen (2000) and Ostermann (2000) by using lagged values of organizational change. Note that this strategy should at most bias our results towards an insignificant effect of HPWOs.

The above considerations lead to the following equations, which will be estimated to analyze the labor market effects of organizational change:

$$\Delta Y_{ijt} = \Delta X_{it}\beta + \Delta Z_{it-1}\gamma + \Delta\epsilon_{ijt}, \tag{2}$$

where Δ is the difference operator. As will be described in more detail below, our data set provides us with information whether an establishment changed its organization before 1993 and between 1993 and 1995, respectively. Therefore we regress changes in the dependent variables between 1993 and 1995 on organizational change before 1993 and changes in the dependent variables between 1995 and 1997 on organizational change between 1993 and 1995. In the estimations we pooled the information on both sub-periods.[9]

3.2. Data Set

To analyze the wage and employment effects of new workplace practices we use a representative German employer-employee linked data set. This data set has been

[9] We estimated all specifications also by fully interacting all variables with a dummy variable which takes a value of 1 for the period 1993-1995 and 0 otherwise, in order to test whether the effects of our different indicators for the use of HPWOs and technological change are significantly different in the two sub-periods. In most cases we could reject the hypothesis that the effects of organizational and technological change on wages and employment are significantly different in the two periods. In those cases we could not reject the hypothesis it appears that the effects are significantly smaller in absolute terms in the period from 1993-1995 if compared to 1995-1997; a result which we expected given the definition of our variables. The only exception are high-skilled blue collar workers, where the effects in the period 1993-1995 are higher than those in 1995-1997. In most of the cases where we could not reject the hypothesis of different coefficients in the two periods we find either that the effects in both periods have the same sign or that the effects in the period from 1993-1995 are insignificant. Hence, if anything, pooling the two sub-periods leads to coefficients which are biased towards being insignificant.

constructed through the combination of two separate data, linkage being facilitated through a unique firm identification number. To our knowledge this is the first empirical analysis which makes use of this employer-employee linked data set. The following paragraphs therefore gives a detailed description of the data construction.

The first data set, the *IAB-establishment panel*, is an annual survey of West-German establishments, administered since 1993 by Infratest Burke Sozialforschung.[10] The data set is a representative sample of German establishments employing at least one employee who pays social security contributions. The data set does not include public service offices who employ only civil servants. The survey was administered through personal interviews and provides general information on the establishment, such as, for example, investment, revenues, the size and composition of their work force, worker turnover, salaries and wages, and changes in the organization of workplaces.

The second data-set, the so-called *Employment Statistics Register*, is an administrative panel data-set of individuals which provides information on wages, skill-levels and other socio-economic characteristics of all employees in Germany paying social-security contributions.[11] The data set is based on the integrated notifying procedure for health insurance, statutory pension scheme and unemployment insurance, which was introduced in 1973. By law employers have to provide information to the social security agencies for those employees registered by the social security system. These notifications are required for the beginning and ending of any employment relationship. In addition, employers are obliged to provide an annual report for each employee covered by social insurance who is employed on the 31st December of each year. This report includes information on the sex, year of birth, nationality, marital status, number of children, occupation, and qualification of the employee. The *Employment Statistics Register* further provides information on the industry and the size of the establishment where an individual is employed. To investigate whether organizational and technological change is *skill-biased*, we differentiate six skill groups

[10] Detailed information on the IAB-establishment panel is given by Bellmann et al. (1994), Bellmann (1997a, 1997b) and Kölling (2000).

[11] Information on the *Employment Statistics Register* is given by Bender et al. (1996, 2000).

using a classification of occupations, where blue-collar workers are stratified into non-qualified, qualified, and engineers and technicians and white-collar workers into those performing simple-services and those performing qualified services and professionals and managers.[12]

In addition to these socio-economic characteristics, the gross annual income of employees is made available for each notification. In our empirical analysis, we used this information to calculate real daily wages. The income information is censored from above by the upper limit of the contribution assessment ceiling for social insurance. This upper limit was a daily wage of 236 DM in 1993, 256 DM in 1995 and 269 DM in 1997. In our sample about 10% of the individuals had censored wages. These individuals, however, are relatively high skilled; i.e. 22% of engineers and technicians, 13% of skilled white-collar workers, and 50% of professionals and managers have censored wage information. The censoring of wages should bias the estimated coefficients on our variables indicating the use of flexible workplace systems and new information and communication technologies towards zero, particularly so for high skilled workers. To circumvent this bias, we estimated Tobit models with the log of real daily wages as a dependent variable separately for the years 1993, 1995 and 1997 for all individuals in our sample.[13] The median daily wages for all workers in a firm and the six different skill groups are calculated using the predicted wages resulting from these estimations for those individuals above the upper limit of the contribution assessment and the actual wages for all other individuals.[14]

Both data sets contain a unique firm identification number, which allows us to match information on all employees obliged to pay social-security with the establishments in the IAB-establishment panel.[15] Matching of the two data sets occurred in two steps. In a first step we selected West-German firms who participated in

[12]See Bellmann et al. (1999) for a more detailed definition of the skill groups.

[13]The results of these estimations are reported in Table 1 of the Appendix.

[14]Note that using the actual (censored) wage information does not lead to significant different results.

[15]Access to this data set will soon be available through the *IAB-Establishment Panel Data Service* (IPDS) by sending a 1-2 page project description. The IPDS will then provide the researcher with 10,000 artificial individual notifications connectable to the test data of the IAB-Establishment Panel. Using this artificial data the researcher can test her estimation programs. When they work properly, the programs could be send to the IPDS, which runs the estimation programs and send the output back to the researcher.

the establishment panel in 1993, 1995 and 1997. We excluded firms in the agricultural, mining and construction sector as well as all firms with missing values for the variables used in the empirical analysis. In a second step, we used the *Employment Statistics Register* to obtain work history information for all full-time employed persons who worked for at least one day in a year within one of the selected establishments. The individual information has been extracted for every 30th of June, the day of reference for the IAB-establishment panel. We excluded apprentices, trainees, persons who are temporarily out of the labor force because of e.g. child bearing or military service, and individuals older than 65 from our individual sample. Using the firm identifier, the two data sets were matched to a linked employer-employee data set, providing detailed information on the characteristics of all employees in a particular firm, who are covered by the social security system. After eliminating all establishments with less than two employees in any of the six skill groups, a total of 517 observations remained for the empirical analysis, of which 251 observations are for the period from 1993 to 1995 and 266 observations for the period from 1995 to 1997.[16] To these firms we merged information on average 265,000 employees from the *Employment Statistics Register*. Note that our final sample of establishments is not representative for all German establishments, since our selecting mechanism favors big establishments.

In all estimations the vector X_{it} includes log real revenues per employee, the proportion of exports over total revenues, the log of total employment and the change in the capital stock. The latter has been proxied by the sum of real per capita investments in the respective periods. The establishments were also asked to rank the technological standard of their production technology relative to other establishments in the sector on a scale from 1 to 5, where 1 indicates that the machines used by the establishments are obsolete and 5 indicates that the machines are state-of-the-art. We used this information to create a variable indicating the age

[16]There might be concerns that our estimation results suffer from a bias due to the possibility that the aggregated variables for some of the different skill groups are based on small number of observations. To address this problem we eliminated all establishments with less than ten employees in any of the six skill groups. This procedure reduces our sample to a total of 228 observations. Note, however, that the main estimation results reported below are not affected by this procedure.

of the capital used by an establishment. We further included six industry dummies and one year dummy. Using the employer-employee linked data set, we calculated the mean age of the employees, and the employment share of females and non-Germans for every establishment in our sample. When investigating the effects of flexible workplace practices on wages and the internal wage structure for the six different skill groups, we further include the employment share of the respective skill groups as explanatory variable. Descriptive statistics of all variables used in the empirical analysis are given in the Appendix.

The vector Z_{it-1} includes different variables indicating organizational and technological change. In 1995, the IAB-establishment panel contained several questions on changes in the organization of work. In this year, the establishments were asked the following questions: *"Over the last 2 years, have there been any of the following organizational changes in your establishment?"* and *"Did your firm introduce any of these changes before 1993?"*. Among the possible answers, we use the following to define indicators of organizational change: "Reduction of the number of hierarchy levels", "Passing on of responsibilities to subordinates", and "Introduction of teamwork or self-responsible working groups". A major weakness of the information on the use of HPWOs provided in the IAB-establishment panel is that we only know whether a firm introduced one or several of the new forms of flexible work practices. Unfortunately the data set gives no information on the number of employees which are covered by these changes.

Using the available information, we calculated different indicators of the use of flexible workplace practices. We created dummy variables indicating whether there has been one of the above organizational changes before 1993 and between 1993 and 1995. The work of Milgrom and Roberts (1990, 1995) indicates that only the introduction of a cluster of new practices allows firms to reach a new optimal organization that leads to a higher performance. If practices are introduced in clusters the above indicators of organizational change should be highly correlated with each other. Therefore, it might be hard to identify the separate effects of these indicators in an empirical investigation of the effects of organizational changes on labor

market outcomes. We therefore constructed two variables indicating the degree of decentralization. First, we created a variable measuring the number of organizational changes which occurred before 1993 and between 1993 and 1995. Second, we applied principal component analysis to the three dummy-variables described above to derive an index of decentralization. The first principal component accounted for 57.5% of the variance and had an eigenvalue of 1.725.[17] The scoring coefficients used for the calculation of the decentralization index are 0.437 for the reduction of hierarchy levels, 0.480 for the delegation of responsibilities, and 0.398 for the introduction of team work.

Many empirical studies on the determinants of rising inequality used information on the proportion of workers using personal-computers or micro-electronic technologies. Unfortunately, the IAB-establishment panel does not provide similar information. Between 1993 and 1995, however, the IAB-establishment panel does contain detailed information on the type of investments in the last year. We use this information to define a dummy variable which takes the value of 1 if the biggest single investment of an establishment was in communication and information technologies, and 0 otherwise. We interpret this variable as an indicator of the degree of the use of new information and communication technologies in an establishment.

3.3. Descriptive Statistics

Table 1 shows some descriptive statistics on the incidence of organizational change in our sample. Before 1993, 66% of the establishment had introduced none of the flexible work practices we consider, 23% at least one, and around 10% two. Only 0.2% had introduced all three of them. However, most of the firms in our sample introduced some form of flexible work practices between 1993 and 1995. In this period only one fourth of the establishments introduced none of the flexible work practices we consider, 23% introduced at least one of the practices, around 21% two, and 32% all three of them. On average the firms in our sample initiated 0.4 of the

[17] The second and third principal component have eigenvalues below 1, supporting the aggregation of the information on organizational change to one common factor.

three different workplace practices before 1993 and 1.6 practices between 1993 and 1995. Based on a representative survey of firms in ten EU countries, the OECD (1999, Table 4.6) reports that between 1993 and 1996 the firms covered by this data set introduced 0.9 out of 4 flexible work practices on average. The difference between the numbers reported by the OECD (1999) and in our sample could be explained by the fact that our data set is biased towards big firms, which are more likely to introduce new forms of workplace organization. In the data set used by the OECD (1999), for example, establishments with more than 1,000 employees introduced on average 1.26 new workplace practices between 1993 and 1996.

With respect to the different forms of organizational innovation it appears that before 1993, every fifth establishment reduced the number of hierarchy levels, 15% delegated responsibilities to lower hierarchy levels and 11% introduced self-managed teams or work groups. Between 1993 and 1995 most of the establishments transfered responsibilities to lower hierarchy levels (56%) and around 51% of the establishments reduced the number of hierarchy levels and/or introduced self-managed teams. These numbers are slightly different to those reported by the OECD (1999). According to them, 19% of the German establishments reported that they initiated the greater involvement of lower level employees between 1993 and 1996; 30% flattened their management structure and 20% installed team-based work organization. The difference could again be explained by the relatively large size of the establishments in our sample, since, for example, big firms have a relatively higher probability of transferring responsibility to lower hierarchy levels and to reduce the number of hierarchy levels than small establishments (OECD, 1999).

Around 7% of the establishments in our sample reported that they invested in IT-technology in 1992 and about 18% in 1993 or 1994 (see Table 1). To study the hypothesis that only the joint introduction of new information technologies and new work practices should have significant labor market effects, we also consider interactions between our indicator variable for technological change and the different indicator variables for the degree of decentralization.

The correlation matrix between the different forms of HPWOs as well as the

dummy variable indicating investments in IT-technology is shown in Table 2. It appears that reducing the number of hierarchy levels and transferring responsibilities to lower levels are strongly positively correlated within the same sub-period and weakly correlated across periods. This indicates that the flattening of the management structure comes about because lower hierarchy levels are acquiring responsibilities instead of higher hierarchy levels taking over the responsibilities of lower levels. Furthermore, the transfer of responsibilities is positively correlated with investment in IT-technology in the same and in the subsequent period indicating that, possibly through improved communication, these practices are complementary.

4. Empirical Results

Table 3 shows the empirical results when estimating equation (2) using the log mean establishment real daily wages as dependent variables. Note that each entry in Table 3 presents the results from a separate regression. Panels A to C of Table 3 present the effects of the dummy variables indicating the different flexible workplace practices on wages, and Panel D and E present the results when using the number of flexible practices and the index of the use of HPWOs derived from principal component analysis. In all estimations we use the full set of control variables described in the last section. We also estimated all equations without variables indicating the structure of the workforce in an establishment to test whether the estimation results change when we do not control for the socio-economic structure of the labor force in an establishment. The results of the estimations with the remaining basic controls, which are not reported here, indicate that including variables indicating the structure of the workforce in an establishment do not significantly affect the coefficients of interest.

Not differentiating between different skill-groups, Panels A through C of Table 3 show that all three work practices have a negative effect on the mean wage in an establishment. However, only the estimated coefficient for the use of self-managed teams is statistically significant. According to this coefficient employees in firms

who introduced self-managed teams earn on average 1.3% less than workers in establishments without such teams. Using the two variables measuring the usage of HPWOs (see Panel D and E of Table 3) confirm these results. For both measures we find a marginally significant negative effect on mean wages in an establishment. Based on the estimated coefficient in Panel D, an additional work practice reduces mean wages in an establishment by 0.5%.

Differentiating between the six skill groups of workers show that unskilled and skilled blue-collar workers and, to a lesser extent, unskilled and skilled white-collar workers suffer from the use of flexible workplace practices. The estimated coefficients in Panel D of Table 3 indicates that an additional workplace practice reduces the wages of unskilled and skilled blue-collar workers by about 1%, those of unskilled white-collar workers by 0.7% and those of skilled white collar-workers by 0.4%. With the exception of a reduction of hierarchy levels, the point estimates for high-skilled blue-collar workers suggest that the use of HPWOs also has a negative effect on their wages. Throughout, however, the estimated coefficients for this group of workers are insignificant. The effects of flexible work practices on high-skilled white-collar workers are positive but also insignificant. These results indicate that unskilled and skilled workers suffer from the use of new workplace practices whereas they do not have a significant impact on the wages of high-skilled workers. Hence, the effect of HPWOs on wages appears to be skill-biased. These results are in line with those obtained by Caroli and van Reenen (2000) for France and the UK, who also find that organizational change reduces the demand for unskilled and semi-skilled manual workers.

Table 4 reports the estimation results when the effect of flexible work practices is evaluated at different percentiles of the wage distribution in an establishment. Referring to all employees in an establishment, Panels A and B of Table 4 shows that a reduction of hierarchy levels reduces the wages at the lower end and the median of the wage distribution in an establishment, whereas the transfer of responsibilities to lower levels does not have significant effects. Self-managed teams have a negative effect on wages at all points of the wage distribution, where the negative effect is

increasing with the position in the wage distribution. According to the estimated coefficients in Panel C of Table 4, self-managed teams reduces the wages at the 20th percentile by 1.2%, those at the median by 1.5% and those at the 80th percentile by 1.9%. Panels D and E of Table 4 confirm the results obtained in Panels A-C. A more extensive use of flexible workplace practices reduces the wages at all percentiles of the wage distribution with those at the top of the distribution losing relatively more than those at the bottom. Based on the results obtained when using the number of flexible work practices as indicator for the use of HPWOs, the implementation of additional work practices reduces wages at the 20th percentile by 0.5%, those at the median by 0.6% and those at the 80th percentile by 0.9%.

The estimation results in Table 4 for the six different skill groups in general confirm the conclusion of Table 3 that the use of HPWOs is skill-biased in the sense that it reduces the wages of unskilled and skilled workers without having significant effects on high-skilled workers. Table 4, however, shows some interesting differences of the effect of HPWOs on the wage distribution within groups. For unskilled and skilled blue collar workers, the negative effects of flexible workplace practices seem to be highest for those in the upper part of the respective wage distribution, whereas the wage distribution within high-skilled blue-collar workers is not affected at all by the use of HPWOs. Comparing unskilled and skilled blue-collar workers further reveals that the point estimates are slighter higher in absolute terms for the latter indicating that these two groups converge to each other. These results suggest that the use of HPWOs lead to a more homogeneous structure of unskilled and skilled blue-collar workers. Different to the blue-collar workers, the largest negative effects for unskilled white-collar workers appear in the bottom of the respective wage distribution. For this group the negative effects of flexible workplace practices are significant only at the 20th percentile and the median wage, whereas wages at the 80th percentile are not affected significantly. For skilled white-collar workers we find negative effects only at the median wage. For high-skilled white-collar workers, however, the results suggest an increasing inequality within this group which originates in a marginally significant positive effect of the use of HPWOs on the wages at the 80th percentile.

In Table 5 we add an interaction variable between the number of flexible workplace practices[18] and the indicator variable for investments in IT-technology to the specification in order to investigate the hypothesis of Milgrom and Roberts (1990, 1995) that the joint use of HPWOs and new IT-technology should show additional effects if compared to a situation where these practices are used solely. Similar to the former tables we present estimation results for the mean wage as well as for wages at different percentiles of the wage distribution in an establishment. For each estimation we added a row which shows the total effect of the joint use of flexible workplace practices on wages. The results for all employees show that firms who use flexible work practices without using new IT-technologies pay lower average wages. The point estimate are similar to those in Table 3 and 4. Furthermore, the negative effects increase again for higher percentiles.

Our results further show that the sole use of new IT-technology does not affect wages significantly. This finding is in line with recent empirical evidence, which stresses the importance of controlling for unobserved individual or establishment heterogeneity when investigating the wage effects of IT-technology (see, for example, DiNardo and Pischke, 1997, Entorf and Kramarz, 1998, and Haisken-DeNew and Schmidt, 1999). Entorf and Kramarz (1998) show that for France, cross-sectional results do indeed demonstrate that computer usage is associated with higher wages. When using panel data, however, the premia for using a computer are rendered insignificant. Using the German Socio-Economic Panel, a panel dataset from 1984 to the present consisting of some 13,500 individuals living in Germany, Haisken-DeNew and Schmidt (1999) show that the computer wage premium is around 7% when relying on cross-section data for 1997. Controlling for unobserved heterogeneity by using panel estimators for 1984-1997, this wage premium reduces to 1% and is barely significant. Based on a panel data set of US establishments, Dohms et al. (1997) show that the positive wage effects of new technologies found in a cross-section analysis disappear as soon as the structure of the workforce in an establishment or

[18] In the following we do not report the estimations results when using the constructed index of HPWOs as independent variable, since they are very similar to those when using the number of flexible workplace practices but much harder to interpret.

unobserved heterogeneity is taken into account. A similar results has been obtained by Black and Lynch (2000).

For all workers in an establishment, the interaction variable between the number of workplace practices and investments in IT-technology is positive, indicating that the joint use of HPWOs and new IT-technology dampens the negative effect of HPWOs. Except for wages at the 80th percentile the interaction term is barely significant. The results for the six skill groups show that the joint use of HPWOs and new IT-technologies reinforces the effects of HPWOs on mean wages for unskilled blue-collar workers and high-skilled white-collar workers and dampens the effect of HPWOs for all other skill groups. However, except for the median wage of high-skilled blue-collar workers and skilled white-collar workers, the interaction term is not significant in all specifications shown in Table 5. The coefficients on the total effect of the joint use of HPWOs and new IT-technology indicates that the mean wages of unskilled and skilled blue-collar workers are negatively affected and those of high-skilled white collar positively affected if an establishment simultaneously introduced HPWOs and new IT-technology. Conditional on using modern IT-technology, an additional workplace practice reduces the wages of unskilled blue-collar workers by 1.4% and those of skilled blue-collar workers by 1.1% whereas it increases the mean wages of high-skilled white-collar workers by 2.4%.

Evaluated at different points of the wage distribution, it appears that the negative effect of the joint use of HPWOs and new IT-technology on the mean wages of unskilled blue-collar workers is mainly due to a reduction of wages at the 80th percentile of the wage distribution in this group. A similar pattern could be observed for unskilled and skilled white-collar workers, even though the joint use of HPWOs and new IT-technology also decreases the median wage of the former. The positive effect of a cluster of HPWOs and IT-technology on the mean wages of high-skilled white-collar workers appears to be a results of wage increases at the tails of the wage distribution of this group. Given that an establishment has invested in new IT-technology, an additional flexible workplace practice increases the wage at the 20th percentile of the wage distribution of high-skilled white workers by 4.3% and

at the 80th percentile by 2.2%.

Table 3 - 5 indicate that the effect of HPWOs on wages is skill biased in the sense that they reduce the wages of unskilled and skilled workers but do not affect those of high-skilled workers. To explore this pattern more closely we estimated equation (2) using the difference in log daily wages between high-skilled workers and the other skill groups separately for blue- and white-collar workers as dependent variable. The results of these estimations are reported in Table 6. With respect to blue-collar workers the results show that the wage differential between high-skilled and unskilled blue-collar workers increases by about 1.5% when an establishment reduced the number of hierarchy levels and by 1.7% when it transferred responsibilities to lower levels. The wage differential between high-skilled and skilled blue collar workers is only affected through a reduction in the number of hierarchy levels. Panel D of Table 6 shows that an additional flexible workplace practices increases the wage differential between high-skilled blue-collar workers and other blue-collar workers by about 8%. This result is partly confirmed when introducing the interaction variable between the use of HPWOs and the use of new IT-technology in Panel E. If an establishment uses only HPWOs without using new IT-technology, the wage differential between high-skilled blue collar workers and other workers increase significantly. If the use of HPWOs is combined with the use of new IT-technology, however, the wage differentials among blue-collar workers do not change. Hence, for blue-collar workers the effect of HPWOs on wages is only skill-biased if these do not come together with main investments in IT-technology.

A slightly different pattern could be observed among white-collar workers. A reduction of the hierarchy levels in a firm increases both the wage differential between high-skilled and skilled and high-skilled and unskilled white-collar workers by about 2%. The differential between high-skilled and unskilled white-collar workers is further significantly affected by the use of self-managed teams. Differently to blue-collar workers, the joint use of HPWOs and new IT-technology affects the wage differentials among white-collar workers significantly. The estimated coefficients in Panel E of Table 6 indicate that the wage differential between high-skilled

and unskilled white-collar workers increases by 1% and the differential between high-skilled and skilled white-collar workers by 0.6% if the use of HPWOs is not combined with new IT-technology. This positive effects on the wage differentials increases to 3.5% and 3.3%, respectively, if an establishment uses both HPWOs and new IT-technology. Therefore one can conclude that among white-collar workers the effect of HPWOs on wages is skill-biased, especially if they are combined with the use of new IT-technology.

Overall, Table 4 gives a mixed picture on the effects of HPWOs on the wage structure within different skill groups in an establishment. The wage structure among unskilled and skilled blue-collars workers seems to become more homogeneous whereas the wage distribution within the other groups seems to be either unaffected or to widen. To get a more rigorous picture of the effects of HPWOs on the wage structure within different skill groups, we estimated equation (2) using the change of the wage difference between the 80th and the 20th percentile as dependent variable. The results of this exercise, which are not reported here, show that this wage differential is not significantly affected by the use of HPWOs for any skill group.[19] Based on these results we conclude that flexible workplace practices do not change the wage distribution within different skill groups.

Using data for the UK and France, Caroli and van Reenen (2000) also conclude that organizational change is "skill-biased". Their results indicate, however, that the impact of organizational change in the UK and France is mainly driven by a reduction of the employment share of unskilled workers rather than wage changes. A similar results has been obtained by Ostermann (2000) for the US. He finds that HPWO practices are associated with increased layoff rates without changing compensation. Table 7 reports the results of estimating equation (2) with employment shares of the different skill groups as dependent variable. Overall, the results indicate that HPWOs do not have significant effects on the employment shares of different skill groups. The only significant effect we find is on unskilled white-workers, for

[19] There are two exceptions. For skilled blue-collar we find a marginally significant negative effect of a transfer of responsibilities and for high-skilled blue-collar workers we find a highly statistically positive effect for the use of self-managed teams.

which the employment share is reduced when HPWOs are combined with new IT-technology. This effect, however, is only statistically significant on a 10%-level.

5. Summary and Conclusions

A growing theoretical and empirical literature is concerned with the effects of flexible workplace systems or High Performance Work Organizations (HPWOs) on wages. These flexible workplace systems are characterized by the introduction or increasing importance of self-managed teams, the reduction of the number of hierarchy levels, a decentralization of decision making within firms, and the replacement of vertical by horizontal communication channels. The existing theoretical literature suggests that workers in firms using HPWOs should earn higher wages than workers in firms who are organized in a traditional "Tayloristic" way. It has been further hypothesized that changes in the organization of work should lead to a segregated labor market, where holistic firms employ only skilled and "Tayloristic" firms employ only unskilled workers. This segregation further leads to decreased within-firm inequality. So far, empirical evidence on the wage effects of organizational change is rather scarce and the results are mixed.

This paper makes use of a new employer-employee-linked data set for Germany to examine the effect of flexible workplace systems on the wage structure across and within firms. The panel structure of the data set allows us to avoid problems such as unobserved heterogeneity and the potential endogeneity of variables describing organizational change in wage and employment regressions, which are inherent in most existing empirical studies on this issue. Our estimation results indicate that firms using HPWOs pay on average lower wages than those not using flexible workplace systems. Furthermore, the effect of HPWOs on wages is skilled biased in the sense that it reduces the wages of unskilled and skilled workers whereas they have either insignificant or positive effects on high-skilled workers. Hence, the use of HPWOs increases both, across firm and within firm inequality. These effects, however, are relatively small. Our estimation results indicate, for example, that an

additional flexible workplace practice decreases the mean wages of unskilled blue-workers at most by 1.4% if the use of HPWOs is combined with the use of new IT-technologies and increases the mean wages of high-skilled white-collar workers by at most 2.5%. Investigating the effects of HPWOs on the wage structure within different skill groups we find that these practices seem to make the wage structure among unskilled and skilled blue-collar workers more homogeneous, whereas the wage inequality within other skill groups seem to be either unaffected or to widen. However, all estimations on the effects of HPWOs on wage inequality within skill groups are rather imprecise. Finally, we do not find evidence that the use of flexible workplace systems affects the employment structure within establishments.

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Table 1:
Descriptive Statistics on Organizational Change in Germany

	Before 1993	1993-1995
Number of Organizational Changes (in %)		
0	66.33	24.89
1	23.31	23.18
2	10.12	20.53
3	0.23	31.54
Mean Number of Organizational Changes	0.442 (0.682)	1.584 (1.172)
Reduction of Hierarchy Levels (in %)	19.39	50.73
Transfer of Responsibilities (in %)	14.18	56.19
Introduction of Self-Managed Teams (in %)	10.67	51.52
Main Investments in IT (in %)	6.55	13.53
Observations	251	266

Notes: (..): standard deviations. The descriptive statistics are weighted by the number of employees in an establishment who pay social security benefits.

Table 2:
Correlation Between Different HPWOs and IT-technology before 1993 and between 1993 and 1995

	Before 1993				1993-1995			
	H	R	T	IT	H	R	T	IT
Before 1993:								
H	1.0000							
R	0.3933‡	1.0000						
T	-0.0742	0.0066	1.0000					
IT	0.0060	0.1621‡	0.0305	1.0000				
1993-1995:								
H	-0.0088	-0.0289	0.1249‡	-0.0383	1.0000			
R	0.1150†	0.1052†	0.0782	0.0530	0.3038‡	1.0000		
T	-0.0376	-0.1038	0.0001	-0.0306	0.0400	-0.0188	1.0000	
IT	-0.0324	0.1641‡	0.0378	0.0942	0.0028	0.1048†	0.0262	1.0000

Notes: (..): 251 observations. Correlation coefficients are weighted by the number of employees in an establishment who pay social security benefits. H: Reduction of Hierarchy Levels; R: Transfer of Responsibilities; T: Introduction of Self-Managed Teams; IT: Main Investments in IT-technology.
†: statistically significant at least at the 10%-level. ‡: statistically significant at least at the 5%-level.

Table 3:
Flexible Workplace Practices and Mean Wages

	All Workers	Blue-Collar Workers			White-Collar Workers		
		Unskilled	Skilled	High-Skilled	Unskilled	Skilled	High-Skilled
Panel A:							
Reduction of Hierarchy Levels	-0.639	-1.381‡	-1.575‡	0.172	-1.014	-1.085‡	0.898
	(0.506)	(0.573)	(0.755)	(0.435)	(0.625)	(0.463)	(0.716)
Panel B:							
Transfer of Responsibilities	-0.712	-1.997†	-1.271	-0.206	-1.110	-0.552	0.252
	(0.561)	(1.087)	(0.933)	(0.455)	(0.729)	(0.507)	(0.674)
Panel C:							
Introduction of Self-Managed Teams	-1.256‡	-1.268†	-1.744‡	-0.766†	-1.536‡	-0.476	0.081
	(0.590)	(0.705)	(0.686)	(0.448)	(0.768)	(0.545)	(0.723)
Panel D:							
Number of Practices	-0.516†	-0.945‡	-0.932‡	-0.144	-0.732‡	-0.441†	0.266
	(0.271)	(0.359)	(0.334)	(0.219)	(0.346)	(0.245)	(0.331)
Panel E:							
Index of HPWOs	-0.518†	-0.969‡	-0.943‡	-0.137	-0.738‡	-0.452†	0.275
	(0.276)	(0.370)	(0.348)	(0.224)	(0.351)	(0.249)	(0.339)

Notes: Dependent variables are measured in first differences × 100. Standard errors in parentheses. 517 observations. Estimations also include a constant term, a dummy variable for main investments in IT-technology, the log of total establishment employment, log of real per capita investments, the log of real per capita revenues, the share of exports on total revenues, a variable indicating the age of the capital, a year dummy, 6 industry dummies, the share of female employees, the share of non-German employees, the mean age of the workers employed in the firm and the respective employment share in the equations for the different skill group. All variables except the year dummy and the 6 industry dummies are measured in first differences. Standard errors are corrected for establishment cluster effect by using a Huber correction technique. Estimation by weighted OLS with the number of employees who pay social security contributions as weights.

‡: statistically significant at least at the 5%-level.

†:statistically significant at least at the 10%-level.

Table 4:
Flexible Workplace Practices and the Wage Structure

Percentiles	All Workers	Blue-Collar Workers			White-Collar Workers		
		Unskilled	Skilled	High-Skilled	Unskilled	Skilled	High-Skilled
Panel A: Reduction of Hierarchy Levels							
20%	-0.806†	-0.800	-1.001	0.344	-1.075†	-0.521	1.913
	(0.489)	(0.510)	(0.681)	(0.764)	(0.625)	(0.585)	(1.630)
50%	-0.900†	-0.100†	-1.072†	0.732†	-1.130†	-1.026†	1.274
	(0.528)	(0.587)	(0.554)	(0.438)	(0.655)	(0.546)	(0.850)
80%	-1.231	-1.658‡	-1.821‡	0.123	-1.291	-0.419	1.811‡
	(0.875)	(0.672)	(0.608)	(0.392)	(0.905)	(0.403)	(0.851)
Panel B: Transfer of Responsibilities							
20%	-0.539	-1.100	-0.122	-0.198	-1.015	-0.588	0.973
	(0.542)	(0.782)	(0.732)	(0.766)	(0.678)	(0.551)	(1.386)
50%	-0.799	-0.526	-0.649	0.197	-1.144	-0.962†	0.050
	(0.674)	(0.664)	(0.664)	(0.402)	(0.802)	(0.505)	(0.885)
80%	-1.281	-1.001	-1.376†	0.478	-1.431	-0.293	1.100
	(0.934)	(0.836)	(0.824)	(0.407)	(0.924)	(0.421)	(0.854)
Panel C: Introduction of Self-Managed Teams							
20%	-1.188‡	-1.042	-1.719‡	-1.544†	-1.028	-0.829	-0.692
	(0.590)	(0.643)	(0.711)	(0.789)	(0.764)	(0.696)	(1.244)
50%	-1.459‡	-1.373‡	-1.856‡	-0.274	-1.404†	-0.618	-0.794
	(0.644)	(0.667)	(0.659)	(0.464)	(0.784)	(0.604)	(0.900)
80%	-1.853†	-1.347†	-1.768‡	0.300	-0.716	-0.283	0.051
	(1.025)	(0.788)	(0.702)	(0.413)	(1.094)	(0.378)	(0.974)
Panel D: Number of Practices							
20%	-0.506†	-0.592‡	-0.562	-0.247	-0.633‡	-0.388	0.497
	(0.264)	(0.300)	(0.346)	(0.406)	(0.317)	(0.307)	(0.701)
50%	-0.629‡	-0.580‡	-0.714‡	0.152	-0.740‡	-0.538†	0.148
	(0.271)	(0.273)	(0.280)	(0.212)	(0.354)	(0.277)	(0.368)
80%	-0.873†	-0.818‡	-1.011‡	0.179	-0.708	-0.205	0.636†
	(0.489)	(0.325)	(0.291)	(0.188)	(0.488)	(0.179)	(0.372)
Panel E: Index of HPWOs							
20%	-0.507†	-0.602†	-0.554	-0.230	-0.644‡	-0.391	0.532
	(0.268)	(0.307)	(0.355)	(0.414)	(0.323)	(0.311)	(0.719)
50%	-0.632‡	-0.580‡	-0.712‡	0.164	-0.749‡	-0.552‡	0.168
	(0.277)	(0.279)	(0.286)	(0.216)	(0.360)	(0.281)	(0.380)
80%	-0.880†	-0.830‡	-1.025‡	0.183	-0.730	-0.209	0.665†
	(0.497)	(0.331)	(0.298)	(0.192)	(0.495)	(0.184)	(0.379)

Notes: Dependent variables are measured in first differences $\times$ 100. Standard errors in parentheses. 517 observations. Estimations also include a constant term, a dummy variable for main investments in IT-technology, the log of total establishment employment, log of real per capita investments, the log of real per capita revenues, the share of exports on total revenues, a variable indicating the age of the capital, a year dummy, 6 industry dummies, the share of female employees, the share of non-German employees, the mean age of the workers employed in the firm and the respective employment share in the equations for the different skill group. All variables except the year dummy and the 6 industry dummies are measured in first differences. Standard errors are corrected for establishment cluster effect by using a Huber correction technique. Estimation by weighted OLS with the number of employees who pay social security contributions as weights.

‡: statistically significant at least at the 5%-level.

†:statistically significant at least at the 10%-level.

Table 5:
Flexible Work Systems, Investments in IT and Wages

	All Workers	Blue-Collar Workers			White-Collar Workers		
		Unskilled	Skilled	High-Skilled	Unskilled	Skilled	High-Skilled
Panel A: Mean Wages							
Number of Practices	-0.586‡	-0.942‡	-0.934‡	-0.164	-0.829‡	-0.495†	0.089
	(0.294)	(0.390)	(0.365)	(0.223)	(0.378)	(0.267)	(0.314)
Investments in IT	-0.522	-0.460	-0.207	0.102	-1.193	-0.933†	0.630
	(0.556)	(1.070)	(0.845)	(1.038)	(0.775)	(0.528)	(1.318)
Number of Practices × Investments in IT	0.667	-0.036	0.012	0.192	0.951	0.520	1.730
	(0.482)	(0.657)	(0.676)	(0.546)	(0.618)	(0.449)	(1.606)
Sum of Coefficients	-0.441	-1.438†	-1.129†	0.130	-1.071	-0.908	2.449‡
	(0.488)	(0.843)	(0.669)	(0.725)	(0.677)	(0.605)	(1.115)
Panel B: 20% Percentile							
Number of Practices	-0.553†	-0.589†	-0.578	-0.276	-0.681†	-0.456	0.228
	(0.286)	(0.330)	(0.372)	(0.422)	(0.349)	(0.338)	(0.698)
Investments in IT	-0.422	-0.217	-0.194	0.432	-0.840	-0.880	1.478
	(0.531)	(1.638)	(1.077)	(1.614)	(0.896)	(0.795)	(2.353)
Number of Practices × Investments in IT	0.452	-0.032	0.158	0.284	0.478	0.664	2.642
	(0.510)	(0.845)	(0.853)	(0.803)	(0.585)	(0.570)	(2.534)
Sum of Coefficients	-0.522	-0.837	-0.614	0.441	-1.043	-0.673	4.348‡
	(0.510)	(1.057)	(0.815)	(1.098)	(0.729)	(0.674)	(1.960)
Panel C: 50% Percentile							
Number of Practices	-0.687‡	-0.516†	-0.640‡	0.082	-0.787‡	-0.616‡	-0.016
	(0.295)	(0.303)	(0.305)	(0.225)	(0.386)	(0.301)	(0.364)
Investments in IT	-0.880	0.165	1.264	-0.228	-1.071	-0.745	0.660
	(0.656)	(1.273)	(1.056)	(0.654)	(0.868)	(0.512)	(1.600)
Number of Practices × Investments in IT	0.556	-0.614	-0.721	0.690†	0.463	0.754†	1.608
	(0.691)	(0.858)	(0.715)	(0.405)	(0.704)	(0.403)	(1.691)
Sum of Coefficients	-1.011	-0.966	-0.096	0.543	-1.396†	-0.607	2.252
	(0.714)	(0.839)	(0.744)	(0.575)	(0.734)	(0.498)	(1.426)
Panel D: 80% Percentile							
Number of Practices	-1.013†	-0.748‡	-0.920‡	0.185	-0.784	-0.198	0.548
	(0.529)	(0.363)	(0.324)	(0.197)	(0.537)	(0.195)	(0.380)
Investments in IT/100	-1.441	-0.056	1.115	-0.688	-1.398	-0.726	0.738
	(1.150)	(1.211)	(1.122)	(0.586)	(0.980)	(0.494)	(1.576)
Number of Practices × Investments in IT	1.354†	-0.671	-0.884	-0.052	0.744	-0.070	0.869
	(0.791)	(0.855)	(0.825)	(0.521)	(0.793)	(0.344)	(1.398)
Sum of Coefficients	1.100	-1.476†	0.689	-0.555	-1.438†	-0.993‡	2.156†
	(0.854)	(0.833)	(0.842)	(0.693)	(0.584)	(0.295)	(1.192)

Notes: Dependent Variable: Δ log(Real Establishment Daily Wages) $\times$ 100. Standard errors in parentheses. 517 observations. Estimations also include a constant term, a dummy variable for main investments in IT-technology, the log of total establishment employment, log of real per capita investments, the log of real per capita revenues, the share of exports on total revenues, a variable indicating the age of the capital, a year dummy, 6 industry dummies, the share of female employees, the share of non-German employees, the mean age of the workers employed in the firm and the respective employment share in the equations for the different skill group. All variables except the year dummy and the 6 industry dummies are measured in first differences. Standard errors are corrected for establishment cluster effect by using a Huber correction technique. Estimation by weighted OLS with the number of employees who pay social security contributions as weights.

‡: statistically significant at least at the 5%-level.

†:statistically significant at least at the 10%-level.

Table 6:
HPWOs, Investments in IT and Within-Firm Wage Inequality

	Blue-Collar Workers		**White-Collar Workers**	
	High-Skilled vs. Unskilled	High-Skilled vs. Skilled	High-Skilled vs. Unskilled	High-Skilled vs. Skilled
Reduction of Hierarchy Levels	1.524‡ (0.630)	1.714‡ (0.767)	1.992‡ (0.797)	2.089‡ (0.719)
Transfer of Responsibilities	1.718† (0.979)	0.991 (0.927)	1.413 (0.898)	0.855 (0.801)
Introduction of Self-Managed Teams	0.445 (0.731)	1.028 (0.638)	1.767‡ (0.884)	0.698 (0.834)
Number of Practices	0.770‡ (0.366)	0.783‡ (0.344)	1.052‡ (0.390)	0.768‡ (0.365)
Number of Practices	0.763‡ (0.388)	0.779‡ (0.365)	0.952‡ (0.397)	0.618† (0.366)
Investments in IT	0.540 (1.216)	0.308 (1.147)	1.534 (1.520)	1.263 (1.420)
Number of Practices × Investments in IT	0.060 (0.652)	0.045 (0.718)	0.977 (1.630)	1.446 (1.465)
Sum of Coefficients	1.363 (0.881)	1.131 (0.787)	3.464‡ (1.328)	3.327‡ (1.269)

Notes: Dependent Variable: Δ Difference between Log(Real Daily Establishment Wages) between high-skilled workers and the other skill groups × 100. See Table 3.

Table 7:
The Effect of Organizational and Technological Change on Employment

	Blue-Collar Workers			White-Collar Workers		
	Unskilled	Skilled	High-Skilled	Unskilled	Skilled	High-Skilled
Reduction of Hierarchy Levels	0.148	0.091	0.013	-0.260†	-0.193	0.202
	(0.340)	(0.184)	(0.248)	(0.144)	(0.189)	(0.221)
Transfer of Responsibilities	0.032	-0.158	0.205	-0.026	-0.154	0.101
	(0.342)	(0.222)	(0.277)	(0.150)	(0.172)	(0.268)
Introduction of Self-Managed Teams	0.314	-0.262	0.030	-0.032	-0.330	0.280
	(0.434)	(0.355)	(0.383)	(0.171)	(0.217)	(0.267)
Number of Practices	0.097	-0.060	0.050	-0.069	-0.135	0.117
	(0.194)	(0.122)	(0.155)	(0.065)	(0.094)	(0.130)
Number of Practices	0.112	-0.035	-0.009	-0.003	-0.132	0.069
	(0.213)	(0.111)	(0.152)	(0.068)	(0.101)	(0.131)
Investments in IT	0.105	-0.021	0.021	0.245	0.246	-0.596
	(0.418)	(0.478)	(0.342)	(0.241)	(0.330)	(0.740)
Number of Practices × Investments in IT	-0.143	-0.237	0.576	-0.640‡	-0.023	0.467
	(0.271)	(0.424)	(0.554)	(0.226)	(0.177)	(0.361)
Sum of Coefficients	0.074	-0.293	0.588	-0.398†	0.090	-0.061
	(0.372)	(0.708)	(0.660)	(0.228)	(0.249)	(0.531)

Notes: Dependent Variable: Employment Shares × 100. Standard errors in parentheses. 517 observations. Estimations also include a constant term, a dummy variable indicating main investments in IT-technology, the log of total establishment employment, log of real per capita investments, the log of real per capita revenues, the share of exports on total revenues, a variable indicating the age of the capital, a year dummy, 6 industry dummies, the share of female employees, the share of non-German employees, and the mean age of the workers employed in the firm. All variables are measured in first differences. Standard errors are corrected for establishment cluster effect by using a Huber correction technique. Estimation by weighted OLS with the number of employees who pay social security contributions as weights.

‡: statistically significant at least at the 5%-level.

†:statistically significant at least at the 10%-level.

Appendix-Table 1: Tobit Estimations of Individual Wages.
(Dependent Variable: log (Real Daily Wages)

	1973		1995		1997	
	Coeff.	S.E.	Coeff.	S.E. .	Coeff.	S.E.
Occupational Education	0.054	0.001	0.057	0.001	0.063	0.001
High School Degree	0.039	0.005	0.053	0.005	0.051	0.005
High School Degree and Occupational Education	0.065	0.003	0.077	0.003	0.084	0.003
University Degree	0.186	0.003	0.195	0.003	0.209	0.003
Foreigner	0.010	0.001	0.015	0.001	0.015	0.001
Age	0.052	0.001	0.055	0.002	0.067	0.002
$\text{Age}^2 \times 10^{-3}$	-0.947	0.036	-0.969	0.039	-0.001	0.042
$\text{Age}^3 \times 10^{-6}$	5.740	0.291	5.630	3.150	0.789	0.034
Skilled blue collar worker	0.057	0.001	0.055	0.001	0.045	0.001
High-skilled blue collar worker	0.252	0.003	0.257	0.003	0.237	0.003
White collar worker	0.238	0.002	0.246	0.002	0.247	0.002
Female	-0.342	0.012	-0.463	0.015	-0.355	0.011
No children	0.006	0.009	-0.013	0.011	0.024	0.006
Married	0.030	0.001	0.031	0.001	0.025	0.001
Female × No children	0.165	0.012	0.275	0.015	0.176	0.011
Log-likelihood	39079.672		21634.232		26750.838	
Observations	275922		274806		244279	
Censored Observations	28084		27505		19869	

Notes: Estimations also include a constant term, and 85 occupation dummies.

Appendix-Table 2: Descriptive Statistics

	1993		1995		1997	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Ln(Mean Daily Wage) of:						
All Workers	5.052	0.137	5.083	0.140	5.076	0.142
Unskilled Blue-Collar Workers	4.928	0.173	4.957	0.160	4.953	0.161
Skilled Blue-Collar Workers	5.029	0.132	5.055	0.138	5.049	0.142
High-Skilled Blue-Collar Workers	5.281	0.138	5.309	0.148	5.317	0.145
Unskilled White-Collar Workers	4.947	0.167	4.973	0.174	4.972	0.174
Skilled White-Collar Workers	5.109	0.148	5.137	0.158	5.155	0.161
High-Skilled White-Collar Workers	5.358	0.150	5.390	0.145	5.386	0.175
Ln(Daily Wage) in the 20th Percentile:						
All Workers	4.861	0.149	4.888	0.151	4.890	0.148
Unskilled Blue-Collar Workers	4.817	0.197	4.844	0.162	4.848	0.161
Skilled Blue-Collar Workers	4.904	0.134	4.923	0.159	4.922	0.167
High-Skilled Blue-Collar Workers	5.147	0.172	5.166	0.186	5.175	0.175
Unskilled White-Collar Workers	4.791	0.172	4.819	0.174	4.818	0.167
Skilled White-Collar Workers	4.903	0.156	4.937	0.161	4.958	0.170
High-Skilled White-Collar Workers	5.271	0.240	5.289	0.244	5.298	0.253
Δ *Ln(Daily Wage) in the 50th Percentile:*						
All Workers	5.031	0.158	5.063	0.163	5.055	0.161
Unskilled Blue-Collar Workers	4.919	0.186	4.943	0.160	4.945	0.166
Skilled Blue-Collar Workers	5.019	0.128	5.046	0.138	5.039	0.143
High-Skilled Blue-Collar Workers	5.298	0.139	5.320	0.154	5.324	0.154
Unskilled White-Collar Workers	4.927	0.164	4.956	0.177	4.952	0.170
Skilled White-Collar Workers	5.102	0.155	5.133	0.159	5.148	0.159
High-Skilled White-Collar Workers	5.450	0.210	5.476	0.216	5.466	0.235
Ln(Daily Wage) in the 80th Percentile:						
All Workers	5.272	0.167	5.311	0.167	5.291	0.182
Unskilled Blue-Collar Workers	5.040	0.156	5.078	0.164	5.066	0.174
Skilled Blue-Collar Workers	5.152	0.125	5.184	0.129	5.175	0.131
High-Skilled Blue-Collar Workers	5.421	0.115	5.449	0.122	5.455	0.130
Unskilled White-Collar Workers	5.099	0.176	5.132	0.183	5.130	0.188
Skilled White-Collar Workers	5.288	0.133	5.320	0.143	5.328	0.145
High-Skilled White-Collar Workers	5.612	0.130	5.647	0.133	5.599	0.207
Employment Share of:						
Unskilled Blue-Collar Workers	0.294	0.241	0.290	0.244	0.284	0.238
Skilled Blue-Collar Workers	0.184	0.145	0.182	0.148	0.182	0.145
High-Skilled Blue-Collar Workers	0.133	0.123	0.134	0.122	0.141	0.127
Unskilled White-Collar Workers	0.125	0.117	0.124	0.121	0.123	0.120
Skilled White-Collar Workers	0.142	0.084	0.144	0.085	0.153	0.094
High-Skilled White-Collar Workers	0.122	0.202	0.126	0.206	0.118	0.190
Main Investments in IT	0.089	0.285	0.111	0.315	0.107	0.310
Total Employment	1381.77	2603.79	1244.084	1655.264	1172.172	1452.217
Revenue per Capita $\times 10^3$	230.940	218.384	254.425	203.816	283.985	208.614
Investments per Capita $\times 10^3$	13.768	24.141	12.121	12.220	12.007	12.864
Export Share	0.221	0.237	0.234	0.247	26.444	26.104
Age of Used Technology	4.016	0.698	3.828	0.721	3.848	0.690
Share of Females	0.314	0.228	0.307	0.225	0.309	0.237
Share of Foreigners	0.115	0.092	0.115	0.092	0.114	0.092
Mean Age of Employees	39.357	2.561	39.753	2.359	40.465	2.231
Observations	251		266		266	

Notes: The descriptive statistics are weighted by the number of employees in an establishment who pay social security benefits.