Discussion Paper No. 03-69

IT, Organizational Change and Wages

Irene Bertschek and Alexandra Spitz

ZEW
Zentrum für Europäische Wirtschaftsforschung GmbH
Centre for European Economic Research

Discussion Paper No. 03-69

IT, Organizational Change and Wages

Irene Bertschek and Alexandra Spitz

Das Papier entstand im Rahmen des Forschungsprojekts „Informationstechnologien, Arbeitsplatzorganisation und qualifikatorische Lohnstruktur“ im Auftrag der Landesstiftung Baden-Württemberg.

The paper was written as part of the research project "ICT, Work Organization, and Wages Across and Within Skill Groups" commissioned by the Landesstiftung Baden-Württemberg foundation.

Non–technical Summary

The effects of information technology (IT) on skills and wages are an extensively discussed topic in the labor market literature, with the skill-bias technological change hypothesis being one of the most prominent themes. However, recent studies on the company-level emphasize that, in order to result in efficiency gains, the use of IT should be accompanied by appropriate organizational changes, so-called high-performance-workplace-organizations, with favorably decentralizing character such as teamwork, flat hierarchies, job rotation or quality circles. The use of IT and organizational changes (OC) are increasingly viewed as strategic complements. In addition, the hypothesis that organizational change itself is skill-biased emerged.

Our study contributes to the discussion about the *joint* effects of IT and OC on wages. We are in the favorable position to have individual-level data to investigate this question. Assuming that IT and OC - as complementary measures - have positive impacts on a company's productivity, we analyze whether employees share in the gains that companies obtain from using IT and from changing their organizational structure. The analyses are based on a large, representative cross-section of West German employees, which were surveyed in 1998 and 1999.

Our results suggest that even when controlling for a wide range of individual characteristics, workplace characteristics and company characteristics, IT users still earn around 6 percent higher wages than their peers. In addition, we find that employees working in companies that have changed their organizational structure earn higher wages independent of the fact whether or not their workplace situation had been directly affected by the organizational change. This result points to wage differentials across companies rather than within companies.

IT, Organizational Change and Wages[§]

Irene Bertschek and Alexandra Spitz*

September 2004

Abstract

Recent studies emphasize the complementary relationship between information technology and organizational changes. We analyze the wage impact of computer usage at the workplace and of organizational changes in companies, taking possible complementarities into account. The analyses are based on individual-level data for West Germany in 1998-1999, including information about individual characteristics, workplace characteristics and company characteristics. We find positive wage markups for computer usage and organizational changes. Wage premiums for organizational changes exist across rather than within firms. We find no evidence for complementarities between computer use and organizational changes in terms of wages.

JEL–classification: J30, J31

Keywords: Information technology, organizational change, wage equations

---

[§]**Acknowledgments:** The paper was written as part of the research project "ICT, Work Organization, and Wages Across and Within Skill Groups" commissioned by the Landesstiftung Baden-Württemberg foundation. Helpful comments by Miriam Beblo, Lex Borghans, Bernd Fitzenberger and Thomas Hempell are gratefully acknowledged.

* ZEW Mannheim, Centre for European Economic Research, Research Group Information and Communication Technologies, P.O. Box 103443, D–68034 Mannheim, Germany, email: bertschek@zew.de and spitz@zew.de.

1 Introduction

The effects of information technology (IT) on skills and wages are an extensively discussed topic in the labor market literature, with the skill-bias technological change (SBTC) hypothesis being one of the most prominent themes.[1] However, recent studies on the company-level emphasize that, in order to result in efficiency gains, the use of IT should be accompanied by appropriate organizational changes, so-called high-performance-workplace-organizations (HPWO), with favorably decentralizing character such as teamwork, flat hierarchies, job rotation or quality circles.[2] The use of IT and organizational changes (OC) are increasingly viewed as strategic complements. In addition, the hypothesis that organizational change itself is skill-biased emerged.[3]

The empirical evidence so far relied heavily on company-level data sets, with most studies focusing on the impact of IT and OC on company productivity, whereas studies that investigate the impact on wages are rare. To the best of our knowledge, Cappelli and Carter (2000) is the only study that analyzes the joint effects of IT and OC on wages. They use data on about 3,300 U.S. establishments of the manufacturing industry and the service sector. They find that employees benefit from IT use and OC in terms of higher wages, however, their results suggest that the effect of OC is limited to the manufacturing sector.

Our study contributes to the discussion about the *joint* effects of IT and OC on wages.

[1] See, for example, the comprehensive reviews by Katz and Autor (1999), Acemoglu (2002), Card and DiNardo (2002), or by Chennells and van Reenen (2002).

[2] Microeconometric evidence for this hypothesis is given, for example, by Bresnahan, Brynjolfsson and Hitt (2002) and by Brynjolfsson and Hitt (2000). Evidence on the quantitative importance of organizational changes can be found in Osterman (1994, 2000).

[3] See Caroli and van Reenen (2001). Aguirregabiria and Alonso-Borego (2001) present evidence suggesting that the reorganization of workplaces may even have a larger impact on the occupational structure of companies than technical capital. Goldin and Katz (1998) discuss the skill upgrading in a historical context. They show that the substitution of unskilled labor by skilled labor and capital began early in the twentieth century. They view this skill upgrading as a result of organizational changes, driven by technological changes. A growing literature emphasizes the impact of organizational changes upon rising wage inequality, see, for example, Kremer and Maskin (1996), Acemoglu (1999), and Lindbeck and Snower (1996). Aghion, Caroli and Garcia-Penalosa (1999) suggest that the impact of organizational changes on wage inequality depends crucially on a companies' choices with respect to its management of human resources.

In contrast to the analysis by Cappelli and Carter (2000), we are in the favorable position to have individual-level data to investigate this question. Assuming that IT and OC - as complementary measures - have positive impacts on a company's productivity, we analyze whether employees share in the gains that companies obtain from using IT and from changing their organizational structure. The analyses are based on a large, representative cross-section of West German employees, which were surveyed in 1998 and 1999.

The use of individual-level data has several advantages compared to company-level data sets: We do not have to fall back upon aggregate information on employees. In particular, we know whether or not an employee uses IT on the job. A special feature of the data is that it includes detailed information about the company the interviewed employees work at. In particular, the employees were asked whether or not they work in companies that reorganized their organizational structure within the last two years. Three forms of organizational changes are considered: restructuring of departments, changes in the management structure and outsourcing of parts of the production process. In addition, there is a question that informs us about whether the employee has been personally affected by the organizational change in the company. This dual information, presence of organizational changes in companies and personal affectedness of employees, allows us to infer the potential reasons for wage differentials.

Our results suggest that even when controlling for a wide range of individual characteristics, workplace characteristics and company characteristics, IT users still earn around 6 percent higher wages than their peers. In addition, we find that employees working in companies that have changed their organizational structure earn higher wages independent of the fact whether their workplace situation had been directly affected by the organizational change. This result points to wage differentials across companies rather than within companies.

The paper is organized as follows: Section 2 reviews previous empirical and theoretical results. Section 3 describes the data and the empirical framework. Estimation results are presented and discussed in section 4. Section 5 concludes.

2 Theoretical Background and Previous Empirical Results

The recent literature about organizational change is closely related to the historical debate about the division of labor and the gains from specialization.[4] Gains from specialization, that is, from the repetition of the same tasks, are due to an increased dexterity of an individual in specific tasks (in the sense of learning-by-doing), time-savings otherwise lost for switching from one activity to another, and increased potential for mechanization. There are, however, also limiting factors such as transaction costs (Yang and Borland, 1991), the extent and characteristics of the market (Piore and Sabel, 1984, Aoki, 1986, and Thesmar and Thoenig, 2000), coordinaton costs or the amount of knowledge possessed by specialists (Becker and Murphy, 1992). Whereas the division of labor, for example, increased enormously during industrialization, which was characterized by mass production, standardized products and a rather stable product mix, there is now vast empirical evidence that job roles have expanded both horizontally, through increased integration of tasks, and vertically, through the introduction of flat hierarchies and autonomous work teams.

In recent decades, empirical studies extolling the productivity effects of workplace innovations emerged, for example, by Black and Lynch (2000, 2001), Caroli and van Reenen (2001), Eriksson (2003) and Huselid (1995). Ichniowski, Shaw and Prennushi (1997) analyze complementarities between human resource management practices. Huselid and Becker (1996) and Wolf and Zwick (2002) concentrate on methodological issues. All of these studies deal with so-called high-performance workplace organizations (HPWO) or innovative human resource management (HRM) practices, meaning work practices with decentralizing character that allocate more decision-making rights as well as responsibility to employees.

Several studies relate these changes in the organization of work to the introduction of IT at the workplace. IT influences both the gains from specialization and the traditional limiting factors. Milgrom and Roberts (1990), for example, emphasize the role of IT embedded in machine tools making them a "programmable, multitask production equipment", which can be cheaply switched from one task to the other and, hence, allow the company to efficiently produce a variety of outputs in very small batches. Lindbeck

[4]Adam Smith (1776) already described how the division of labor increases economic growth.

and Snower (2000) emphasize overall changes in the nature of work, for which advances in IT is one important driving force. In addition to the characteristics of IT to allow machines to become flexible and versatile, they accentuate the greater access to information and the reduced communication time owing to the introduction of IT at the workplace, which facilitates decentralization of decision-making and enables employees to become more involved in each others tasks ("multitasking"). However, Lindbeck and Snower also stress the importance of the growth of human capital per worker, generated by education systems, which has ensured that workers have become more versatile as well, and that workers have become to prefer jobs that allow them to exercise a variety of skills.

There are, in general, two arguments for the joint technological and organizational changes. On the one hand, IT itself calls for a reorganization of work through its differing impact on different tasks employees have to perform on the job (see, for example, Autor, Levy and Murnane, 2003, and Spitz, 2004). On the other hand, IT enables organizational changes. For example, the flattening of a company's hierarchical layers (accompanied with a wider control span at each layer) is encouraged by the improved monitoring technology owing to the increased access to information and lower costs of communication. The implication of both arguments is that companies have to adapt their organizational structures when implementing IT in order to use these technologies efficiently.

Empirical company-level evidence for the hypothesis of IT as an enabling technology is given by Bresnahan et al. (2002) and Brynjolfsson and Hitt (2000) on the basis of different U.S. company data sets. Bertschek and Kaiser (2004) take into account the simultaneity between productivity and OC and provide evidence for companies belonging to the German business-related services sector.

The effect of OC on employees is much less studied. Cappelli and Neumark (2001) find that HPWO are associated with higher labor costs suggesting that the higher productivity of companies that introduced HPWO is to some extent offset by the higher costs. In an extreme scenario, this offsetting relationship may even result in a decline in profitability owing to OC. Appelbaum, Bailey, Berg and Kalleberg (2000) consider five worker outcome dimensions in their study: the extent to which workers trust their managers, the degree to which workers perceive their jobs to be intrinsically rewarding, a worker's commitment to the organization, job satisfaction and work-related stress. They find, for example, that the opportunity to participate substantially in the company's decision-making process is positively related to trust and intrinsic rewards. Their analyses focus on nonmonetary benefits that employees derive from performing their tasks. However, there are few studies

investigating the effect of OC on worker's wages.[5]

From the point of view of the company, there are some arguments why employers should share parts of the gains with their employees. Foremost, employees may get more productive owing to the OC. But there are also a variety of additional arguments, not related to productivity considerations, as pointed out by Black and Lynch (2000): Firstly, companies may have to pay a wage premium in order to attenuate resistance to workplace changes of employees and to ensure that employees actively collaborate with respect to the implementation of OC. Secondly, employers may also have to pay a wage premium in order to indemnify employees for the increased job insecurity that may be associated with the workplace reorganizations. And thirdly, employees may acquire additional skills owing to the workplace restructuring that are valuable to outside companies, such as problem solving or interpersonal skills. Hence, employers may have an incentive to pay a wage markup in order to ensure that employees stay with their company. Appelbaum et al. (2000) provide additional theoretical arguments, why one would expect companies that change their organization to pay higher wages. The greater discretionary effort that is required from workers in more participatory work settings speaks in favor of a positive link between OC and wages. Higher wages give employees an incentive to exert such discretionary effort.

Reviewing the above arguments reveals that they generally fall either within the framework of efficiency wage models or in the context of compensating wage differential models. Efficiency wage models, on the one hand, provide rationales why employers pay wages (to all their employees) that are above market-clearing level.[6] Efficiency wages are part of an employer's compensation policy. They are particularly important in work environments that involve unforeseeable contingencies and discretionary power by employees, which make the writing of explicit contracts very costly, if not impossible. Efficiency wages are one measure that provides incentives for employees to maximize their productivity and to remain attached to a company for long periods of time.[7] Employees are willing

[5]There is now a growing literature that investigates the impact of organizational changes on wage inequality (see Aghion, Caroli and Garcia-Penalosa, 1999, for a review). The major argument is that organizational changes increase the productivity gap between individuals with different skill levels.

[6]See Yellen (1984) for a review of efficiency wage models. Akerlof and Yellen (1990) provide a collection of the classical studies in this body of literature.

[7]Another instrument of an employer's compensation policy is incentive pay, which relates employee's

to exert effort (and stop shirking) because their wages are in excess of what they could earn elsewhere. In addition, a company's high pay strategy attracts a large pool of applicants, allowing the company to hire only the best applicants and, hence, to build up and maintain a high quality work force.

Compensating wage differentials, on the other hand, are wage markups that companies have to pay in order to compensate workers for undesirable working conditions. Typical examples for such undesirable working conditions are dirt, heat, danger or noise. However, in the context of this study, one might also think about increased job insecurity and aversion of workers to changes in job content as "unpleasant" features. The compensating wage differentials aim at giving the worker an incentive to adapt to the new working environment. Companies thus compensate employees who accept the new paradigm by paying them more than comparable employees in jobs that do not have these particular characteristics.

As the organizational changes of recent years focus on increased employee involvement and greater discretion for employees with respect to the organization of work, both efficiency wage and compensating wage arguments may be particularly important.

The first type of questions with respect to organizational changes in the survey on which this analysis is based asks for whether or not the survey participants work in companies that implemented organizational changes. Thus, wage differences found for this group of employees apply independent of whether or not the survey participant has been personally affected by organizational changes. This question allows it to investigate whether companies that implemented organizational changes pay systematically different wages to all members of their work force, that is, it hints to wage differentials across companies.

The second type of question asks for whether survey participants have been personally affected by OC, subject to the fact that their companies implemented organizational changes. This question allows us to analyze whether companies pay systematically different wages only to that part of their workforce that witnessed a particular change in their job content in recent years owing to OC. Thus, the question hints at wage differentials within companies.

The few empirical studies that investigate the relationship between HPWO and wages

---

wages directly to some measure of output. However, monitoring and the measurement of output on which remuneration might be based is often costly.

find contradictory results. Bauer and Bender (2001) find that HPWO are associated with higher wages and higher wage dispersion in Germany. The results of Black and Lynch (2000) and Appelbaum et al. (2000) suggest that companies that introduced HPWO have higher company performance and are paying higher wages. Cappelli and Neumark (2001) find that HPWO are associated with higher labor cost, which are very likely to result from increased employee compensation. Osterman (2000), in contrast, does not find that employees are profiting from the introduction of HPWO in terms of greater wage increases or increased job security.

None of these studies investigates the effects on wages when IT and OC are introduced jointly. As already mentioned in the Introduction, Cappelli and Carter (2000) is the only analysis studying the question of joint effects at the company-level. By contrast, our study analyzes this question at the individual-level.

3 Data and Empirical Framework

The analysis is based on the "Qualification and Career Survey", which is a survey of employees carried out by the German Federal Institute for Vocational Training (Bundesinstitut für Berufsbildung, BIBB) and the Research Institute of the Federal Employment Service (Institut für Arbeitsmarkt- und Berufsforschung, IAB). It is a rich source of information on the qualification and occupational career trends of German employees. We use the most recent cross-section, which was launched in 1998-1999, because it is the only one that contains information on both the diffusion of IT at the workplace and organizational changes in companies.

The complete sample contains more than 34,000 observations. For the purpose of the analysis at hand, we restrict the sample to male employees with residence in West Germany and German nationality. Self-employed were also withdrawn from the sample. These restrictions reduce the sample to around 12,300 individuals. The persons in the sample are between 18 and 65 years old. The companies employing these employees cover a wide range of industries both manufacturing and services, however, companies in the agricultural sector are excluded.

Our basic framework closely follows Krueger (1993) who estimates extended income functions originating from Mincer (1974) by ordinary least squares (OLS). In addition to the main variables of interest, IT and OC, three types of variables are considered in the analyses: individual characteristics, company characteristics and workplace characteris-

tics. We include variables reflecting individual characteristics in order to account for the fact that employees systematically differ with respect to characteristics that may affect both computer usage and wages. As more highly skilled workers are more likely to use computers at work and earn higher wages, we control for the level of formal education of employees, work experience and tenure with the current employer. As wages of civil servants are determined in another process than wages of employees in private companies, we also include a dummy variable for civil servants into the regressions.

One drawback of most estimations on individual-level data is that they generally do not have much information on employers. Employer information may, however, be important for the analysis if they determine systematic effects on wages, IT usage and OC. Our data set allows us to take various company characteristics into account such as company size, industry affiliation, innovation strategy, IT intensity of the sector and company performance. Based on previous empirical research, we expect, for example, that larger companies pay higher wages and that they are more likely to introduce OC than smaller companies. Furthermore, we expect "IT-intensive" companies to pay higher wages and that they are more likely to introduce OC than companies with less IT-intensive production processes (Osterman, 1994).

Another feature that distinguishes our data set from others is that it includes information on the task composition of occupations.[8] These tasks describe the occupational context in which IT is introduced and organizational changes are made. In addition, this information on occupational skill requirements allows us to further reduce unobserved heterogeneity.

The variables used in the estimations are constructed as follows (Summary statistics are in Table 1):

Hourly Wages: The survey contains information on monthly earnings, according to 18 categories. To each category midpoints are assigned. These midpoints are then divided by the number of hours an individual usually spends at work.[9] Compared to other data sets that are usually used in comparable analyses such as CPS for the U.S. or the IAB-S for Germany, this data set has the advantage that earnings of highly paid workers are

[8]For a detailed analysis of how the task composition of occupations changed in West Germany since 1979 see Spitz (2004).

[9]Comparable procedures are often used in literature, for example, by DiNardo and Pischke (1997) and by Entorf and Kramarz (1997).

not censored from above. The summary statistics show that employees earned on average around 30 German Marks in 1998/99. Minimum wages were only slightly larger than 3 German Marks, whereas maximum wages approached nearly 100 German Marks. In all estimations, the logarithm of wages is used as dependent variable.

IT equipment: The survey participants indicate whether or not they use one or more of the following devices: personal computers, laptops, other kinds of computers, scanners or computerized control devices such as computer numerical control machines. Based on these questions an IT-dummy is formed that indicates whether an employee uses one or more of the above devices on the job. Table 1 shows that around 60 percent of employees used one of the IT devices at the workplace in 1998/99.

Organizational Changes (OC): The data set contains information about three measures of organizational changes. Employees are asked whether the company for which they work had introduced one or more of the following three different kinds of measures of organizational change in the previous two years: reorganization of departments (RD), changes in the management structure (MS), and outsourcing (OUT) of a part or parts of the production process. These different measures are used in the analysis as dummy variables that indicate whether or not the respective measure had been implemented. In addition, we construct a dummy variable "organizational change" that takes the value one if companies had introduced at least one of the above measures. The use of this variable in the estimation attempts to take account of potential collinearity between the OC variables.[10]

According to the summary statistics in Table 1, 42 percent of the employees belong to companies that restructured departments. Management structures had been changed in the case of 32 percent of survey participants and 19 percent indicate to belong to companies in which parts of the production process had been outsourced. Table 2 indicates that the frequencies of all three types of OC increase with company size.

One drawback of this data set is that the variables capturing OC are less detailed and less precise than measures used in previous research, for example, Ichniowski et al. (1997) or Osterman (1994). Therefore, in the following paragraphs we will relate our measures to those previously used. As Ichniowski, Kochan, Levine, Olson and Strauss (1996) em-

[10]The correlation between the restructuring of departments and outsourcing (changes in the management structure) is 0.359 (0.464). The correlation between changes in the management structure and outsourcing is 0.309.

phasize, the term "innovative work practice" has no settled meaning. As a result, there is a large variety of measures used in literature. They all have in common that they characterize a shift away from traditional forms of work organization, which was associated with "...tightly defined jobs with associated rates of pay, clear lines of demarcation separating the duties and rights of workers and supervisors, decision-making powers retained by management...", toward workplaces with "...greater degree of flexibility in work organization, cooperation between labor and management, and worker participation in decisions and financial well-being of the company (Ichniowski et al., 1996, p.300)". This widely observed shift is the basis for our interpretation of the variables measuring OC in the data set.

Restructuring of departments (RD):[11] The most common organizational change that affected the structure of departments during the 1990s was the introduction of self-managed teams and employee problem-solving groups, instruments that largely decentralized decision-making and increased employee involvement. While it is true that the survey question is an imprecise measure of the implementation of teamwork, we argue that, since the restructuring of department has taken place between 1997 and 1999, it is justified to consider this measure as an organizational change with decentralizing character. This notion is supported by the respondent's answers to questions of how their work had changed between 1997 and 1999. For example, 30 percent of employees that work in companies that reorganized their departments between 1997 and 1999 report that they have greater discretionary power with respect to the planning and performing of their own work in 1999 than in 1997, whereas only 16 percent of employees that work in companies that did not reorganize their departments report so (see Table 3).[12] For 39 (62) percent of employees, who report that their companies reorganized their departments, the variety of tasks (the amount of specialist knowledge) they have to perform increased between 1997 and 1999, whereas this is the case for only 22 (39) percent of employees who work in companies that did not reorganize their departments. Interestingly, for the question of whether control by supervisors increased, employees who work in companies that reorganized their department have higher fraction in the "increased" and "decreased" category

[11]The exact wording of the question is: "In the last two years, has there been a restructuring or reorganization of departments in your company?"

[12]The exact wording of the question is: "In the last two years, did your discretionary power of planning and executing your work increase, stayed the same or decreased?"

than those in companies that did not change the structure of their departments. This pattern may reflect the better monitoring technologies that are now available owing to IT, which are, most probably, implemented and used to a greater extent by companies that changed their organization. Overall, the answers to these four questions are, however, in line with the characteristics that are usually attributed to a more decentralized organization of work.

Changes in the management structure (MS):[13] Given the time period (1997-1999), we assume that this measure reflects the flattening of a company's hierarchy. This may have an inverse effect on managers who loose power and potentially their job owing to the abolishment of hierarchy levels. However, a flattening of a company's hierarchical layer is usually accompanied with an increased control span at each layer. In addition, this measure enhances the decision-making authority of the individual employee and enriches the range of tasks as employees often rotate across jobs. This theoretical thinking is supported by the survey results. Table 4 shows how work has changed between 1997 and 1999 depending on whether or not companies had changed their management structure. The results are similar to those in Table 3. The fraction of employees who report that they had more discretionary power over their work (had more versatile and interesting work) in 1999 than in 1997 is larger in companies that changed their management structure. The amount of specialist knowledge required to perform the work increased also for a larger fraction of workers. Similar to the above result, a larger proportion of employees that work in companies that changed the management structure report an increase of control by supervisors and a decrease of control by supervisors. Our conclusion from the answers to these four questions is again that they are in line with the characteristics of flatter hierarchies. The results by Appelbaum et al. (2000) suggest that this feature of flatter organizational structures has a positive impact on an employee's motivation and is beneficial to an employee's identification with his company.

Outsourcing (OUT):[14] During the 1990s, companies have increasingly externalized certain tasks that were previously performed by their employees. They then buy these products and services from companies that are specialized in those tasks. Outsourcing

[13]The exact wording is: "In the last two years, has there been a change in the structure of management in your company?"

[14]The exact wording is: "In the last two years, has your company increasingly outsourced parts of the production process or bought more intermediate products from other companies?"

allows the companies to concentrate on their core competencies, to replace fixed costs by variable costs, and to increase flexibility.

Being directly affected by organizational changes: The data set includes information on whether the survey participant has been directly affected by an organizational change. Thus, analogously, we construct dummy variables for whether or not employees have been directly affected by these measures. Six percent of survey participants indicate that they have been directly affected by outsourcing activities of their company (see Table 1). 19 percent report that their workplace has been directly affected by a restructuring of departments. Changes in the management structure directly affected 21 percent of employees. Focusing attention to only those employees who report that they work in companies that changed their organization also reveals interesting patterns: 44 percent of employees who report that their companies restructured departments have been directly affected by this measure, and 64 percent of employees who work in companies that changed the structure of management have been directly affected, whereas the majority (94 percent) of employees who report that their companies outsourced part of the production process has not been directly affected.

IT and OC are often viewed as strategic complements. As Table 5 shows, IT users are more likely to work in companies that reorganized their production processes. The higher incidence holds for all three practices. However, the difference is most pronounced for the restructuring of departments. 54 percent of the IT users reported to work in companies that restructured their department compared to 26 percent for IT non-users. In addition, IT users are also more likely to be directly affected by organizational changes. For example, 25 percent of IT users report to be directly affected by a restructuring of departments compared to 9 percent of IT non-users.

Table 5 also demonstrates major differences with respect to the educational attainment of IT users and IT non-users and their wage outcome indicating that IT users have a higher educational attainment and earn higher wages.

Workplace Characteristics: The analyses by Autor, Levy and Murnane (2003) and Spitz (2004) document how IT has changed the content of work towards analytical and interactive activities and away from manual and cognitive routine activities. The data set at hand is a cross-section, thus changes in the task composition of occupations cannot be taken into account. However, the data set allows us to consider task levels, capturing the content of jobs, and therefore, it gives a description of the context in which IT is used

and organizational changes have been made. Survey participants are asked what kind of activities they perform at the workplace. Based on these activities five categories are constructed, which classify the occupational skill requirements: analytic tasks, interactive tasks, repetitive cognitive tasks, repetitive manual tasks and non-repetitive manual tasks. Table 6 shows the list of activities that employees were asked for in the questionnaire and how the activities are classified in the five task categories. On the individual-level i, the task measures ($Task_{ij}$) are defined as:

$$Task_{ij} = \frac{\text{number of activities in category } j \text{ performed by } i}{\text{total number of activities in category } j} * 100 \tag{1}$$

where

$$j = \begin{cases} 1 & : \text{ analytic tasks} \\ 2 & : \text{ interactive tasks} \\ 3 & : \text{ routine cognitive tasks} \\ 4 & : \text{ routine manual tasks} \\ 5 & : \text{ non-routine manual tasks.} \end{cases}$$

For example, if the analytical task category includes 4 activities and employee i indicates that she performs 2 of them, her analytical task measure is 50. Spitz (2004) includes further details on the concept of skill requirements of occupations. On average, employees perform, for example, 16 percent of analytical activities, whereas they perform 30 percent of repetitive cognitive activities (Table 1).

The data set also contains information about the current occupation of employees. Occupations are grouped according to the (2-digit-level) classification of occupational titles by the Federal Employment Bureau, 1999, leading to 78 occupational groups.

Individual characteristics: We distinguish three levels of formal educational attainment of employees. Employees with a low level of education are those with no further vocational training. Employees with medium levels of education have a vocational qualification either from an apprenticeship or they are graduated from a vocational college. Employees holding a degree from a university or a technical college are classified as having a high level of educational attainment. This categorization corresponds closely to the institutional setting of the German education system and is often used in literature, see, for example, Bellmann, Reinberg and Tessaring (1994) or Fitzenberger (1999). In contrast, U.S. studies

usually use the number of schooling years as a measure of education (see Card, 1999, for further discussions). As shown in Table 1, the largest part of the survey participants, 70 percent, has a medium qualification level, whereas 19 percent are highly qualified and only 10 percent have a low education level.

Survey participants also indicate their first year of work. Based on these answers, we calculate (potential) work experience (1999-first year of work). In addition, employees indicate the year in which they started to work with the current employer. This information is used to calculate company tenure (1999-first year with current employer).

Company characteristics: Company size has been identified as an important component of wage determination in previous studies, finding that larger companies pay higher wages to employees with similar characteristics (see, for example, Brown and Medoff, 1989, Schmidt and Zimmermann, 1991). A recent contribution disentangling the sources for these firm-size wage differentials using employer-employee data is Abowd, Kramarz and Margolis (1999). In our analysis, company size measured as the number of employees is captured by 7 size classes. Companies with one to four employees are classified to belong to the first size bracket and companies with more than 1,000 employees to the last one. Based on these size classes, 7 dummy variables are formed. Most of the survey participants, 27 percent, belong to companies with a size class from 10 up to 49 employees, followed by the size class from 100 up to 499 employees (see Table 2). Companies with more than 1000 employees are represented by 16 percent of the survey participants. Less than 14 percent of the interviewed employees belong to small companies with less than ten employees.

The data set also includes information about the performance of companies. The survey participants were asked whether the company was doing very good, good, rather bad or bad. For each of these categories, we constructed a dummy variable. The results of Wolf and Zwick (2002), for example, suggest that company performance and the implementation of organizational changes are correlated. In addition, we expect a company's pay to its IT users to be related to its performance. Table 1 shows that 19 percent of employees report to work in companies that are doing very well and 63 percent work in companies that are doing well. 18 percent of employees work in companies that are either doing rather bad or bad.

Companies are classified according to 48 detailed industry codes. Based on these

codes we group companies into three sectors: manufacturing, trade, and services.[15] The inclusion of these variables accounts for inter-industry wage differentials that are not already captured by the observed individual and company characteristics (see, for example, Krueger and Summers, 1987, Dickens and Katz, 1987, Gibbons and Katz, 1992 and Abowd, Kramarz and Margolis, 1999).

In order to identify companies operating in "IT-intensive" industries, we construct a dummy variable that takes the value one if the IT intensity of the industry is higher than the average IT intensity of the sector to which it belongs. In addition, the survey participants were asked whether or not their company introduced new products or services to the market within the last two years. Based on these answers a dummy variable for "product innovation" was constructed. We expect companies in technology intensive industries as well as innovative companies to pay higher wages and to have a higher likelihood to implement organizational changes.

4 Empirical Results

Table 7 displays the estimation results of the basic wage regressions. Each row represents a separate OLS regression. The result in the first row (Panel A) shows that the raw log wage differential for IT use in West Germany is 0.282 (about 32 percent) in 1998/99.[16] The regressions in Panel B show that employees who work in companies that restructured their departments, changed their management structure or outsourced parts of their production earn significantly higher wages. The coefficient in the bivariate regression that includes the dummy for "organizational change", which takes the value one if companies had introduced at least one of the measure of organizational changes, is also positive and highly significant. In addition, employees that have been directly affected (Panel C) by a restructuring of departments, changes in the management structure or a company's outsourcing activities earn significantly higher wages. The information in Panel A about an

[15] We also ran regressions that included more detailed industry dummies. The results that we report in Section 4 are robust to this change in specification.

[16] This figure is slightly smaller than the raw log wage differential of 0.288 that DiNardo and Pischke (1997) report for Germany based on the 1991-1992 cross-section of the BIBB/IAB data. Thus, in contrast to the period between 1979 and 1991-1992, where the raw log wage differentials for computer use increased steadily (although at a declining pace), as shown in the paper by DiNardo and Pischke, it remained stable or even slightly declined in the 90s.

individual's usage of IT is the type of information that is usually available in individual-level data sets that in general do not provide information about company characteristics such as organizational changes. The information about organizational changes (Panel B) are usually available in company-level data sets that then include only aggregate information about wages and IT usage such as average wages of employees or the proportion of employees using IT. The advantage of this data set is that it includes information on both IT on the individual-level and organizational changes on the company-level. In addition, it includes individual information about whether employees had been personally affected by these organizational changes. This advantage will be taken into account in the analyses that follow.

These bivariate regressions suffer from some of the most prominent drawbacks of previous research. Estimates based on individual-level data, that is, the majority of studies analyzing the relationship between IT usage and wages, cannot adequately tell whether employers differ systematically in a way that affects wages (such as differences in work organization). Estimates based on company-level data, that is, the majority of studies on high-performance workplace practices, are not able to take into account individual differences that affect wages (such as IT usage on the job). For example, the positive relationships between IT usage and wages shown in Panel A might reflect that IT users are more likely to work in companies that restructured their organization, which often pay higher wages, whereas the positive relationship between organizational changes and wages (Panel B) might reflect that companies that restructured their organization have a larger fraction of IT users, who generally earn higher wages. That is, owing to the covariation in the introduction of IT and the implementation of organizational changes, one might end up by incorrectly attributing the positive wage effect of one factor to the other.

The first extension, thus, is to estimate regressions that include both information about IT usage and about organizational changes simultaneously in the specification. The results are shown in Table 8, each column represents a separate OLS regression. Columns (1)-(3) show that the coefficient of IT use and the dummies for the different organizational changes decline compared to the bivariate results in Table 7. For example, conditional on the "restructuring of department" variable, the coefficient of IT use drops by 12 percent. However, IT users still earn around 28 percent higher wages than IT non-users. Conditioning on "changes in the management structure" reduces the IT-coefficient by 20 percent, whereas conditioning on "outsourcing" reduces the IT-coefficient only by 5 per-

cent. The coefficients of the variables for the different measures of organizational changes decline even to a larger extent owing to the inclusion of the IT use variable. The coefficient of the "restructuring of departments" variable declines by 38 percent (column 1), the result in column 2 shows that the wage markup for employees that work in companies who changed their management decreased by 35 percent and the coefficient of the "outsourcing" variable drops by 22 percent.

The result is similar when the dummy for "organizational changes" is included in the regression instead of the separate measures (column 4) and also, when all variables reflecting organizational changes are included jointly in the specification (column 5). Column 5 shows that including the different measures for organizational changes jointly reduces the respective coefficients by around 60 percent, however, each of them still remains positive and highly significant. In addition, the coefficient for IT usage changes hardly.

Although these specifications only focus on the main variables of interest of this study, they already indicate that it is important to consider both individual and company information. The reduction in coefficients owing to the joint inclusion of variables of IT usage and organizational changes indicate that studies that are not able to account for the covariation in IT usage and the implementation of organizational changes overestimate the respective coefficients.

Unreported results in which the information about whether employees had been directly affected by the organizational changes are included in the specification instead of the "broad" information of organizational changes as in Table 8 show similar patterns, although the coefficients are generally smaller. The coefficient of IT use has always a magnitude of around 16 percent, whereas the coefficients for the different measures of "direct" organizational changes decline to around 7-10 percent. All coefficients remain highly significant.

As outlined in Section 2, IT and organizational changes are often viewed as strategic complements. Therefore, IT users might be particularly involved in the introduction of organizational changes by supporting the successful implementation from a technical point of view. Moreover, the productivity effects of OC might be more pronounced for IT users than for IT non-users. Therefore, IT users in companies that changed organization may be particularly rewarded.

The regressions in Table 9 include interactions between the IT use variable and the dummies for organizational changes in order to account for potential complementarities. The interaction term of the "restructuring of departments" variable and IT is positive but

insignificant, whereas the interaction terms for the two other measures of organizational changes are negative. IT users working in companies that changed their management structure earn significantly (10 percent level) lower wages than their peers. In terms of wages, the results do not suggest that there is a complementary relationship between IT use and organizational changes.

However, IT and organizational changes may still be strategic complements in production as suggested by company-level studies (for example, Bresnahan et al., 2002). The weak evidence for interaction effects in the wage regressions may be informative about the type of computing that is important for companies that change their organizational structure. Bresnahan (1999) distinguishes between three main categories: *organizational computing* such as corporate accounting systems, supply chain management systems, customer relationship management systems or transaction processing systems, *scientific or technical computing* in factories and laboratories, and *individual productivity computing* such as word-processing or computer-aided design. The measure of IT equipment in this study reflects individual productivity computing and, partly, scientific or technical computing, but does not capture organizational computing. However, in the process of restructuring of departments, changes in the management structure or outsourcing, organizational computing is likely to be more important than individual computing or technical computing.

Up to now, the analysis focused on the "broad" variables of organizational change and neglected the information about whether employees have been personally affected. The specification in Table 10 includes both types of variables for organizational changes. As before, each column represents a separate OLS regression. Column (1) shows that the positive relationship between a restructuring of departments and wages does not depend on whether or not employees have been directly affected by this measure. The two other measures of OC convey a different picture. Column (2) shows that employees who have been directly affected by a change in management structure earn significantly lower wages than employees who have not been directly effected. This suggests that employees rather lose than gain competencies owing to the reduction in hierarchical layers. The joint effect, that is, the sum of coefficients of the variable for the change in management structure and the variable for "being personally affect", is positive, however. The result in column (3) shows that employees who have been directly affected by outsourcing activities of companies earn significantly higher wages than their peers, suggesting that compensating wage differentials might play a role in the corresponding companies. However, the wage

markup for being personally affected is rather small in size compared to the effect that accrues to all employees in companies that engaged in outsourcing. As will be seen in analyses that follow, the coefficients of the measures of OC for employees that had been directly affected become insignificant as soon as the specification accounts for additional observable differences. The coefficients of the measures for the direct affectedness by OC become insignificant owing to the controls, whereas the broad measures of OC remain (mostly) significant. It is interesting to note that in Table 10 the IT wage differential is hardly affected by the inclusion of the variables that measure the personal affectedness by OC.

The previous specifications are scarce in the sense that they focus solely on the relationships between the main variables of interest. They omit, however, a large number of factors that may be correlated with both IT usage and organizational changes. Results from previous empirical studies suggest, for example, that employees with high levels of education earn higher wages and are more likely to use IT at the workplace and that companies that implement organizational changes have a higher fraction of highly educated employees. Previous research also finds that larger companies and more innovative companies use more IT, are more likely to change their organizational structure and pay higher wages. In addition, previous analyses point to the fact that IT is complementary to analytical and interactive tasks, for which employees with high levels of education (who earn higher wages) have a comparative advantage, whereas IT substitutes for cognitive and manual routine activities, which are usually performed by employees with lower levels of education. In sum, previous analyses emphasize that there is a large number of observable and (for the researcher) unobservable factors that may influence IT use, organizational changes and wages.

Having only a cross-section at hand, we are not able to control for (time-constant) unobserved heterogeneity by taking individual-specific fixed effects into account. However, this caveat is to some extent outweighed by the fact that the data set includes many variables that are potentially correlated with IT use, organizational changes and hourly wages. These variables fall within three broad categories: individual characteristics, company characteristics and workplace characteristics (for a detailed description see Section 3). In order to assess the importance of different factors, we are going to augment the specification step-by-step. First by individual characteristics, then by workplace characteristics, and last by company characteristics. Individual characteristics are: level of

formal education, work experience, tenure with the current employer and a dummy for civil servants. Company characteristics are: company size, sector affiliation, innovative strategy, IT intensive industries and company performance. Workplace characteristics are: five task categories (analytic, interactive, routine cognitive, routine manual and non-routine manual) and occupational affiliation.

Table 11 shows the results of the specification that includes individual characteristics. The IT wage differential and the wage markup for organizational changes drops by around 30 percent (compared to Table 9) owing to the covariates. In addition, the coefficients of the variables that capture whether employees have been directly affected are now insignificant in all three specifications. The coefficients of the covariates are highly significant and convey the typical picture: wages increase in educational attainment, wages increase (with a decreasing pace) in years of work experience and tenure with the current employer tends also to increase wages.

The insignificant coefficients of variables capturing the affectedness reflect one important difference between traditional work systems, often termed Fordist or Tayloristic, and modern work systems. Modern measures of work organization are not directed to individual employees, their goal is to increase organizational efficiency. Maximizing organizational productivity dominates the maximization of individual productivity, which was the goal of work organization in the past. Therefore, it seems reasonable for employers to pay higher wages to all their employees instead of only rewarding a particular group of employees.

In the following regressions, we do not report the results for the variables that capture whether employees have been directly affected anymore. The coefficients are always insignificant and the inclusion of these variables in the specification does not alter the results for the other variables.

Table 1: Summary Statistic

	Mean	Std. Deviation	Min.	Max.	Observations
Information Technology					
IT	0.57	0.50	0	1	12334
Organizational Change					
restructuring of departments	0.42	0.49	0	1	11751
change in management structure	0.32	0.47	0	1	11785
outsourcing	0.19	0.40	0	1	11575
being directly affected by...					
...restructuring of departm.	0.19	0.39	0	1	11751
...change in management struct.	0.21	0.41	0	1	11785
...outsourcing	0.06	0.24	0	1	11575
Qualification					
high education level	0.19	0.39	0	1	12340
medium education level	0.70	0.46	0	1	12340
low education level	0.10	0.30	0	1	12340
experience	21.42	11.65	0	47	12340
tenure	12.98	1 0.49	0	47	12340
(hourly) wages (in DM)	29.72	12.24	3.19	98.68	10506
Workplace Characteristics:					
analytic task measure	15.95	25.07	0	100	12319
interactive task measure	0.74	29.52	0	100	12319
repetitive cognitive task measure	0.28	45.95	0	100	12319
repetitive manual task measure	24.03	34.51	0	100	12319
non-repetitive manual task measure	24.32	24.99	0	50	12319
Company Characteristics					
IT intensive industry	0.56	0.50	0	1	12340
product innovation	0.42	0.49	0	1	11803
very good company performance	0.19	0.39	0	1	8331
good company performance	0.63	0.48	0	1	8331
rather bad company performance	0.15	0.35	0	1	8331
bad company performance	0.03	0.17	0	1	8331

Table 2: Company Size Distribution

			Perc. share of companies with		
Number of employees	Freq.	Percent	RD	MS	OUT
1 to 4	581	4.79	14.95	10.42	8.16
5 to 9	1088	8.97	15.24	12.64	5.94
10 to 49	3266	26.93	25.29	20.86	10.24
50 to 99	1609	13.27	36.29	28.68	13.38
100 to 499	2697	22.24	54.44	39.88	24.83
500 to 999	963	7.72	62.74	48.04	29.15
1000 and more	1950	16.08	71.13	56.05	39.94
Total	12127	100.00			

Table 3: Changes in Work between 1997 and 1999 for Employees in Companies that Reorganized their Departments

A. Did your discretionary power over your work...		
	RD=0	RD=1
increased	16.51	30.57
stayed the same	70.49	58.25
decreased	6.20	8.18
B. Has the versatility and interest of your work...		
	RD=0	RD=1
increased	22.33	38.97
stayed the same	71.50	54.37
decreased	4.40	5.80
C. Has the extent of supervision...		
	RD=0	RD=1
increased	9.52	16.80
stayed the same	72.78	62.73
decreased	10.60	14.38
D. Has the amount of specialist knowledge required to perform your job...		
	RD=0	RD=1
increased	39.37	62.09
stayed the same	57.26	35.48
decreased	2.04	1.88

The figures refer to the percentage of employees who report that the respective scenario applied to their work. The figures in each category do not sum up to 100 percent because the questionnaire also included the possibility for respondents to indicate that the type of question does not apply to their work.

Table 4: Changes in Work between 1997 and 1999 for Employees in Companies that Changed their Management Structure

A. Did your discretionary power over your work...		
	MS=0	MS=1
increased	18.26	30.67
stayed the same	69.41	57.05
decreased	6.16	8.83
B. Has the versatility and interest of your work...		
	MS=0	MS=1
increased	24.90	38.30
stayed the same	69.05	54.65
decreased	4.41	6.18
C. Has the extent of supervision...		
	MS=0	MS=1
increased	9.50	18.89
stayed the same	72.23	61.05
decreased	10.72	15.19
D. Has the amount of specialist knowledge required to perform your job...		
	MS=0	MS=1
increased	42.50	61.98
stayed the same	54.14	35.83
decreased	2.05	1.80

The figures refer to the percentage of employees who report that the respective scenario applied to their work. The figures in each category do not sum up to 100 percent because the questionnaire also included the possibility for respondents to indicate that the type of question does not apply to their work.

Table 5: Summary Statistics for IT users and IT non-users

	Sample Means by IT-use			
	IT user		IT non-user	
	Mean	Std. Deviation	Mean	Std. Deviation
restructuring of departments	0.54	0.50	0.26	0.44
change in management structure	0.41	0.49	0.21	0.41
outsourcing	0.23	0.42	0.15	0.36
being directly affected by...				
...restructuring of departm.	0.25	0.44	0.09	0.29
...change in management struct.	0.25	0.43	0.15	0.36
...outsourcing	0.07	0.26	0.04	0.19
high education level	0.30	0.46	0.05	0.22
medium education level	0.65	0.48	0.77	0.42
low education level	0.05	0.22	0.17	0.38
experience	20.85	11.38	22.18	11.95
tenure	13.82	10.59	11.87	10.26
wage	33.41	12.85	25.01	9.54

Table 6: Assignment of Activities

Classification	Tasks
analytic	researching, evaluating and planning,
	making plans, constructing, designing, sketching
	working out rules/regulations
	using and interpreting rules
interactive	negotiating, lobbying, coordinating, organizing
	teaching or training
	selling, buying, advising customers, advertising
	entertaining or presenting
	employing or managing personnel
routine cognitive	calculating, bookkeeping
	correcting of texts/data
	measuring of length/weight/temperature
routine manual	operating or controlling machines
	setting up machines
non-routine manual	repairing or renovation houses/apartments/machines/vehicles
	restoring art/monuments
	serving or accomodating

Table 7: Bivariate OLS Regressions for the Effect of IT and Organizational Changes on Wages

Dependent Variable: Log(Hourly Wages)		
	Coeff.	R^2
	(Std. Error)	No. of Observations
A.		
IT	0.282***	0.120
	(0.007)	10501
B.		
restructuring of departments	0.182***	0.052
	(0.008)	10034
chg. in management structure	0.168***	0.040
	(0.008)	10067
outsourcing	0.144***	0.021
	(0.009)	9879
organizational change	0.204***	0.066
	(0.008)	10506
C.		
being directly affected by...		
...restructuring of departments	0.138***	0.019
	(0.010)	10034
...chg. in management structure	0.120***	0.015
	(0.009)	10067
...outsourcing	0.140***	0.007
	(0.015)	9879

Heteroscedasticity-consistent standard errors are in parentheses.
***, **, *-indicate significance at the 1, 5, 10 percent level.

Table 8: OLS Regressions for the Effect of IT and Organizational Change on Wages

Dependent Variable: Log(Hourly Wages)					
	(1)	(2)	(3)	(4)	(5)
IT	0.248***	0.226***	0.269***	0.244***	0.241***
	(0.008)	(0.008)	(0.007)	(0.008)	(0.008)
Organizational Changes					
restructuring of dept.	0.112***				0.072***
	(0.007)				(0.009)
chg. in management structure		0.110***			0.063***
		(0.008)			(0.009)
outsourcing			0.113***		0.061***
			(0.009)		(0.010)
organizational change				0.136***	
				(0.008)	
R^2	0.141	0.137	0.132	0.151	0.149
Number of observations	10030	10063	9876	10501	9633

Heteroscedasticity-consistent standard errors are in parentheses.

***, **, *-indicate significance at the 1, 5, 10 percent level.

Table 9: Complementarities between IT and Organizational Change

Dependent Variable: Log(Hourly Wages)			
	(1)	(2)	(3)
IT	0.247***	0.264***	0.273***
	(0.010)	(0.009)	(0.008)
Organizational Changes			
restructuring of dept.	0.111***		
	(0.012)		
restructuring of dept. * IT	0.001		
	(0.016)		
chg. in management structure		0.129***	
		(0.013)	
chg. in management structure * IT		-0.028*	
		(0.016)	
outsourcing			0.129***
			(0.014)
outsourcing * IT			-0.025
			(0.018)
R^2	0.141	0.137	0.132
Number of observations	10030	10063	9876

Heteroscedasticity-consistent standard errors are in parentheses.
***, **, *-indicate significance at the 1, 5, 10 percent level.

Table 10: Wage Differentials across and within Firms

Dependent Variable: Log(Hourly Wages)			
	(1)	(2)	(3)
IT	0.248***	0.255***	0.269***
	(0.008)	(0.008)	(0.007)
Organizational Changes			
restructuring of dept.	0.114***		
	(0.009)		
chg. in management structure		0.131***	
		(0.011)	
outsourcing			0.112***
			(0.010)
Being Directly Affected By...			
restructuring of dept.	-0.005		
	(0.011)		
chg. in management structure		-0.031***	
		(0.012)	
outsourcing			0.002***
			(0.017)
R^2	0.141	0.138	0.132
Number of observations	10030	10063	9876

Heteroscedasticity-consistent standard errors are in parentheses.
***, **, *-indicate significance at the 1, 5, 10 percent level.

Table 11: OLS Regressions for the Effect of IT and Organizational Change on Wages: Individual Characteristics Only

Dependent Variable: Log(Hourly Wages)			
	(1)	(2)	(3)
IT	0.172***	0.174***	0.182***
	(0.007)	(0.007)	(0.007)
Organizational Changes			
restructuring of dept.	0.077***		
	(0.007)		
chg. in management structure		0.079***	
		(0.007)	
outsourcing			0.085***
			(0.008)
Being Directly Affected By...			
restructuring of dept.	-0.010		
	(0.011)		
chg. in management structure		-0.015	
		(0.011)	
outsourcing			-0.002
			(0.015)
Individual Characteristics			
high educ. level	0.435***	0.440***	0.441***
	(0.015)	(0.015)	(0.016)
medium educ. level	0.129***	0.131***	0.135***
	(0.013)	(0.012)	(0.013)
experience	0.020***	0.020***	0.020***
	(0.001)	(0.001)	(0.001)
experience^2 *(1/100)	-0.034***	-0.035***	-0.035***
	(0.002)	(0.002)	(0.002)
tenure	0.008***	0.008***	0.009***
	(0.000)	(0.000)	(0.000)
R^2	0.32	0.32	0.32
Number of observations	10030	10063	9876

Control variable is a dummy variable for civil servants. Employees with low levels of education are the base category. Heteroscedasticity-consistent standard errors are in parentheses. ***, **, *-indicate significance at the 1, 5, 10 percent level.

Table 12 shows the results when workplace characteristics and 77 occupation dummies are additionally included in the specification. Again, the coefficients for the IT use variables as well as the different measures of organizational changes drop considerably. Comparing the results from Tables 9, 11 and 12 shows that the inclusion of the workplace characteristics has a larger quantitative impact on the size of the IT use variable than the inclusion of the individual characteristics, suggesting that it is important to analyze the implementation of IT with the occupational context in mind. The results of the five task categories show that wages are positively related to the extent of non-routine cognitive activities both analytical and interactive, whereas they are negatively related to non-routine manual activities.[17] The coefficients of the individual characteristics decline owing to the inclusion of the workplace characteristics in the specification, but the functional form of the relationship remains unchanged.

[17]We additional investigated potential complementary or substitutive relationships between workplace tasks and IT usage by including interaction terms in the specification (see Spitz, 2004). In terms of wages, the results do not hint to complementary or substitutive effects.

Table 12: OLS Regressions for the Effect of IT and Organizational Change on Wages: Individual and Workplace Characteristics

Dependent Variable: Log(Hourly Wages)					
	(1)	(2)	(3)	(4)	(5)
IT	0.066***	0.062***	0.067***	0.062***	0.060***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.010)
Organizational Changes					
restructuring of dept.	0.052***				0.028***
	(0.007)				(0.008)
chg. in management structure		0.060***			0.043***
		(0.007)			(0.008)
outsourcing			0.053***		0.031***
			(0.008)		(0.008)
organizational change				0.065***	
				(0.008)	
Workplace Characteristics					
analytical tasks	0.040***	0.037***	0.041***	0.037***	0.041***
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
interactive tasks	0.134***	0.138***	0.144***	0.134***	0.131***
	(0.015)	(0.015)	(0.015)	(0.014)	(0.015)
routine cognitive tasks	0.021	0.022	0.017	0.019	0.017
	(0.015)	(0.015)	(0.015)	(0.014)	(0.015)
routine manual tasks	-0.019	-0.018	-0.013	-0.018	-0.017
	(0.021)	(0.021)	(0.022)	(0.021)	(0.022)
non-routine manual tasks	-0.106***	-0.106***	-0.103***	-0.104***	-0.104***
	(0.015)	(0.014)	(0.015)	(0.014)	(0.015)

<Table continues on next page>

<*Continued from previous page*>

Dependent Variable: Log(Hourly Wages)					
	(1)	(2)	(3)	(4)	(5)
Individual Characteristics					
high educ. level	0.231***	0.237***	0.2369***	0.238***	0.228***
	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)
medium educ. level	0.069***	0.073***	0.074***	0.075***	0.068***
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
experience	0.022***	0.022***	0.022***	0.022***	0.022***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
experience^2 *(1/100)	-0.037***	-0.037***	-0.038***	-0.038***	-0.037***
	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)
tenure	0.007***	0.007***	0.007***	0.007***	0.007***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R^2	0.38	0.38	0.38	0.39	0.38
Number of observations	8602	8609	8476	8910	8296

Control variables are: Dummy variable for civil servants and 77 occupation dummies. Employees with low levels of education are the base category. Heteroscedasticity-consistent standard errors are in parentheses. ***, **, *-indicate significance at the 1, 5, 10 percent level.

The results of the richest specification additionally including company characteristics are shown in Table 13, which reports only the coefficients of the most interesting variables. The control variables are listed at the bottom of Table 13.[18]

As expected, both the IT use wage differential and the wage markup for organizational changes drop again owing to the inclusion of the company characteristics. The IT use wage differential is reduced to 6 percent, which is only 20 percent of the bivariate result of 0.282. It is robust across the different specifications in columns (1)-(5). Also, the coefficients of the different measures of organizational changes decline. The results now suggest that employees that work in companies that restructured their departments do not earn significantly higher wages (column 1). However, the coefficients for employees working in companies that changed their management structure (column 2) or outsourced

[18]The control variables convey the usual picture. For example, that manufacturing is the highest paying sector and that wages increase in company size.

part of their production (column 3) are still significant and positive, although they are quantitatively small.

The results show that companies operating in IT intensive industries pay significantly higher wages. However, we do not find significant effects for product innovators. The dummy variables for company performance indicate that wages are increasing in performance. Unreported results that did not include the information about company performance show that the IT coefficient as well as the coefficients for the different measures of OC are higher when company performance is included in the specification (everything else equal to specification in Table 13). This result suggests that companies with performance problems are more likely to introduce organizational changes and that they pay their IT users lower wages.[19]

Owing to the company controls, the negative relationship between routine manual tasks and wages now turns out to be significant. The negative relationship between non-routine manual tasks remains significantly negative, but the size of the effect declines. The results for the individual characteristics remain relatively unchanged by the company controls.

Overall, one might conclude that we find positive wage effects of both IT use and organizational changes, in particular changes in management structure and outsourcing activities. The size of the IT wage differential is in the order of magnitude of coefficients typically reported in studies using panel methods.[20] The richness of the data set thus seems to be equally successful in reducing unobserved heterogeneity as methods that remove time-constant unobserved heterogeneity. However, in line with findings of Entorf and Kramarz (1998), we do not interpret this result as causal in the sense that the introduction of IT at the workplace immediately increases individual productivity and thus wages. We rather argue that employees get more productive through the experience they gain with using IT. Our results do not hint to a complementary relationship between IT and OC in terms of wages.

The interpretation of our results might be encumbered with an important caveat: although the coefficients for the different OCs are small or even insignificant, they might be upward biased because those employees that have been mostly affected by the OCs have been dismissed. The survey on which our analyses are based, however, only includes

[19]Wolf and Zwick (2002) also find that companies with productivity problems tend to introduce organizational changes.

[20]Bell (1996), for example, report a coefficient of 0.047 in fixed-effects regressions using data for U.K.

employees, but not unemployed persons. Thus, we are not able to take account of persons who are affected by organizational changes in the sense that they lose their jobs. Using matched employer-employee data Jacobson, LaLonde and Sullivan (1993), for example, find that high-tenure workers that are displaced and then rehired end up with considerable wage losses. Rationalizing production processes in order to save costs might be involved with the dismissal of employees – an effect that cannot be captured by our data base.

This argument applies in particular to the case of outsourcing when companies not only source out certain tasks but whole workplaces. The fact that 94 percent of employees in our sample who report that their company outsourced part of the production has not been directly affected supports this conjecture.

According to a survey by the ZEW (Centre for European Economic Research) among more than 4,000 companies in the year 2000, the most important reasons for outsourcing of IT-related tasks have been the higher competency and quality of specialized companies, the possibility to save costs and the lack of time to do certain IT-tasks internally. In these company-level data, no significant correlation between outsourcing and the expected development of employment can be found.

Several studies name the concentration on core competencies, cost reductions and lack of qualified personnel as the most important reasons for outsourcing decisions, see, for example, Henkel and Kaiser (2002, p.13) for the case of IT-outsourcing. The results by Falk and Koebel (2002) suggest that rather output growth than input substitution drives the increasing use of imported materials and purchased services. There seems to be no significant relationship between outsourcing and labor demand. The study by Heshmati (2003) gives a comprehensive overview on the effects of general outsourcing. The decision to source out might differ across company size. For instance, large companies might source out whole departments, which will lead to dismissals if the corresponding tasks are not done within the company anymore. On the other hand, the employees working in the outsourced department might continue their work within a new enterprise as it is, for example, the case for the Deutsche Bank that outsourced its IT-department to IBM, thus, about 900 former Deutsche Bank employees are now working for IBM (Lamberti, 2003). Small companies, in contrast, will probably outsource single tasks rather than whole departments. In our data set, the percentage share of employees working in companies with organizational changes increases with company size for all three types of OC considered as shown in Table 2.

This caveat of neglecting dismissals seems to be less severe for "changes in the man-

agement structure" and "restructuring of departments". For example, 64 (44) percent of employees who report that their companies changed the structure of the management (restructured departments) have been directly affected. These types of organizational changes supposed to increase the degree of employee involvement in decision-making or increase the degree of flexibility in work organization, thereby increasing employees' motivation. Appelbaum et al. (2000), for example, report on a survey that investigates workers' attitudes and experience with modern forms of work organization. They report that participation in decisions has a strong and positive effect on employees' perception of the intrinsic rewards of jobs, that is they find the jobs more meaningful and challenging. In addition, Appelbaum et al. (2000) find that more participatory work systems enhances employees' trust in managers. It is very unlikely that employees would have these perceptions if the organizational changes had involved large scale dismissals.

The data set in this study includes information about employees' work satisfaction. Survey participants indicate their satisfaction with the career opportunity in the company, the working atmosphere, the task they have to perform and the pressure exerted on them. Descriptive statistics (not reported) show that, on average, employees who work in companies that changed their organization are more satisfied with their work, although the differences in means are often not significant.

Table 13: OLS Regressions for the Effect of IT and Organizational Change on Wages: Individual, Workplace and Company Characteristics

Dependent Variable: Log(Hourly Wages)					
	(1)	(2)	(3)	(4)	(5)
IT	0.060***	0.056***	0.056***	0.056***	0.053***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Organizational Changes					
restructuring of dept.	0.006				-0.009
	(0.010)				(0.011)
chg. in management structure		0.035***			0.036***
		(0.010)			(0.010)
outsourcing			0.030***		0.026**
			(0.010)		(0.011)
organizational change				0.027***	
				(0.010)	
Workplace Characteristics					
analytical tasks	0.064***	0.061***	0.061***	0.061**	0.064***
	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)
interactive tasks	0.155***	0.152***	0.158***	0.154***	0.154***
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
routine cognitive tasks	0.014	0.018	0.013	0.016	0.012
	(0.016)	(0.017)	(0.017)	(0.016)	(0.017)
routine manual tasks	-0.045**	-0.051**	-0.044*	-0.048**	-0.046**
	(0.023)	(0.023)	(0.023)	(0.022)	(0.023)
non-routine manual tasks	-0.091***	-0.091***	-0.089***	-0.092***	-0.090***
	(0.018)	(0.018)	(0.018)	(0.017)	(0.018)

<*Table continues on next page*>

<*Continued from previous page*>

Dependent Variable: Log(Hourly Wages)					
	(1)	(2)	(3)	(4)	(5)
Individual Characteristics					
high educ. level	0.188***	0.184***	0.181***	0.189***	0.176***
	(0.024)	(0.024)	(0.024)	(0.024)	(0.025)
medium educ. level	0.041**	0.037***	0.039**	0.041**	0.035**
	(0.017)	(0.017)	(0.018)	(0.017)	(0.018)
experience	0.020***	0.020***	0.020***	0.020***	0.020***
	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)
experience^2 *(1/100)	-0.034***	-0.034***	-0.034***	-0.034***	-0.034***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
tenure	0.005***	0.005***	0.005***	0.005***	0.005***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Company Characteristics					
IT intensive industry	0.028***	0.027***	0.030***	0.027***	0.030***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
product innovation	0.017*	0.013	0.015*	0.012	0.014
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
very good company performance	0.072***	0.082***	0.077***	0.076**	0.086***
	(0.026)	(0.027)	(0.027)	(0.026)	(0.028)
good company performance	0.046*	0.054**	0.049**	0.050**	0.056**
	(0.025)	(0.025)	(0.025)	(0.025)	(0.026)
rather bad company performance	0.036	0.044*	0.038	0.036	0.046*
	(0.026)	(0.026)	(0.026)	(0.026)	(0.027)
R^2	0.42	0.42	0.41	0.42	0.42
Number of observations	5495	5482	5395	5600	5305

Control variables are: Dummy variable for civil servants, sector dummies, dummies for 6 company size categories, 77 occupation dummies. Employees with low levels of education working in large companies in the services sector are the base category. Heteroscedasticity-consistent standard errors are in parentheses. ***, **, *-indicate significance at the 1, 5, 10 percent level.

5 Conclusions

In this study we analyze whether the use of IT at the workplace and organizational changes are positively related to individual wages taking possible complementarities between IT and OC into account. In addition, the data set allows us to investigate whether wage markups for employees that work in companies that have changed their organization accrue only to those that have been directly affected or to all employees. We use a large individual-level data set that includes information about individual characteristics, workplace characteristics and company characteristics referring to West Germany in 1998-1999.

Our findings suggest that IT users earn about 6 percent higher wages than observably similar IT non-users. We interpret this positive wage effect of IT use not as causal in the sense that only the implementation and use of IT at the workplace increases individual productivity and thus wages. In line with previous research, we rather believe that employees get more productive through their experience they gain with using IT.

Employees working in companies that have changed their management structure or have outsourced part of their production process earn significantly higher wages. Interestingly, this positive wage markup is not related to the fact of whether or not employees had been personally affected by these organizational changes. By contrast, companies that have implemented organizational changes seem to pay higher wages to all of their employees — a result that speaks in favor of wage differentials across rather than within companies. In addition, in terms of wages, we do not find evidence for a complementary relationship between IT and organizational changes.

One might argue that the quantitative importance of the wage effects, about 6 percent for IT usage and 3 percent for organizational changes, are small. In particular, as most studies on IT wage differentials conclude that there are no wage effects of IT usage if they find comparable figures. However, in the light of the fact that unions and employer associations in Germany typically bargain for wage increases of about 4 percent, the sizes of the estimated coefficients should not be disparaged in its importance for employees.

References

Abowd, J., Kramarz, F. and Margolis, D. (1999). High Wage Workers and High Wage Firms, *Econometrica* **67**(2): 251–333.

Acemoglu, D. (1999). Changes in Unemployment and Wage Inequality: An Alternative Theory and some Evidence, *American Economic Review* **89**(5): 1259–1278.

Acemoglu, D. (2002). Technical Change, Inequality, and the Labor Market, *Journal of Economic Literature* **40**: 7–72.

Aghion, P., Caroli, E. and Garcia-Penalosa, C. (1999). Inequality and Economic Growth: The Perspective of the New Growth Theories, *Journal of Economic Literature* **37**: 1615–1660.

Aguirregabiria, V. and Alonso-Borego, C. (2001). Occupational Structure, Technological Innovation, and Reorganization of Production, *Labour Economics* **8**: 43–73.

Akerlof, G. and Yellen, J. (1990). *Efficiency Wage Models of the Labor Market*, Cambridge University Press, Cambridge.

Aoki, M. (1986). Horizontal vs. Vertical Structure of the Firm, *American Economic Review* **76**(5): 971–983.

Appelbaum, E., Bailey, T., Berg, P. and Kalleberg, A. (2000). *Manufacturing Advantage: Why High Performance Work Systems Pay Off*, Cornell University Press, Ithaca, NY.

Autor, D., Levy, F. and Murnane, R. (2003). The Skill Content of Recent Technological Change: An Empirical Exploration, *Quarterly Journal of Economics* **118**(4): 1279–1333.

Bauer, T. and Bender, S. (2001). Flexible Work Systems and the Structure of Wages: Evidence from Matched Employer-Employee Data, *Discussion Paper 353*, IZA.

Becker, G. and Murphy, K. (1992). The Division of Labor, Coordination Costs, and Knowledge, *Quarterly Journal of Economics* **107**(4): 1137–1160.

Bell, B. (1996). Skill-Biased Technical Change and Wages: Evidence from a Longitudinal Data Set, *Technical report*, Nuffield College.

Bellmann, L., Reinberg, A. and Tessaring, M. (1994). Bildungsexpansion, Qualifikationsstruktur und Einkommensverteilung: Eine Analyse mit Daten des Mikrozensus und

der Beschäftigtenstatistik, *in* R. Lüdeke (ed.), *Bildung, Bildungsfinanzierung und Einkommensverteilung*, II. Schriftenreihe des Vereins für Socialpolitik, Gesellschaft für Wirtschafts- und Sozialwissenschaften, Berlin, pp. 13–70.

Bertschek, I. and Kaiser, U. (2004). Productivity Effects of Organizational Change: Microeconometric Evidence, *Management Science* **50**(3): 394–404.

Black, S. and Lynch, L. (2000). What's Driving the New Economy: The Benefits of Workplace Innovation, *Working Paper 7479*, NBER.

Black, S. and Lynch, L. (2001). How to Compete: The Impact of Workplace Practices and Information Technology on Productivity, *Review of Economics and Statistics* **83**(3): 434–445.

Bresnahan, T. (1999). Computerisation and Wage Dispersion: An Analytical Reinterpretation, *Economic Journal* **109**: F390–F415.

Bresnahan, T., Brynjolfsson, E. and Hitt, L. (2002). Information Technology, Workplace Organization, and the Demand for Skilled Labor: Firm Level Evidence, *Quarterly Journal of Economics* **117**(1): 339–376.

Brown, C. and Medoff, J. (1989). The Employer-Size Wage Effect, *Journal of Political Economy* **97**(5): 1027–1059.

Brynjolfsson, E. and Hitt, L. (2000). Beyond Computation: Information Technology, Organizational Transformation and Business Performance, *Journal of Economic Perspectives* **14**(4): 23–48.

Cappelli, P. and Carter, W. (2000). Computers, Work Organization, and Wage Outcomes, *Working Paper 7987*, NBER.

Cappelli, P. and Neumark, D. (2001). Do "High-Performance" Work Practices Improve Establishment-Level Outcomes?, *Industrial and Labor Relations Review* **54**(4): 737–775.

Card, D. (1999). The Causal Effect of Education on Earnings, *in* O. Ashenfelter and D. Card (eds), *Handbook of Labor Economics*, Elsevier Science, Amsterdam, pp. 1801–1863.

Card, D. and DiNardo, J. (2002). Skill Biased Technological Change and Rising Wage Inequality: Some Problems and Puzzels, *Journal of Labor Economics* **20**(4): 733–783.

Caroli, E. and van Reenen, J. (2001). Skill-Biased Organizational Change? Evidence from a Panel of British and French Establishments, *Quarterly Journal of Economics* **116**(4): 1449–1492.

Chennells, L. and van Reenen, J. (2002). Technical change and the structure of employment and wages: A survey of the microeconometric evidence, *in* N. Greenan, Y. L'Horty and J. Mairesse (eds), *Productivity, Inequality and the Digital Economy*, MIT Press, Cambridge, MA, pp. 175–223.

Dickens, W. and Katz, L. (1987). Inter-Industry Wage Differences and Industry Characteristics, *in* K. Lang and J. Leonard (eds), *Unemployment and the Structure of the Labor Market*, Basil Blackwell, New York, pp. 48–89.

DiNardo, J. and Pischke, J. (1997). The Returns to Computer Use Revisited: Have Pencils Changed the Wage Structure Too?, *Quarterly Journal of Economics* **112**: 291–303.

Entorf, H. and Kramarz, F. (1997). Does Unmeasured Ability Explain the Higher Wages of New Technology Workers?, *European Economic Review* **41**: 1489–1509.

Entorf, H. and Kramarz, F. (1998). The Impact of New Technologies on Wages: Lessons from Matching Panels on Employees and on Their Firms, *Economics of Innovation and New Technology* **5**: 165–197.

Eriksson, T. (2003). The Effects of New Work Practices - Evidence from Employer-Employee Data, *in* T. Kato and J. Pliskin (eds), *The Determinants of the Incidence and the Effects of Participatory Organizations*, Advances in the Economic Analysis of Participatory and Labor-Managed Firms Volume 7, Elsevier, New York, pp. 3–30.

Falk, M. and Koebel, B. (2002). Outsourcing, Imports and Labour Demand, *Scandinavian Journal of Economics* **104**(4): 567–586.

Fitzenberger, B. (1999). *Wages and Employment Across Skill Groups*, Vol. 6 of *ZEW Economic Studies*, Physica–Verlag, Heidelberg and New York.

Gibbons, R. and Katz, L. (1992). Does Unmeasured Ability Explain Inter-Industry Differentials, *Review of Economic Studies* **59**(3): 515–535.

Goldin, C. and Katz, L. (1998). The Origins of Technology-Skill Complementarity, *Quarterly Journal of Economics* **113**: 693–732.

Henkel, J. and Kaiser, U. (2002). Fremdvergabe von IT-Dienstleistungen aus personalwirtschaftlicher Sicht, *Discussion Paper 02-11*, ZEW Mannheim.

Heshmati, A. (2003). Productivity Growth, Efficiency and Outsourcing in Manufacturing and Service Industries, *Journal of Economic Surveys* **17**(1): 79–112.

Huselid, M. (1995). The Impact of Human Resource Management Practices on Turnover, Productivity, and Corporate Financial Performance, *Academy of Management Journal* **38**(3): 635–672.

Huselid, M. and Becker, B. (1996). Methodological Issues in Cross-Sectional and Panel Estimates of the Human Resource-Firm Performance Link, *Industrial Relations* **35**(3): 400–422.

Ichniowski, C., Kochan, T., Levine, D., Olson, C. and Strauss, G. (1996). What Works at Work: Overview and Assessment, *Industrial Relations* **35**(3): 299–333.

Ichniowski, C., Shaw, K. and Prennushi, G. (1997). The Effects of Human Resource Management Practices on Productivity: A Study of Steel Finishing Lines, *American Economic Review* **87**: 291–313.

Jacobson, L., LaLonde, R. and Sullivan, D. (1993). Earnings Losses of Displaced Workers, *American Economic Review* **83**(4): 685–709.

Katz, L. and Autor, D. (1999). Changes in the Wage Structure and Earnings Inequality, *in* O. Ashenfelter and D. Card (eds), *Handbook of Labor Economics*, Elsevier Science, Amsterdam, pp. 1463–1555.

Kremer, M. and Maskin, E. (1996). Wage Inequality and Segregation by Skill, *Working Paper 5718*, NBER.

Krueger, A. (1993). How Computer have Changed the Wage Structure: Evidence from Microdata, 1984-1989, *Quarterly Journal of Economics* **108**(1): 33–60.

Krueger, A. and Summers, L. (1987). Reflections on the Inter-Industry Wage Structure, *in* K. Lang and J. Leonard (eds), *Unemployment and the Structure of the Labor Market*, Basil Blackwell, New York, pp. 17–47.

Lamberti, H. (2003). Mit IT-Sourcing zu einer neuen Stufe der Industrialisierung im Bankbetrieb, *Zeitschrift für das gesamte Kreditwesen* **6**: 307–309.

Lindbeck, A. and Snower, D. (1996). Reorganisation of Firms and Labor-Market Inequality, *American Economic Association Papers and Proceedings* **86**: 315–321.

Lindbeck, A. and Snower, D. (2000). Multitask Learning and the Reorganisation of Work: From Taylorsitic to Holistic Organization, *Journal of Labor Economics* **18**(3): 353–376.

Milgrom, P. and Roberts, J. (1990). The Economics of Modern Manufacturing: Technology, Strategy, and Organization, *American Economic Review* **80**(3): 511–528.

Mincer, J. (1974). *Schooling, Experience, and Earnings*, New York.

Osterman, P. (1994). How Common is Workplace Transformation and Who Adopts It?, *Industrial and Labor Relations Review* **47**(2): 173–188.

Osterman, P. (2000). Work Reorganization in an Era of Restructuring: Trends in Diffusion and Effects on Employee Welfare, *Industrial and Labour Relations Review* **53**(2): 179–196.

Piore, M. and Sabel, C. (1984). *The Second Industrial Divide*, Basic Books, New York.

Schmidt, C. and Zimmermann, K. (1991). Work Characteristics, Firm Size and Wages, *Review of Economic Studies* **73**(4): 705–710.

Smith, A. (1776). *The Wealth of Nations*, Modern Library, New York.

Spitz, A. (2004). Are Skill Requirements in the Workplace Rising? Stylized Facts and Evidence on Skill-Biased Technological Change, *Discussion Paper 04-33*, ZEW Mannheim.

Thesmar, D. and Thoenig, M. (2000). Creative Destruction and Firm Organization Choice, *Quarterly Journal of Economics* **115**(4): 1201–1237.

Wolf, E. and Zwick, T. (2002). Reassessing the Impact of High Performance Workplaces, *Discussion Paper 02–07*, ZEW.

Yang, X. and Borland, J. (1991). A Microeconomic Mechanism for Economic Growth, *Journal of Political Economy* **99**(3): 460–482.

Yellen, J. (1984). Efficiency Wage Models of Unemployment, *American Economic Review* **74**(2): 200–205.